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# About the University

## New Jersey Institute of Technology

NJIT's history spans the Industrial Revolution to the Information Age. Newark was a factory town when the tuition-free evening school was founded in 1881 to support local industries. The first 90 students - including machinists, draftsmen, carpenters, printers, electricians and clerks - studied algebra, geometry, trigonometry, chemistry, physics and drawing. The range of courses offered is testimony to the fact that, from the beginning, NJIT’s programs have provided a broad-based foundation to prepare students for success in the workplace and in life. From those early days, science and technology have been the engines fueling the university's development.

Over time, the university both anticipated and responded to change by expanding its curriculum and mission. Most notably, in 1919 the university established baccalaureate programs in three engineering fields. By 1975, NJIT offered a broad range of undergraduate and graduate degrees including architecture, engineering, computer science, management and other science-oriented programs. All of these programs included significant research and public service components with the goal of providing an academic environment that fosters intellectual depth and breadth, as well as social responsibility.

Today, continuing a fourfold mission of instruction, research, economic development and public service, NJIT is among the leading comprehensive polytechnic universities in the nation. With well over 11,000 students, NJIT is the largest technological university in the New York metropolitan region. The university has state-of-the-art facilities with more than 2 million square feet located on a 48-acre campus in Newark, and a solar observatory in Big Bear Lake, California. With robust distance education programs, NJIT's degree and non-degree programs are available throughout the world.

## NJIT Mission Statement

*On July 1, 2015, NJIT introduced its 2020 Vision --A Strategic Plan to chart the university's course for the next five years, to ensure the transformational change envisioned and academic excellence.*

NJIT is the **state’s technological research university**, committed to the **pursuit of excellence** —

- in undergraduate, graduate and continuing professional ***education***, preparing students for productive careers and amplifying their potential for lifelong personal and professional growth
- in the conduct of ***research*** with emphasis on applied, interdisciplinary efforts encompassing architecture and the sciences, including the health sciences, engineering, mathematics, transportation and infrastructure systems, information and communications technologies
- in contributing to ***economic development*** through the state’s largest business incubator system, workforce development, joint ventures with government and the business community, and through the development of intellectual property
- in ***service*** to both its urban environment and the broader society of the state and nation by conducting public policy studies, making educational opportunities widely available and initiating community-building projects.

NJIT **prepares its graduates** for positions of leadership as professionals and as citizens; **provides educational opportunities** for a broadly diverse student body; responds to needs of large and small businesses, state and local governmental agencies and civic organizations; and **advances the uses of technology** as a means of improving the quality of life.

NJIT offers a **comprehensive array of programs** in engineering and engineering technology, computer science, architecture, applied sciences, mathematics, management, policy studies, and related disciplines throughout New Jersey and the nation.

## NJIT's Six Colleges

NJIT's roots are in engineering education. For more than eight decades since 1919, **Newark College of Engineering (NCE)** has been preparing engineering students to use science, mathematics, technology and problem-solving skills to design, construct, test and maintain products, services and information systems. NCE alumni lead major corporations, hold senior public positions, own their own businesses and teach at universities. NCE offers students a practical, hands-on and rigorous engineering education--one that prepares them to succeed professionally.

NJIT’s **New Jersey School of Architecture**, established in 1973, is one of the largest architecture schools in the nation -- nationally recognized for integrating computer technology into its design curriculum. The college’s design curriculum was so successful that in 2008 it changed its name to the **College of Architecture and Design**, now comprised of the **New Jersey School of Architecture** and the **School of Art and Design**.

The **College of Science and Liberal Arts (CSLA)**, established in 1982, is at the forefront of many national research activities from solar astronomy to mathematical modeling. CSLA prepares students for professional and public leadership with essential specialized knowledge and social intelligence, including the foundation for careers in law and medicine. Major fields include: applied physics, biology, chemistry, math, environmental science, communications and other liberal arts.

The **Martin Tuchman School of Management**, established in 1988, combines the best of traditional business disciplines (e.g., finance, marketing, accounting, e-commerce) with the power of STEM (science, technology, engineering and mathematics) to develop professionals who are applications-focused and success driven .

The **Albert Dorman Honors College**, established in 1994, offers one of the nation's leading technologically oriented honors programs for students who are prepared to undertake a rigorous and individualized course of study. Through accelerated programs, community service, study abroad and a range of colloquia, students prepare to be leaders, problem solvers and innovators.

The **Ying Wu College of Computing**, established in 2001, provides advanced interdisciplinary information systems, information technology, and computer science degree programs to students on campus and online. Specialized research includes: networking and computer security, big data analytics, bioengieering , bioinformatics, and game development.

## A Public Research University

NJIT is designated as a “Research Intensive” University by the Carnegie Foundation and ranks among the "best national universities" by *U.S. News and World Report*. The university expends more than $75 million in a panoply of research and development partnerships with industry, government and other universities. NJIT researchers are making important advances in a wide range of areas, including: solar research, nanotechnology, resilient design, tissue engineering and other life sciences, biomedical engineering, cybersecurity, transportation and business management.

As a public research university, NJIT is educating leaders for a technology-driven economy. The university is constantly updating educational programs to emphasize marketplace skills, and redesigning its methods of delivering education. Computing and information technology underpin every facet of the NJIT mission.

## The Digital Campus

As one of America’s most digitally-enabled universities, NJIT is nationally recognized as a pioneer in the use of information technologies from developing complex algorithms to reducing simulation times on large-scale parallel computers, to advancing the frontiers of visualization technology in computer-aided design, to patenting optics-based sensors, to developing computer-based infrastructure management systems, to developing advanced computer-mediated communications systems.

NJIT's Information Services and Technology (IST) division provides members of the university community with universal access to a wealth of resources and services available over the NJIT network and the advantages of a highly computing-intensive environment. EDUCAUSE has recognized the university for streamlining student processes “with creativity, efficiency, and effectiveness worthy of emulation.”

At NJIT, the latest advances in telecommunications and multimedia technologies are used to enhance the delivery of courses and the overall educational experience, allowing students to experience many aspects of a “virtual university” in a traditional campus setting. Computers and information technology play an important role in virtually every task performed on campus, from cutting-edge research to applying for on-campus student employment. Computers assist in teaching and independent study, campus communication, library research, engineering and architectural designs. Students register for classes, check the status of financial aid, run degree audits, ask questions of academic advisors, and pay their bill – all online. Students can access the tools they need to design new buildings, develop complex solutions to engineering problems or compile detailed management analyses – all by logging on to the NJIT network. With connectivity to Internet2, students have the opportunity to work closely with faculty and researchers as new families of advanced applications are developed for an increasingly networked and information-based society.

NJIT’s multi-gigabit network connects more than 6,500 nodes in classrooms, laboratories, residence halls, faculty and staff offices, the library, student organization offices and others. The campus wireless network blankets the university’s public, classroom and outdoor areas. Both networks provide access to a wealth of shared information services. Included among these are high-performance, multiprocessor servers used for simulation and computational research; disk arrays for storage of large data sets; communication servers for computer conferencing and e-learning, and a digital library with access to over 41,000 online journals. A virtual private network combined with Internet access extends access to network services to faculty, staff and students at home, work, any of the university’s extension sites or throughout the world.

Students, faculty, staff, and alumni receive a single university computing ID (UCID) that authenticates them as members of the NJIT community and authorizes them to role-based campus services. Highlander Pipeline, the NJIT portal, is the starting point for most online services. Students have access to hundreds of computer workstations in public-access computer labs across the campus, supplemented by special-purpose departmental facilities. A healthy mix of Windows, Mac, Linux, and other Unix operating environments support the diverse needs of a technological research university. Campus-wide software licenses provide NJIT faculty and students with the latest versions of the most popular Microsoft products, as well as software tools for virus-protection, statistical analysis, mathematical programming, computer-aided design and visualization, and much more. Advanced software libraries support the computational research needs of faculty and students in mathematics, engineering and the sciences.

The Office of Instructional Technology and Media Services provides several facilities used for live and recorded broadcast of e-courses as well as satellite down-links for a wide variety of video conferences and other educational and public service satellite broadcasts. Several interactive television studio classrooms provide distance learning facilities. Multimedia capability is now being deployed to all areas on campus via network-based video technologies.

In addition to these extensive resources, several departments have special facilities for the support of individual academic programs, including the New Jersey School of Architecture's award-winning Imaging Laboratory that provides students an opportunity to explore new media and images that alter the way buildings are visualized, interpreted and created.

NJIT is one of the founding members and administrative home to NJEDge.Net, New Jersey's higher education network. NJEDge.Net provides collaborative resources and networked information services to its members and affiliates in support of education; research and development; outreach and public service; as well as economic development throughout the state of New Jersey. With 102 connected institutions including all of New Jersey's research universities, NJEDge.Net leverages economies of scale and supports new and emerging technology-enabled forms of inter-institutional collaboration among members and affiliates.

## Library Services

The university's Robert W. Van Houten Library is located in a facility for study, researching, and browsing. The library collection comprises 160,000 volumes of books, conference proceedings, reports, dissertations and theses. In addition, the library receives approximately 1,000 current technical journal titles in printed format and provides customized electronic access to over 41,000 journals in electronic format. Access to journal literature in engineering, science, management, architecture, and other subject areas is provided by a variety of indexing and abstracting services.

In Fall 1997 the Van Houten Library opened the Information Commons, which has many workstations with access to the Internet. CompendexWeb, Proquest Direct, EbscoHost, Scifinder Scholar, IEEExplore, the ACM Digital Library and Medline are among the many databases that students, faculty and staff may search. These services may also be accessed remotely.

The library provides individualized reference services, literature searches, and instruction on the use of information resources. In addition, students may supplement NJIT library resources by borrowing material from the Newark Public Library and the libraries of Rutgers University--Newark Campus, the University of Medicine and Dentistry of New Jersey, and the eight state colleges of New Jersey. Interlibrary loan arrangements with more distant institutions are also available.

Included among the library's resources is a small museum containing items developed and manufactured by Edward Weston, a scientist, prolific inventor, and a founding member of the university's Board of Trustees. Dr. Weston's rare book collection is also maintained by the library and is available to scholars and other interested in the history of science and technology.

The Barbara and Leonard Littman Library (http://archlib.njit.edu), a department of the university's Van Houten Library located in the College of Architecture and Design, maintains a core collection of architecture information materials including books, journals, maps, drawings, models and over 70,000 slides.

A team of highly trained information and research assistants, reference and instructional librarians bridge the gaps between research resources and users. They provide ad hoc assistance in person via the Research Helpdesk at the Van Houten Library and the service desk at the Littman Architecture Library, or by phone (973-596-3210 for Van Houten and 973-596-3083 for Littman), email, and instant messaging. More information about the library can be found at www.library.njit.edu (http://www.library.njit.edu).

## Consortium with Rutgers-Newark and Rutgers University Biomedical and Health Sciences (RBHS)

NJIT, Rutgers-Newark and Rutgers University Biomedical and Health Sciences (RBHS), New Jersey's university of the health sciences, offer 10 joint master's or doctoral degree programs, placing them as leaders in development of programs to prepare individuals for a world increasingly multidisciplinary and technological in nature.

The three institutions are partners in University Heights Science Park, designed as a mixed-use, multi-sponsor science and technology park. University Heights Science Park is a partnership among academia, the community, private industry, and local, state and federal governments, which provide opportunities to transfer university-based research and technology to public uses. The 50-acre University Heights Science Park is adjacent to the NJIT campus. Each year, thousands of students from NJIT, Rutgers-Newark and Rutgers University Biomedical and Health Sciences take courses at the institutions. NJIT and Rutgers-Newark cosponsor common seasons of theatrical productions, as well as "World Week," and a variety of other cultural and social activities.

## NJIT Campus

Located in the University Heights section of Newark, NJIT's 48-acre campus is adjacent to the campuses of Rutgers-Newark and Essex County College and a short distance from RBHS. The campus is reached easily via interstate highways and public transportation. New Jersey Transit's City Subway stops on campus, the Pennsylvania Railroad Station is five minutes from campus and Newark International Airport is located within five miles of NJIT. NJIT's campus is only 15 minutes from New York City and about 90 minutes from Philadelphia.

The expansion and improvement of NJIT's campus facilities have been vigorous, proceeding pursuant to a carefully drawn long-range plan, providing an environment conducive to accomplishment of the university's mission.

NJIT is adding to its $1 billion in capital inventory with a $300 million campus-wide building program that is helping transform research, teaching and campus life.  New and renovated facilities, some financed in part by the State of New Jersey Higher Education Capital Facilities Grant Programs, include:

- Central King Building--with state-of-the-art teaching and learning hubs, due in early 2017
- Life Sciences and Engineering Building--a $19 million facility with a primary focus on biomedical engineering, due in fall 2016
- Wellness and Events Center--a $100 million facility that will serve the entire campus and house athletics
- Science and Technology Park Parking Facility--a 7-floor parking facility, due in fall 2016.

NJIT's campus is home to some 20 R&D centers supported with industry, state, federal, foundation and university funding. NJIT's three-story Otto H. York Center for Environmental Engineering and Science houses a number of state and federally funded research centers.

The 187,000-square-foot William S. Guttenberg Information Technologies Center houses the Center for Manufacturing Systems and the Multi-lifecycle Engineering Research Center. The building is the site of the Ying Wu College of Computing and industrial and manufacturing engineering instruction and research facilities.

The Campus Center houses the food court, dining room and a more informal eating facility, The Highlander Cafe. In addition, there is a campus theater in which student productions are staged, an athletic field, tennis courts and indoor recreational facilities, including a swimming pool, racquetball courts, weight rooms, track, aerobics room and more. The residence halls provide dormitory and apartment-style coed living accommodations for some 2000 students.

# Academic Calendar

## Fall Semester 2016

| Month | Day | Day of Week | Description |
|---|---|---|---|
| September | 5 | Monday | Labor Day - No Classes - Administrative Offices Closed |
| September | 6 | Tuesday | First Day of Classes |
| September | 10 | Saturday | Saturday Classes Begin |
| September | 12 | Monday | Last Day to Add/Drop a Class |
| September | 12 | Monday | Last Day for 100% Refund, Full or Partial Withdrawal |
| September | 13 | Tuesday | W Grades Posted for Course Withdrawals |
| September | 19 | Monday | Last Day for 90% Refund, Full or Partial Withdrawal - no refund for partial withdrawal after this date |
| October | 3 | Monday | Last Day for 50% Refund, Full Withdrawal |
| October | 24 | Monday | Last Day for 25% Refund, Full Withdrawal |
| November | 7 | Monday | Last Day to Withdraw |
| November | 22 | Tuesday | Thursday Classes Meet |
| November | 23 | Wednesday | Friday Classes Meet |
| November | 24 | Thursday | Thanksgiving Recess Begins |
| November | 27 | Sunday | Thanksgiving Recess Ends |
| December | 14 | Wednesday | Last Day of Classes |
| December | 15 | Thursday | Reading Day |
| December | 16 | Friday | Final Exams Begin |
| December | 22 | Thursday | Final Exams End |
| January | 3 | Thursday | Final Grades Due |

## Spring Semester 2017

| Month | Day | Day of Week | Description |
|---|---|---|---|
| January | 16 | Monday | Martin Luther King, Jr. Day |
| January | 17 | Tuesday | First Day of Classes |

| | | | |
|---|---|---|---|
| January | 21 | Saturday | Saturday Classes Begin |
| January | 23 | Monday | Last Day to Add/Drop a Class |
| January | 23 | Monday | Last Day for 100% Refund, Full or Partial Withdrawal |
| January | 24 | Tuesday | W Grades Posted for Course Withdrawals |
| January | 30 | Monday | Last Day for 90% Refund, Full or Partial Withdrawal - no refund for partial withdrawal after this date |
| February | 13 | Monday | Last Day for 50% Refund, Full Withdrawal |
| March | 6 | Monday | Last day for 25% Refund, Full Withdrawal |
| March | 12 | Sunday | Spring Recess Begins - No Classes Scheduled - University Open |
| March | 19 | Sunday | Spring Recess Ends |
| March | 27 | Monday | Last Day to Withdraw |
| April | 14 | Friday | Good Friday - No Classes Scheduled - University Closed |
| May | 2 | Tuesday | Friday Classes Meet |
| May | 2 | Tuesday | Last Day of Classes |
| May | 3 | Wednesday | Reading Day |
| May | 4 | Thursday | Reading Day |
| May | 5 | Friday | Final Exams Begin |
| May | 11 | Thursday | Final Exams End |
| May | 16 | Tuesday | Final Grades Due |
| May | TBA | TBA | Commencement |

# Accreditation

New Jersey Institute of Technology is accredited by the Middle States Commission on Higher Education, 3624 Market Street, Philadelphia, PA 19104. (267-284-5000) The Middle States Commission on Higher Education is an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

Most of NJIT's eligible professional programs, both graduate and undergraduate, are accredited by the respective accrediting agency for their field. Addresses and telephone numbers for all of these accrediting agencies are listed below.

Details about the accreditation of specific programs are included in the descriptions of those degrees.

- **ABET**
- **(CAC of ABET)** Computing Accreditation Commission of ABET
- **(EAC of ABET)** Engineering Accreditation Commission of ABET
- **(TAC of ABET)** Technology Accreditation Commission of ABET
- 111 Market Place, Suite 1050
- Baltimore, MD 21202
- Tel. (410) 347-7700
- 
- **AACSB International**
- 777 South Harbour Island Boulevard
- Suite 750
- Tampa, FL  33602-5730
- Tel. (813) 769-6500
- 
- **Middle States Commission on Higher Education**
- 3624 Market Street
- Philadelphia, PA 19104

- Tel. (215) 662-5606
-
- **National Architectural Accrediting Board, Inc. (NAAB)**
- 1735 New York Avenue, NW
- Washington, DC 20006
- Tel. (202) 783-2007

# Directory

**Faculty at NJIT**

## Governing Boards

**Board of Trustees**

The NJIT Board of Trustees (p. 14) is the legal governing body of the university appointed by the governor and confirmed by the state senate.

**Board of Overseers**

The NJIT Board of Overseers (p. 15) serves as the governing body for the Foundation at NJIT and provides a key advisory link with a wide range of organizations in the business community.

**Boards of Visitors**

NJIT A (http://www.njit.edu/about/boards/boardsofvisitors.php)dvisory Boards (p. 17) serve in an advisory capacity to departments and programs, offering guidance on issues ranging from curricular matters to recruitment efforts to marketing activities.

# Board of Trustees

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**Dr. Ned J. Corron**
U.S Army AMCOM

**Mr. Erik Gordon**
Trillium Trading, LLC

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JP Morgan Chase

**Dr. Zahur Islam**
Novartis Pharmaceuticals (http://www.novartis.com)

**Ms. Krystyna J. Monczka**
Hewitt Associates

**Mr. George Quillan**
Prudential Financial (http://www.prudential.com/view/page/public)

**Dr. Richard Silberglitt**
Rand Corporation (http://www.rand.org)

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Modus Quantitative Advisors

**Dr. Benjamin White**
Exxon Research & Engineering (http://www.exxon.com/USA-English/GFM/default.aspx)

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# Research Centers and Labs

NJIT's research program focuses on applied research in the most promising of emerging technologies, with emphasis on technology transfer and commercialization. Research at NJIT is organized around multi-disciplinary centers of excellence that encourage partnerships among various disciplines, as well as with other educational institutions, private enterprise and government agencies.

## Research Centers in Life Sciences and Engineering

- **Center for Injury Biomechanics, Materials and Medicine: Experiments and modeling of blast and blunt Traumatic Brain Injury (TBI).**
- **Center for Membrane Technologies**: Micro- and nanoporous filters for medicine and pharmaceutical manufacture.
- **Engineering Research Center for Structured Organic Particles:** (http://www.ercforsops.org) Particle technology to improve the way pharmaceuticals, foods and agriculture products are manufactured.
- **Rehabilitation Engineering Research Center**: Neurorehabilitation and robotics; virtual reality rehabilitation.

## Research Laboratories in Life Sciences and Engineering

- **Neural Interface Laboratory:** (http://web.njit.edu/~sahin) Interfaces with the central nervous system to record volitional control signals and micro-stimulate the spinal cord to improve the motor function after injury.
- **Stem Cells and Tissue Engineering Lab:** (http://web.njit.edu/~cho) Natural biopolymer, micropatterning techniques.
- **Swarm Lab**: Mechanisms underlying the coordination of large animal groups.
- **Tissue Models Lab:** (http://www.tissuemodels.net) Cell and tissue biology based on the use of micro- and nanotechnologies.
- **The Vision and Neural Engineering Lab** (http://web.njit.edu/~alvarez)**:** Oculomotor dynamics, vergeance eye movements.

## Research Centers on Sustainable Systems and Manufacturing

- **Center for Building Knowledge:** (http://centers.njit.edu/cbk) Educational facilities, health care and aging environments, developmental disabilities planning, historic preservation, housing and community development.

- **Center for Natural Resources Development and Protection**: Field, analytic and computational studies of techniques for dealing with coastal pollution and stormwater management.
- **Center for Resilient Design:** (http://centerforresilientdesign.org) Ready-to-build designs and expertise for smarter, more sustainable designs in areas affected by natural and man-made disasters.
- **Center for Manufacturing Systems**: Advanced technology center with a dual mission of providing manufacturing support for university research programs and offering design and manufacturing expertise to small and mid-size companies.
- **Membrane Science, Engineering and Technology (MAST) Center**: Development of specialized membrane technology for Energy Production, Water Treatment, Pharmaceutical Purification and Chemical Processing.
- **Microelectronics Fabrication Center**: Application-specific integrated circuits, optical switches, pressure sensors, and MEMS for biomedical, biometrics, and microfluidics application.
- **New Jersey Center for Engineered Particulates**: Tailored particle coatings for pharmaceuticals, food, cosmetics, ceramics, defense, electronics and specialty chemicals.
- **New Jersey Homeland Security Technology Systems Center**:Technologies to deter or respond to the threat or terrorist attacks
- **York Center for Environmental Engineering and Science**: Hazardous substance management, pollution remediation and prevention, sustainable manufacturing.

## Research Laboratories on Sustainable Systems and Manufacturing

- **Imaging Laboratory** (http://design.njit.edu/forstudents/computing.php)**:** Computer-aided design in architecture.
- **Laboratory for Process and Field Analytical Chemistry:** On-line process analysis, environmental monitoring, portable instruments for on-sire environmental measurement.
- **W.M. Keck Laboratory**: Manipulation of liquid flows and the small particles/microorganisms they transport in biological and biomedical technologies.

## Research Centers in Data Science and Information Technologies

- **Center for Solar Terrestrial Research:** Solar optical astronomy, solar radiophysics, terrestrial science.
- **Center for Wireless Communications and Signal Processing Research:** (http://cwcspr.njit.edu) Multi-carrier systems, Turbo Coding techniques, ultra-wideband communications, MIMO systems.
- **Cybersecurity Research Center** seeks to address ongoing and long-term future needs to research new methods for understanding how these systems can be compromised and fail, how to design cyber systems so they are secure, and how to improve or fix the cyber infrastructure that has already been deployed
- **Leir Center for Financial Bubble Research:** (http://www.leirbubblecenter.org) Quantitative and qualitative research to determine how a financial bubble can be identified including its stages of development and what policies can best manage its impacts.
- **LIXIN-NJIT Economic Risk Early Warning Center** (http://centers.njit.edu/lixin): Methodologies of early warming for studying macroeconomic risk; industry risk identification and early warning; bank liquidity risk warning index system; bank credit risk and internal credit rating.
- **New Jersey Health Information Technology Extension Center** (http://www.njhitec.org): Meaningful use of electronic health records.
- **Structural Analysis of Biomedical Ontologies Center:** (http://cs.njit.edu/~oohvr/SABOC) Medical terminologies and ontologies.

## Research Laboratories in Data Science and Information Technologies

- **Advanced Networking Laboratory** Engages in research to improve the performance, dependability, and trustworthiness of telecommunications networks.
- **Data and Knowledge Engineering Laboratory:** Data mining, bioinformations, computational biology.
- **electronic Arts Habitat (eArtH):** Multimedia, social computing, human-computer interaction.

## Research Centers in Trans-disciplinary Areas

- **Center for Applied Mathematics and Statistics: Mathematical biology, fluid dynamics, wave propagation.**
- **Intelligent Transportation System Resource Center:** (http://transportation.njit.edu/NCTIP/research/ResRep.asp?status=Ongoing&projectNo=210&grantNumber=0) To assist NJDOT in developing and implementing a comprehensive ITS management strategy.
- **National Center for Transportation and Industrial Productivity** (http://transportation.njit.edu/nctip)**:** Freight movement at domestic and international gateways, global competitiveness, intermodal passenger and freight transportation systems.
- **North Jersey Transportation Planning Authority:** (http://www.njtpa.org) Maintaining and improving transportation systems.

- **Transportation, Economic and Land Use System (TELUS)** (http://www.telus-national.org): Computerized transportation planning and programming.

## Small Business and Entrepreneurship

- **Enterprise Development Center** (http://www.njit-edc.org)**: EDC companies have access to NJIT facilities and can partner with researchers to help grow their business.**
- **New Jersey Innovation Acceleration Center** (http://centers.njit.edu/njiac)**: Student, faculty and community based entrepreneurs access to training and other resources.**
- **NJIT Procurement Technical Assistance Center (PTAC)** provides contractual and technical assistance to small-established New Jersey businesses, who are interested in marketing their products, services to federal, state and local government agencies.  The center operates under a cost sharing cooperative agreement between Department of Defense and New Jersey Institute of Technology.
- **ManufactureNJ (MNJ):** is one of several New Jersey Talent Networks each of whose focus is on the specific needs of other key industries including:  Financial Services; Health Care; Transportation, Logistics, and Distribution' Life Sciences; Hospitality and Retail; and Technology and Entrepreneurship.

# Programs

| College | Department | Degree Level | Discipline | Special Degree Options |
|---|---|---|---|---|
| SL | Mathematics | Master's | Applied Mathematics - M.S. (p. 784) | |
| SL | Mathematics | Bachelor's | Applied Mathematics and Applied Physics - B.S. | Double Major (p. 405) |
| SL | Physics | Bachelor's | Applied Physics - B.S. (p. 422) | |
| SL | Physics | Bachelor's | Applied Physics - B.S./M.D. | Accelerated (p. 420) |
| SL | Physics | Master's | Applied Physics - M.S. (p. 800) | |
| SL | Physics | Doctoral | Applied Physics - Ph.D. (p. 809) | |
| SL | Mathematics | Master's | Applied Statistics - M.S. (p. 786) | |
| AD | Architecture | Master's | Architecture (professional or post-professional) - M.Arch. and Civil Engineering - M.S. | Double Major (p. 642) |
| AD | Architecture | Master's | Architecture (professional or post-professional) - M.Arch. and Infrastructure Planning - M.I.P. | Double Major (p. 646) |
| AD | Architecture | Master's | Architecture (professional or post-professional) - M.Arch. and Management - M.S. | Double Major (p. 645) |
| AD | Architecture | Bachelor's | Architecture - B.Arch. (p. 144) | |
| AD | Architecture | Bachelor's | Architecture - B.Arch. and Civil Engineering - M.S. | B.S./M.S. (p. 156) |
| AD | Architecture | Bachelor's | Architecture - B.Arch. and Infrastructure Planning - M.I.P. | B.S./M.S. (p. 152) |
| AD | Architecture | Bachelor's | Architecture - B.Arch. and Management - M.S. | B.S./M.S. (p. 160) |
| AD | Architecture | Bachelor's | Architecture - B.Arch. and Technology - M.B.A. | B.S./M.S. (p. 148) |
| AD | Architecture | Bachelor's | Architecture - B.S. (p. 131) | |
| AD | Architecture | Bachelor's | Architecture - B.S. and Civil Engineering - M.S. | B.S./M.S. (p. 138) |
| AD | Architecture | Bachelor's | Architecture - B.S. and Infrastructure Planning - M.I.P. | B.S./M.S. (p. 136) |
| AD | Architecture | Bachelor's | Architecture - B.S. and Management - M.S. | B.S./M.S. (p. 141) |
| AD | Architecture | Bachelor's | Architecture - B.S. and Technology - M.B.A. | B.S./M.S. (p. 133) |
| AD | Architecture | Master's | Architecture - M.Arch. (p. 641) | |
| AD | Architecture | Master's | Architecture - M.S. (p. 641) | |
| SL | Chemistry & Environmental Sci. | Bachelor's | BioChemistry - B.S. (p. 306) | |
| SL | Mathematics | Master's | BioStatistics - M.S. (p. 788) | |
| CC | Computer Science | Bachelor's | Bioinformatics - B.S. (p. 203) | |
| CC | Computer Science | Master's | Bioinformatics - M.S. (p. 674) | |
| CC | Computer Science | Bachelor's | Bioinformatics for Honors Premed Students - Accelerated B.S. | Accelerated (p. 200) |
| SL | Biology | Bachelor's | Biology - B.A.<br>• Cell Biology<br>• Ecology and Evolution<br>• Neurobiology | |
| SL | Biology | Bachelor's | Biology - B.A./M.D., D.M.D., D.D.S., O.D. | Accelerated |
| SL | Biology | Bachelor's | Biology - B.A./Physical Therapy Ph.D. | Accelerated |
| SL | Biology | Bachelor's | Biology - B.A./Physician Assistant | Accelerated (p. 292) |
| SL | Biology | Bachelor's | Biology - B.S. | |
| SL | Biology | Master's | Biology - M.S. (p. 737) | |
| SL | Biology | Doctoral | Biology - Ph.D. (p. 738) | |
| SL | Biology | Bachelor's | Biology and Chemistry - B.S. | Double Major (p. 295) |
| SL | Mathematics | Bachelor's | Biology and Mathematical Sciences - B.S. | Double Major (p. 406) |
| EN | Bio-Medical Engineering | Bachelor's | Biomedical Engineering - Accelerated B.S. | Accelerated, Accelerated (p. 463) |
| EN | Bio-Medical Engineering | Bachelor's | Biomedical Engineering - B.S. (p. 465) | |
| EN | Bio-Medical Engineering | Master's | Biomedical Engineering - M.S. (p. 864) | |

| College | Department | Degree Level | Discipline | Special Degree Options |
|---|---|---|---|---|
| EN | Bio-Medical Engineering | Doctoral | Biomedical Engineering - Ph.D. (p. 865) | |
| EN | Chemi, Biologic & Pharama Engr | Master's | Biopharmaceutical Engineering - M.S. (p. 875) | |
| SL | Physics | Bachelor's | Biophysics - B.S. (p. 425) | |
| CC | Information Systems | Bachelor's | Business & Information Systems - B.S. (p. 221) | |
| CC | Information Systems | Master's | Business & Information Systems - M.S. (p. 694) | |
| SM | Management | Bachelor's | Business - B.S. (p. 571)<br>• Accounting (p. 573)<br>• Finance (p. 573)<br>• Innovation and Entrepeneurship (p. 574)<br>• International Business (p. 574)<br>• Management Information Systems (p. 574)<br>• Marketing (p. 574) | |
| SM | Management | Doctoral | Business Data Science - Ph.D. | |
| EN | Chemi, Biologic & Pharama Engr | Bachelor's | Chemical Engineering - B.S. (p. 475) | |
| EN | Chemi, Biologic & Pharama Engr | Master's | Chemical Engineering - M.S. (p. 879) | |
| EN | Chemi, Biologic & Pharama Engr | Doctoral | Chemical Engineering - Ph.D. (p. 886) | |
| SL | Chemistry & Environmental Sci. | Bachelor's | Chemistry - B.S. (p. 311) | |
| SL | Chemistry & Environmental Sci. | Bachelor's | Chemistry - B.S. for Pre-Professional Students | Accelerated (p. 304) |
| SL | Chemistry & Environmental Sci. | Master's | Chemistry - M.S. (p. 753) | |
| SL | Chemistry & Environmental Sci. | Doctoral | Chemistry - Ph.D. (p. 758) | |
| EN | Civil & Environmental Engr | Bachelor's | Civil Engineering - B.S. (p. 482) | |
| EN | Civil & Environmental Engr | Master's | Civil Engineering - M.S. (p. 901) | |
| EN | Civil & Environmental Engr | Doctoral | Civil Engineering - Ph.D. (p. 920) | |
| SL | Humanities | Bachelor's | Communication and Media - B.A. (p. 367) | |
| SL | Humanities | Bachelor's | Communication and Media - B.A./J.D. | Accelerated (p. 370) |
| SL | Humanities | Bachelor's | Communication and Media - B.S. (p. 375) | |
| SL | Humanities | Bachelor's | Communication and Media - B.S./J.D. | Accelerated (p. 358) |
| SL | Humanities | Bachelor's | Communication and Media - B.S./Medicine, Dentistry, Physical Therapy and Optometry | Accelerated (p. 361) |
| SL | Mathematics | Master's | Computational Biology - M.S. (p. 788) | |
| EN | Electrical & Computer Engr. | Bachelor's | Computer Engineering - B.S. (p. 492) | |
| EN | Electrical & Computer Engr. | Master's | Computer Engineering - M.S. (p. 934) | |
| EN | Electrical & Computer Engr. | Doctoral | Computer Engineering - Ph.D. (p. 956) | |
| CC | Computer Science | Bachelor's | Computer Science - B.A. (p. 201) | |
| CC | Computer Science | Bachelor's | Computer Science - B.S. (p. 205) | |
| CC | Computer Science | Master's | Computer Science - M.S. (p. 675) | |
| CC | Computer Science | Bachelor's | Computer Science and Applied Physics - B.S. | Double Major (p. 207) |
| CC | Computer Science | Bachelor's | Computer Science and Mathematical Sciences, Applied Mathematics - B.S. | Double Major (p. 209) |

| College | Department | Degree Level | Discipline | Special Degree Options |
|---|---|---|---|---|
| CC | Computer Science | Bachelor's | Computer Science and Mathematical Sciences, Computational Mathematics - B.S. | Double Major |
| CC | Computer Science | Doctoral | Computing Sciences - Ph.D. (p. 684) | |
| CC | Computer Science | Bachelor's | Computing and Business - B.S. (p. 210) | |
| CC | Computer Science | Master's | Computing and Business - M.S. (p. 679) | |
| EN | Engineering Technology | Bachelor's | Concrete Industry Management - B.S. (p. 515) | |
| EN | Civil & Environmental Engr | Master's | Critical Infrastructure Systems - M.S. (p. 909) | |
| CC | Computer Science | Master's | Cyber Security and Privacy - M.S. (p. 680) | |
| AD | School of Art & Design | Bachelor's | Digital Design - B.A. (p. 171) | |
| EN | Electrical & Computer Engr. | Bachelor's | Electrical Engineering - B.S. (p. 495) | |
| EN | Electrical & Computer Engr. | Master's | Electrical Engineering - M.S. (p. 936) | |
| EN | Electrical & Computer Engr. | Doctoral | Electrical Engineering - Ph.D. (p. 957) | |
| CC | Information Systems | Master's | Emergency Management and Business Continuity - M.S. | |
| EN | Mechanical & Industrial Engr | Master's | Engineering Management - M.S. (p. 972) | |
| EN | Office of the Dean (NCE) | Bachelor's | Engineering Science - B.S. (p. 556) | |
| EN | Bio-Medical Engineering | Bachelor's | Engineering Science, Biomedical Pre-Health - B.S. | Accelerated |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Computer Technology - B.S. (p. 510) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Construction Engineering Technology - B.S. (p. 518) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Construction Management Technology - B.S. (p. 521) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Electrical and Computer Engineering Technology - B.S. (p. 524) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Manufacturing Engineering Technology - B.S. | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Mechanical Engineering Technology - B.S. (p. 528) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Medical Informatics Technology - B.S. (p. 531) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Surveying Engineering Technology - B.S. (p. 533) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Technology Education - B.S. (p. 536) | |
| EN | Engineering Technology | Bachelor's | Engineering Technology, Telecommunications Management Technology - B.S. (p. 539) | |
| EN | Civil & Environmental Engr | Master's | Environmental Engineering - M.S. (p. 910) | |
| EN | Civil & Environmental Engr | Doctoral | Environmental Engineering - Ph.D. (p. 921) | |
| SL | Chemistry & Environmental Sci. | Bachelor's | Environmental Science - B.S. (p. 312) | |
| SL | Chemistry & Environmental Sci. | Master's | Environmental Science - M.S. (p. 754) | |
| SL | Chemistry & Environmental Sci. | Doctoral | Environmental Science - Ph.D. (p. 760) | |

| College | Department | Degree Level | Discipline | Special Degree Options |
|---|---|---|---|---|
| SL | Chemistry & Environmental Sci. | Master's | Environmental and Sustainability Policy - M.S. (p. 756) | |
| EN | Mechanical & Industrial Engr | Master's | Healthcare Systems Management - M.S. (p. 974) | |
| SL | History | Bachelor's | History - B.A. (p. 327) | |
| SL | History | Bachelor's | History - B.A./D.P.T. | Accelerated (p. 323) |
| SL | History | Bachelor's | History - B.A./J.D. | Accelerated (p. 325) |
| SL | History | Bachelor's | History - B.A./M.D., D.M.D., D.D.S., O.D. | Accelerated (p. 325) |
| SL | History | Master's | History - M.S. | |
| CC | Information Systems | Bachelor's | Human-Computer Interaction - B.S. (p. 224) | |
| AD | School of Art & Design | Bachelor's | Industrial Design - B.S. (p. 179) | |
| EN | Mechanical & Industrial Engr | Bachelor's | Industrial Engineering - B.S. (p. 550) | |
| EN | Mechanical & Industrial Engr | Master's | Industrial Engineering - M.S. (p. 976) | |
| EN | Mechanical & Industrial Engr | Doctoral | Industrial Engineering - Ph.D. (p. 986) | |
| CC | Information Systems | Bachelor's | Information Systems - B.A. (p. 217) | |
| CC | Information Systems | Master's | Information Systems - M.S. (p. 701) | |
| CC | Information Systems | Doctoral | Information Systems - Ph.D. (p. 704) | |
| CC | Information Technology | Bachelor's | Information Technology - Accelerated B.S. and J.D. | Accelerated (p. 238) |
| CC | Information Technology | Bachelor's | Information Technology - B.S. (p. 238) | |
| CC | Information Technology | Master's | Information Technology and Administration Security - M.S. (p. 708) | |
| AD | Architecture | Master's | Infrastructure Planning - M.I.P. (p. 647) | |
| AD | School of Art & Design | Bachelor's | Interior Design - B.A. (p. 176) | |
| SM | Management | Master's | International Business - M.S. (p. 1003) | |
| EN | Electrical & Computer Engr. | Master's | Internet Engineering - M.S. (p. 949) | |
| SL | History | Bachelor's | Law, Technology and Culture - B.A. (p. 329) | |
| SM | Management | Master's | Management - M.S. (p. 1003) | |
| SM | Management | Master's | Management of Technology - E.M.B.A. (p. 1000) | |
| SM | Management | Master's | Management of Technology - M.B.A. (p. 1001) | |
| EN | Mechanical & Industrial Engr | Master's | Manufacturing Systems Engineering - M.S. (p. 978) | |
| SL | Physics | Doctoral | Materials Science and Engineering - Ph.D. (p. 810) | |
| SL | Mathematics | Bachelor's | Mathematical Sciences - B.S.<br>• Mathematical Biology (p. 401)<br>• Mathematics of Finance and Actuarial Science (p. 403)<br>• Applied Mathematics (p. 408)<br>• Applied Statistics and Data Analysis (p. 410)<br>• Computational Mathematics (p. 412) | |
| SL | Mathematics | Bachelor's | Mathematical Sciences - B.S./M.D. | Accelerated (p. 398) |
| SL | Mathematics | Bachelor's | Mathematical Sciences - B.S./M.D., D.M.D., D.D.S., O.D. | Accelerated (p. 399) |
| SL | Mathematics | Doctoral | Mathematical Sciences - Ph.D. (p. 791) | |
| SL | Mathematics | Master's | Mathematical and Computational Finance - M.S. (p. 790) | |
| EN | Mechanical & Industrial Engr | Bachelor's | Mechanical Engineering - B.S. (p. 552) | |

| College | Department | Degree Level | Discipline | Special Degree Options |
|---|---|---|---|---|
| EN | Mechanical & Industrial Engr | Master's | Mechanical Engineering - M.S. (p. 981) | |
| EN | Mechanical & Industrial Engr | Doctoral | Mechanical Engineering - Ph.D. (p. 988) | |
| EN | Mechanical & Industrial Engr | Master's | Occupational Safety and Health Engineering - M.S. (p. 983) | |
| SL | History | Bachelor's | Patent Law, Technology and Culture - B.A. (p. 332) | |
| SL | Chemistry & Environmental Sci. | Master's | Pharmaceutical Chemistry - M.S. (p. 757) | |
| EN | Chemi, Biologic & Pharama Engr | Master's | Pharmaceutical Engineering - M.S. (p. 880) | |
| EN | Mechanical & Industrial Engr | Master's | Pharmaceutical Systems Management - M.S. (p. 985) | |
| EN | Electrical & Computer Engr. | Master's | Power and Energy Systems - M.S. (p. 952) | |
| SL | History | Bachelor's | Pre-Law - B.A./J.D. | Accelerated (p. 327) |
| SL | Humanities | Master's | Professional and Technical Communication - M.S. (p. 773) | |
| SL | Humanities | Bachelor's | Science, Technology & Society - B.S./J.D. | Accelerated (p. 381) |
| SL | Humanities | Bachelor's | Science, Technology & Society - B.S./M.D., D.D.S., O.D. | Accelerated (p. 364) |
| CC | Information Systems | Bachelor's | Science, Technology and Society/Business and Information Systems - B.S. | Double Major (p. 227) |
| SL | Humanities | Bachelor's | Science, Technology, & Society - B.S. (p. 384) | |
| CC | Computer Science | Master's | Software Engineering - M.S. (p. 683) | |
| EN | Electrical & Computer Engr. | Master's | Telecommunications - M.S. (p. 953) | |
| SL | Humanities | Bachelor's | Theatre Arts and Technology - B.A. (p. 372) | |
| EN | Civil & Environmental Engr | Master's | Transportation - M.S. (p. 912) | |
| EN | Civil & Environmental Engr | Doctoral | Transportation - Ph.D. (p. 922) | |
| AD | Architecture | Doctoral | Urban Systems - Ph.D. (p. 648) | |
| CC | Information Systems | Bachelor's | Web & Information Systems - B.S. (p. 230) | |

# Undergraduate Catalog

NJIT offers 126 degree programs (http://www.njit.edu/education/degreeprograms) through six professional schools and colleges. You can double major, design an interdisciplinary major, opt for an accelerated bachelor's or master's degree program, and cross-register at nearby schools such as Rutgers University–Newark (http://www.newark.rutgers.edu).

# Academic Policies and Procedures

## Registration

NJIT has an advance self-registration system that obligates all students currently enrolled in undergraduate degree programs to register in advance for their courses. Registration is required each semester for courses offered in the next academic session (fall, winter, spring, summer). Students are advised according to the curriculum for their major, as outlined in the degree program listing in the undergraduate catalog. Students are required to meet with their academic advisor prior to registration; an advisor hold on registration will be removed with advisor authorization only.

All students register online via Highlander (http://my.njit.edu) Pipeline (http://my.njit.edu). An approved registration guarantees class seats until the first class meeting. Students who do not attend the first class meeting may lose their place in class.

The office of the registrar is located in the Student Mall, on the ground floor of the parking facility. During the Fall and Spring semesters, the office is open Monday, Tuesday, Thursday, and Friday from 8:30 am to 4:30 pm and Wednesday, 8:30 am to 6:00 pm.

### Currently Enrolled Students

Currently enrolled students are informed of registration procedures via their NJIT email account for the fall and spring semesters by the Office of the Registrar during March and October respectively, and must then register during the advance registration period. Instructions for the summer session are provided with the fall registration materials.

### New and Readmitted Students

The Office of University Admissions informs prospective and readmitted students of registration procedures.

### Non-Matriculated Students

Non-matriculated students should contact the Office of University Admissions for details of admission and registration procedures at least one month before the date of intended enrollment. Extension and distance learning students should contact the Division of Continuing and Professional Education.

### Auditing a Course

Students who wish to audit a course must state their intention to do so at the time of registration. Change in auditing status is not permitted once a semester has begun. Students who audit are required to pay full tuition and fees for the course. Audited courses are not counted in determining full-time status. Students on probation are not permitted to audit.

### Undergraduate Registration in Graduate Courses

Undergraduate students who wish to take 500- or 600-level courses must obtain the written approval of the graduate advisor for the program that offers the course, their undergraduate advisor and submit an "Approval for Undergraduates Taking Graduate Courses (http://www.njit.edu/registrar/forms)" form. If undergraduates wish to take 600-level courses, they must also obtain written approval from the chairperson of the department offering the course. Undergraduates are not permitted to take 700-level courses.

The undergraduate and academic advisor will review the student's academic record prior to approval. Approval can be granted only to students who have completed the appropriate prerequisites for the course and are in satisfactory academic standing. The approval will be noted on an "Approval for Undergraduates Taking Graduate Courses (http://www.njit.edu/registrar/forms)" form that requires appropriate signatures and reports the student's cumulative undergraduate GPA. Students shall have a cumulative undergraduate GPA of 2.5 to be approved for registration in 500-level courses (500G for Architecture) and 2.8 for registration in 600-level courses.

Students whose undergraduate GPA is below the 2.5 or 2.8 minima, are considering courses out of the student's current major, are lacking appropriate prerequisites, have completed any prior graduate courses with a grade below a B, or have already completed 9 or more credits at the 500 level and above (15 credits for those in the B.S./M.S. program), or have an excessive number of credits for the undergraduate degree will also require review by the associate provost of graduate studies and the program advisors.

Undergraduate students who enroll in graduate courses for undergraduate credit pay tuition at the undergraduate rate. Grades will follow the graduate grading system.

Undergraduate students should be aware that need-based financial aid may not be sustainable for registration in graduate courses.

## Course Additions and Schedule Changes

Students who add a course to their program will be charged the full tuition and fee for the course added. All schedule changes are completed via ***Highlander Pipeline.***

Courses cannot be added after the fifth day of the semester. Students cannot receive credit for courses if they are not registered. Attendance in a class without proper registration for that class is not permitted.

## Withdrawal from Courses

Students who wish to withdraw from courses should first determine if the withdrawal would have an impact on full-time status, financial support, or academic standing and progress. They should consult their advisor in advance.

Students wishing to withdraw from courses may do so without academic penalty by the end of the ninth week of the semester only via ***Highlander Pipeline***. Failure to do so will result in grades other than W.

Discontinued attendance or verbal approval to withdraw alone will not result in a W and most likely will instead result in an undesirable final grade.

## Withdrawal from NJIT

Students wishing to withdraw entirely from the university may do so without penalty by the end of the ninth week of the semester via ***Highlander Pipeline***. Failure to do so will result in grades other than W.

## Continuity of Registration

A student must register each fall and spring semester continuously from the semester in which first registered until the semester in which graduated. Students who are voluntarily not taking classes or who have been granted a leave of absence will comply with this requirement by registering for "maintaining registration". Students who allow their registration to lapse will have to apply for readmission on the same basis as new students, can be readmitted only with the consent of their department, and the university is under no obligation to readmit them. Students who are in academic suspension are an exception to this rule, and are governed by the policy on reinstatement after academic suspension.

## Maintenance of Registration

Students enrolled in a degree program who find it necessary to temporarily discontinue their studies are permitted to maintain registration for a fee each semester they do not register. International students on F-1 and J-1 visa status may not maintain registration unless they have obtained prior written permission from the Office of International Students and the Office of Graduate Studies.

Students who maintain registration are emailed registration notices for the following semester and are not required to reapply for admission. To maintain registration, students must register for "Maintaining Registration" via ***Highlander Pipeline***.

Each semester, in which registration is maintained, is counted in the total time period allotted to complete degree requirements except for students with an approved leave of absence.

## Responsibility for Registration

NJIT emails notices in advance to NJIT student email accounts. RStudents are expected to obtain all necessary information and comply with all registration procedures on time. New international students are only permitted to register after attending the required international student orientation program. Students who receive financial support must be in attendance at NJIT.

## Course Cancellations

Courses listed in this catalog are offered at the discretion of each offering department. When there is inadequate registration for a course, it may be cancelled without notice. The registrar or academic department will attempt to notify all students of course cancellations before the first meeting of the semester.

## Room Changes

Room and laboratory changes are noted in the online schedule maintained by the registrar via ***Highlander Pipeline***.

# Curriculum Change Procedure

If a curriculum is revised after a student has been admitted, the student has the option of pursuing the revised curriculum or the curriculum in place at the time of admission. The decision to follow the revised curriculum must be made no later than the end of the academic year in which the revised curriculum becomes operative.

Academic departments which are implementing curriculum changes should notify all students who will be affected by the changes to outline/explain these changes. Notification should be multi-faceted (i.e., letters, announcements on homepages, meetings with groups of students, announcements in class) to ensure wide dissemination of information. Bridge courses may be developed to facilitate a student’s switching to a revised curriculum.

Final Exam Conflict Policy

In the event that three final exams are scheduled on the same day or that two exams are scheduled for the same hour of the same day, the following rules shall be used to resolve such conflicts:

**Rule 1.** Final examinations of courses with multiple sections taking a common final examination shall be taken during their regularly scheduled period.

If the conflict is not completely resolved by Rule No.1, then Rule No.2 shall be used to resolve the remaining conflict.

**Rule 2.** The final examination for a course of higher numerical value shall be taken during the regularly scheduled period. (e.g. ME 470 Engineering Properties of Plastics will be taken before ME 455 Automatic Controls or HIST 351 Ancient Greece and the Persian Empire).

If the conflict is still not completely resolved by Rules No.1 and 2, Rule No.3 shall be used to resolve the remaining conflict.

**Rule 3.** The final examinations of courses with the same numerical value (e.g. CE 210 Construction Materials and Procedures and STS 210 General Psychology) shall be taken in alphabetical order of the prefix of the course number (e.g. CE 210 Construction Materials and Procedures during its regularly scheduled period and EE during some other period which is mutually convenient).

Once priority has been determined for the examination to be taken during its regularly scheduled period, the deferred examination may be taken during the conflict period at the end of all other examinations, with an evening section of the course, or by special arrangement between the instructor and the student; if that arrangement does not create another conflict for the student.

# Credit For Courses Not Taken At NJIT

## Registration at Another College

Students in good standing at NJIT wishing to take courses at a college or university[1] other than those included in the cross-registration program must:

1. Obtain an Approval for Courses at other Colleges Form (http://www.njit.edu/registrar/forms) from the Registrar's office.
2. Obtain approval from the NJIT department giving the comparable course prior to enrolling in the course. Be prepared to show the department advisor a catalog description of the course(s) you intend to take.
3. Have the form countersigned by the registrar and your home department retain one copy. Registrar will retain original and send a copy to the NJIT department involved.
4. Take the copy to host college and follow their registration procedure.
5. Upon completion of the course(s), arrange to have an official transcript sent from the host college to the NJIT Registrar. Upon receipt, transfer credit will be posted to your NJIT transcript provided the grade earned is a "C" or higher.
6. Courses completed at another college other than "cross-registered courses" will not be factored in the calculation of the NJIT semester but they may apply to the NJIT Undergraduate Course Repetition Policy.
7. Summer classes may be taken at Rutgers-Newark or Essex County College only if the course(s) is (are) not offered at NJIT during the summer.
8. Calculus I and II (equivalents of MATH 111 Calculus I, MATH 112 Calculus II, MATH 113 Finite Mathematics and Calculus I and MATH 114 Finite Mathematics and Calculus II) may be taken in the summer at other colleges/universities where the duration of the summer course is eight (8) weeks or more.
9. Physics I and II (equivalents of PHYS 111 Physics I and PHYS 121 Physics II) may be taken in the summer at other colleges/universities where the duration of the summer courses is six (6) weeks or more.
10. Throughout a student's academic career at NJIT, a maximum of two (2) humanities or social science GUR-equivalent courses may be taken at other colleges/universities during the summer. However, the capstone seminar in humanities and social science must be taken at NJIT.

Approval for Undergraduate Courses at Another School (http://www.njit.edu/registrar/forms/ugapprv.pdf)

[1] Exclusive of cross-registration at Rutgers-Newark College of Arts and Sciences, Essex County College, RBHS.

# Cross-Registration Procedure

Matriculated NJIT students may cross-register for courses at Rutgers-Newark College of Arts and Sciences, Essex County College and at the Rutgers Biomedical and Health Sciences (RBHS). Eligible students who wish to do so should follow current procedures as described on the Registrar's website (http://www.njit.edu/registrar).

## Summer Students

The above procedure applies only to fall and spring undergraduate courses. For summer courses, a form entitled "Permission to Take Courses at Other Colleges (http://www.njit.edu/registrar/forms)" must be processed through the registrar's office and the student must pay the applicable tuition and fees to the host school.

## Cross-Registration Rutgers Students

Rutgers students cross-registering for courses at NJIT must be matriculated in a degree-granting program on the Newark campus.

# Transfer Credit

Transfer credit may be awarded at the time of admission for courses that are equivalent to those offered by NJIT. A minimum grade of C must be earned in the course in order to receive transfer credit. All transfer credit must be documented by an official transcript issued by the school where the course was completed. Students who have attended foreign institutions of higher education must also submit an evaluation of their work made by World Educational Services Inc. or another approved service. Students are required to submit course descriptions for all course work taken outside of the United Stated to the Registrar's Office.  Further information regarding evaluations may be obtained from the Registrar's Office (http://www.njit.edu/registrar).

# Credit for AP Courses

Advanced placement credit can be given in certain cases; please refer to the appropriate section under Admissions.

# Credit for Non-Traditional Learning

Students may be granted course credit for certain college-level knowledge acquired through non-traditional education such as independent study or job-related experiences. This credit may be granted for successfully passing selected DANTES or CLEP (College Level Examination Program) Subject Examinations, or, if credit is sought for advanced courses, by successfully passing a special departmental examination. Interested students should contact the Counseling Center for additional information about CLEP or DANTES examinations: (973) 596-3414. Students should contact the appropriate academic department for information about special departmental examinations. A fee is charged for these examinations.

# Credits That Must Be Taken at NJIT

To be eligible for graduation, students transferring to NJIT must complete in residence at NJIT, at least 33 credits in upper division courses approved by the department of their major study.

# Skills Testing

NJIT places prime importance on its students' ability to communicate. The ability to communicate effectively what has been learned in courses is essential, and so the university requires students to master the verbal skills necessary for writing and speaking clear, correct English. Appropriate developmental work may be assigned to students who do not demonstrate the mastery of these skills. To the extent appropriate to the course, instructors in all disciplines stress the importance of writing and speaking ability.

## English as a Second Language (ESL)

Students whose first language is not English and/or whose English proficiency is limited will be required to take a special examination in English and enroll for the appropriate course in their first semester. Placement in the appropriate course (ENG 095 General Skills in English as a Second Language or the sequence HUM 099S-100S) is based on performance in the examination. Tutoring is a required part of these courses. Students will not be permitted to enroll in cultural history courses until they have achieved satisfactory grades in HUM 099S-100S (and ENG 095 General Skills in English as a Second Language, if required).

The ESL Program offers ESL sections of a number of courses in the humanities and social sciences department. These sections carry full academic credit and are designed to help students strengthen their English language proficiency while also mastering course content. Enrollment in the ESL section of a course is optional. ESL sections include HUM 211 The Pre-Modern World, HUM 212 The Modern World, HIST 213 The Twentieth-Century World, ENG 352 Technical Writing, LIT 320 American Literature, and LIT 350 Fiction.

# Freshman Placement

Upon deposit and completion of the math placement test, all freshmen will be placed in courses according to their major curriculum and based on standards established by specific departments (i.e. Humanities/English, Mathematics, Chemistry and Computer Science).

# Transfer Testing

Transfer students who do not receive transfer credit for required first year courses in Humanities/English, mathematics, chemistry and/or computer science are required to take placement tests. The results will be used to make course placement decisions.

# Professional Skills Examinations

NJIT actively participates in programs that assure the quality of education in all undergraduate majors. In some cases, this participation requires students to prepare and sit for professional examinations. In other cases, NJIT students are required to sit for examinations, especially during the sophomore and senior years. Since these examinations carry no credit, they are not specifically listed in the major curricula listed elsewhere in this catalog. Nonetheless, these proficiency examinations are part of degree requirements, and students selected to participate in such examinations are required to take them.

All students enrolled in an Accreditation Board for Engineering and Technology, Inc. (ABET) accredited engineering program at NJIT are required to take an assessment examination, the Basic Engineering Skills Test (BEST), in the junior or senior year. The examination is offered at the beginning of the fall and the spring semester. Taking the examination is a graduation requirement commencing with students entering Newark College of Engineering in Fall 2000.

## Enrollment Status

**Full-Time Students:** Undergraduate students registered for 12 credits or more throughout an entire semester are considered full-time.

International students must maintain full-time status each semester.

**Part-Time Students:** Students registered for fewer than 12 credits during a semester.

## Attendance Policy

- All undergraduates are expected to attend all regularly scheduled classes. In the case of hybrid and fully online **classes, participation in discussion forums and other required online activities is expected**.
- Attendance, by itself, shall not constitute a basis for grading except for certain clearly designated courses. These courses include, but are not limited to, all Physics and Mathematics 100 and 200 level courses in which a student missing more than three classes may be required to withdraw.
- **Students who expect to miss classes or exams because of religious observance must submit to their instructors, by the end of the second week of classes, a written list of dates that will be missed. Students are expected to make up missed work. Faculty are expected to make reasonable attempts to accommodate students who are appropriately following this policy.**
- **Instructors are obligated to explain clearly, on all syllabi to be distributed at the beginning of each semester, what is expected of students in terms of activities such as class participation, reading assignments, and reports and how these activities factor into student grades.**
- Instructors are not obligated to make allowances for student absences unless those absences are due to illness or similarly unavoidable causes.
- When, in the opinion of the instructor, a student is jeopardizing the successful completion of the academic requirements of a subject due to excessive absences, the instructor will initiate an absence warning (Academic Warning Notice), which is to be sent to the student by the instructor.
- It is understood that this policy on attendance is intended to reinforce students' personal responsibility to be present in class in order to:
  - Gain mastery of the subject matter, ideas, and techniques developed in the course.
  - Take examinations, tests and quizzes.
  - Participate in oral presentations, seminars, and field trips.
  - Participate in group activities such as laboratory experiments and study projects.
  - Remain fully informed as to class plans, announcements, and assignments.

**(Effective Fall 2011)**

## Grades

The following grades will be used:

| Grade | Description |
|---|---|
| A | Superior |
| B+ | Excellent |
| B | Very Good |
| C+ | Good |
| C | Acceptable |
| D | Minimum |
| F | Inadequate |
| AUD | Audit |
| I | Incomplete--given in rare instances to students who would normally have completed the course work but who could not do so because of special circumstances. It is expected that coursework will be completed during the next regular semester. If this grade is not removed before final grades are due at the end of the next regular semester, a grade of F will be issued. |
| W | Withdrawal |
| S | Satisfactory |

| | |
|---|---|
| U | Unsatisfactory |

## Satisfactory and Unsatisfactory

The grades S or U report progress in co-op, teaching methods, ESL and physical education courses. The grade of S is given for satisfactory progress and U is given for unsatisfactory progress. Students who fail to meet with their advisors or do not satisfy relevant attendance requirements will receive a U grade. Credits for courses in which U is received cannot count toward a degree.

## Grade Reports

Students can view term grades along with their entire academic record via ***Highlander Pipeline***. The web term grade report is valid for employee tuition reimbursement if this benefit is available through the student's employer.

## Grade Changes

Grade change requests will  be accepted no later than the final grade due date the end of the subsequent semester.

## Grade Disputes

Students are expected to resolve disputes about grades with their instructors. If they cannot reach a satisfactory settlement with their instructor, students are permitted to request the intervention of the chairperson of the department and the dean of the school or college.

## Credit by Examination

Examinations to earn credit are available in certain courses. Students who believe they have the background covered in a given course should consult with their advisor and the department offering the course to see whether an examination is offered. To receive credit by examination, a student must perform at a level equivalent to a grade of "C" in the course. Students who have failed or attempted a course at NJIT may not take an examination for credit in that course. A fee will be charged for the examination.

## Transcript of Grades

Students who wish to obtain a transcript issued on their behalf must submit a request via ***Highlander Pipeline***. Please allow 10 days to process the request. Transcripts will not be issued to or on behalf of a student with an outstanding financial obligation to the university. Official transcripts bearing the university's raised seal will be issued only to other educational institutions, government agencies, or employers.

## Dean's List

Students matriculated in a regular program can qualify for academic honors at the end of the fall and spring semesters if they have completed 12 or more degree credits in the semester, achieved a GPA of 3.00 or better in the semester, and have no incomplete grades or any grade lower than a "C" in the semester. The Dean's List is posted on the student transcript.

# Policy on Academic Standing for Undergraduate Students

## Academic Standing

NJIT is committed to enabling its matriculated students to reach graduation in a timely fashion.  The policies and procedures described here are meant to ensure that our students are aware of their academic status and receive the support they need to overcome any academic difficulties.  If, after appropriate intervention from NJIT, a student fails to make progress towards graduation, NJIT is committed to helping the student make alternative academic plans in a timely manner.

Academic standing is determined for matriculated students only and is recorded on their academic transcripts.  The policies and procedures governing academic standing are the same for all students (full-time, part-time, and transfer students).

A student’s academic standing at NJIT is determined twice a year, at the end of the fall and spring semesters after grades for the aforementioned semesters have been submitted.  Academic standing is based on both the cumulative grade point average (CUM GPA) and the semester grade point average (TERM GPA) the student has earned.  Any conditions associated with the academic standing determined at the end of a semester are effective for the next academic semester.  Regardless of performance in courses that students may take during summer or winter sessions (which are not considered regular semesters), academic standing for such sessions is the one determined at the end of the immediately prior fall or spring semester in which students were enrolled in courses.

Students determined to be in any category other than Good Standing are notified via electronic mail of their academic standing

The categories of academic standing, along with the corresponding policies, are given below.

### Good Standing

Students with TERM and CUM GPA of at least 2.0 are placed in Good Standing.

## Academic Warning

Students are placed on Academic Warning in the following cases:

1. They have completed their first semester at NJIT with a TERM GPA of at least 1.75 but lower than 2.0, or
2. They have a TERM GPA lower than 2.0, a CUM GPA of at least 2.0, and have never previously had any academic standing other than Good Standing.

Students can be placed on Academic Warning only once during their studies at NJIT.

In the semester following the one in which they were placed on Academic Warning, students cannot attempt more than 15 credits and they must meet with their academic advisor as per the advisor's specifications. If the student decides to take courses during the summer, the limit is 9 credits.

At the end of their first semester of enrollment after they have been placed on Academic Warning, students must earn a TERM (and CUM) GPA of at least 2.0 in order to be placed in Good Standing; otherwise, students are placed on Academic Probation.

## Academic Probation

Students are placed on Academic Probation in the following cases:

1. They have completed their first semester at NJIT with a TERM GPA lower than 1.75, or
2. They have a TERM GPA lower than 2.0 and had been placed on Academic Warning in any prior semester at NJIT, or
3. They have a CUM GPA below 2.0 and have never previously had any academic standing other than Good Standing (this rule is not applicable to students who have just completed their first semester at NJIT with a TERM GPA of at least 1.75).

Students can be placed on Academic Probation only once during their studies at NJIT.

In the semester following the one in which they were placed on Academic Probation, students cannot attempt more than 14 credits, must meet with their academic advisor as per the advisor's specifications, and must follow an improvement plan as per the advisor's recommendations. The plan may include the use of resources such as academic support workshops provided by the Advising Success Center (ASC). If the student decides to take courses during the summer, the limit is 9 credits.

At the end of their first semester of enrollment after they have been placed on Academic Probation, students must earn a CUM (and TERM) GPA of at least 2.0 in order to be placed in Good Standing; otherwise, students are placed on Academic Pre-Suspension or Academic Suspension.

## Academic Pre-Suspension

Students are placed on Academic Pre-Suspension if at the end of their first semester of enrollment after they have been placed on Academic Probation, have a TERM GPA of at least 2.0 but their CUM GPA is still below 2.0. Students on Academic Pre-Suspension are given the opportunity to attempt up to a total of 12 credits to achieve a CUM GPA of 2.0 and return to Good Standing. Attempted credits refer to those for which an actual letter grade was earned as well as those for which a W (Withdrawal) has been entered. Students on Academic Pre-Suspension are only allowed to attempt credits in courses that have been explicitly approved by their academic advisor. While on Academic Pre-Suspension, students must meet with their academic advisor as per the advisor's specifications. Students on Academic Pre-Suspension are not allowed to register for courses offered in the winter session. If the student decides to take courses during the summer, the limit is 9 credits.

At the end of their first semester of enrollment after they have been placed on Academic Pre-Suspension, students must earn a CUM (and TERM) GPA of at least 2.0 in order to be placed in Good Standing. If they have attempted 12 credits and their TERM (and CUM) GPA is below 2.0, students are placed on Academic Suspension; if they have attempted less than 12 credits and achieved a TERM GPA of at least 2.0, students are placed again on Academic Pre-Suspension and given a final semester to attempt the remaining of the 12 advisor-approved credits and achieve a CUM GPA of at least 2.0.

## Academic Suspension

Students are placed on Academic Suspension in the following cases:

1. They have either a TERM GPA or a CUM GPA lower than 2.0 and had been placed on Academic Probation in any of their prior semesters at NJIT, or
2. They have a TERM (and CUM) GPA lower than 2.0 at the end of a semester following one in which they were placed on Academic Pre-Suspension.

Students can be placed on Academic Suspension only once during their studies at NJIT.

Students placed on Academic Suspension are not permitted to enroll in courses at NJIT unless they are reinstated, as described below.

## Academic Dismissal

Students who reach the point of Academic Suspension after reinstatement following their first Academic Suspension are permanently dismissed from the university. Academically dismissed students can neither be reinstated nor readmitted to the university under any circumstances.

## Student Appeals

Students cannot appeal any decision on their academic standing except a decision to place them on Academic Suspension. Information on how to file an appeal following placement on Academic Suspension is provided in the notification sent (via electronic mail) to the students regarding their academic standing. The appeal documents must be submitted electronically and are reviewed by the Committee on Undergraduate Academic Standing. The Committee does not meet in person with students filing appeals and its decision is final. Students with successful appeals are placed on Academic Pre-Suspension. Students are notified of the Committee's decision via electronic mail.

## Reinstatement after Academic Suspension

Students who are suspended from the university may apply for reinstatement after a lapse of at least one fall or spring semester. Final decisions about applications for reinstatement are made by the appropriate academic department on the basis of its written policy, after students have met with an academic advisor.

## Extenuating Circumstances

The university continues to make every effort to protect students' academic and personal information. Moreover, maintaining the confidentiality of students' medical information is a legal and ethical duty, as defined by federal and state laws and regulations, and by the courts. Whenever students have a situation that affects their academic standing, it should be brought to the Dean of Students. This includes medical or psychological documentation to support a student's claim. Students should not bring such information to their instructors, nor should it be requested by a faculty member. The Dean of Students has a physician and staff psychologists to evaluate such information to verify its legitimacy. The Dean of Students will then notify the faculty member(s) if a student has a legitimate absence and will ask that the student receive consideration in making up any missed course work or exam. This process ensures confidentiality of students' information and, just as important, consistency in dealing with such matters.

# Undergraduate Course Repetition Policy

An NJIT student may take a single course no more than four times at NJIT and/or another institution, including withdrawals. If an undergraduate course is repeated at NJIT, then the lowest of the grades is excluded in computation of the cumulative GPA and all other grades are included. All grades are shown on the student's transcript. In the case where the student passes the course by earning transfer credit, only the lowest letter grade (B, C, D, or F) is excluded from the GPA calculation.

# Change of Major

Students seeking change of major must submit a Change of Major form to the Registrar, with signature approvals from the student's current and new department representatives. For students with an approved change of major, grades in all courses that are not applicable to students' new majors, as determined by the new advisor, are excluded from the cumulative grade calculation. The new recalculated GPA will be in effect at the end of the semester in which the student transfers. Advisors arbitrate which classes can apply to new major. **(Effective Summer 2011)**

# Class Standing

A student's class/year standing is determined by the number of course credits earned: first year standing, 0--28 credits; sophomore standing, 29--56 credits; junior standing, 57--90 credits; and senior standing, 91+ credits.

# Graduation

New Jersey Institute of Technology is authorized to grant degrees by the Commission on Higher Education. Each degree is certified by a diploma bearing the university seal and the signatures of officers of the university.

Candidates for graduation who satisfactorily complete a regular undergraduate program receive the bachelor's degree in the program pursued. Each prospective candidate for any degree must file an application for graduation on or before the deadline date set by the university.

In order to graduate, students must attain a cumulative grade point average of 2.0 in all the courses listed in the catalog as being required in the appropriate curriculum. They must also earn a cumulative GPA of 2.0 in the upper division course requirements of their major as determined by the academic department offering the major.

Additive credit courses will be excluded from the calculation of the cumulative GPA requirements for graduation.

NJIT holds its annual commencement exercises in May of each year. Graduates who obtain their degree at any of the 3 degree dates (August, January or May) are encouraged to participate.

# Credits That Must Be Taken at NJIT

To be eligible for graduation, students transferring to NJIT must complete in residence at NJIT, at least 33 credits in upper division courses approved by the department of their major study.

## Graduation with Academic Honors

The academic honors of cum laude (GPA of 3.400--3.649), magna cum laude (GPA of 3.650-3.849), and summa cum laude (GPA of 3.850--4.00) are awarded to qualified students at graduation. Note that to be eligible for academic honors, students must complete a minimum of 60 credits in residence at NJIT, with at least 33 credits in upper division courses, counting towards their degree at NJIT.

## Expiration of Credit

For all degrees, course credits normally expire ten years after completion of the semester in which they were earned. Expired course credits cannot be used to fulfill degree requirements and must be replaced by current course credits. Students may apply to the department which offered the course or which approved the transfer of course credit for an extension of these course credits.

# Special Degree Options

## Two Baccalaureate Degrees

Qualified students whose special interests and career plans make such study appropriate may be granted permission to earn two undergraduate baccalaureate degrees.

Written approval to undertake this curriculum must be obtained from each of the departments involved and the dean(s) of the appropriate college(s). In addition to meeting all general university requirements, the candidate for two degrees must earn at least 30 credits more than is required for either degree and must fulfill all requirements of the two degree programs. Normally this requires five years of study.

## Double Major

Qualified students whose career plans make such study appropriate may be granted permission to major in two disciplines. Written approval of the proposed curriculum by the department chairperson(s) offering the majors, subject to the review and authorization of the appropriate dean(s), must be obtained by the student. The candidate for the double major must fulfill all requirements for both majors (the second major is noted on the transcript.) In some instances, there is an articulated double major with Rutgers-Newark.

## Dual Major with Rutgers-Newark

NJIT and Rutgers-Newark offer their students the option of pursuing a dual major at the two institutions. NJIT students may elect to pursue a dual (or second) major at Rutgers-Newark. Acceptance into the Rutgers-Newark major program is consistent and uniform with practices in place at NJIT and is determined solely by Rutgers-Newark. Upon successful completion of the major, Rutgers-Newark conveys certification for graduation to the appropriate certifying office at NJIT. In addition, NJIT certifies for graduation the completion of the NJIT major and any and all college requirements. NJIT then annotates the student's transcript to read: "Completion of Major Program in (name of major), (date) at Rutgers-Newark."

This option may not apply to chemistry/applied chemistry, mathematics/applied mathematics, physics/applied physics, information systems/computer science, management/School of Management programs.

## Minors

Minors require a **minimum** number of credits of which half must be in upper level courses and earned at NJIT.  Minors may not be earned in the student's same major area of studies.  Courses to fulfill the minor do not need to be exclusive to the minor.  Exceptions may include a federated department.

Students wishing to earn minors are responsible for registering their intent with the registrar's office no later than the semester preceding graduation. They must complete the Declare a Minor form (https://www5.njit.edu/registrar/sites/registrar/files/lcms/forms/UPDATEDminor.pdf) which is available from, and should be returned to, the Registrar's Office.

# Academic Minors

## College of Computing Sciences

- Computer Science Minor (p. 212) (not for Computer Engineering majors)
- Computer Science Minor (p. 212) (for Computer Engineering majors)
- Data Analytics (http://catalog.njit.edu/undergraduate/computing-sciences/information-systems/data-analytics-minor)
- Design of the User Experience Minor (p. 232)
- Business and Information Systems Minor (p. 232) (not for Computing Sciences majors)
- Business and Information Systems Minor (p. 233) (for Computing Sciences majors)
- Information Technology Minor (p. 244) (not for Computing Sciences majors)
- Information Technology Minor (p. 244) (for Computing Sciences majors)

- Mobile and Web Minor (p. 233)

## College of Science and Liberal Arts

- Applied Mathematics Minor (p. 402)
- Applied Physics Minor (http://physics.njit.edu/Minor.php)
- Applied Statistics Minor (p. 404)
- Biological Sciences Minor (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/biological-sciences-minor)
- Chemistry Minor (p. 315) (not for Chemical Engineering majors)
- Chemistry Minor (p. 476) (for Chemical Engineering majors)
- Communication Minor (p. 387)
- Computational Mathematics Minor (p. 409)
- Electronic Creative Writing Minor (p. 387)
- Environmental Science Policy Minor (p. 315)
- Environmental Studies Sustainability Minor (p. 427)
- Global Studies Minor (http://catalog.njit.edu/undergraduate/science-liberal-arts/humanities/global-studies-minor)
- History Minor (p. 342)
- Journalism Minor (p. 388)
- Leadership and Aerospace Studies Minor (p. 286)
- Legal Studies Minor (p. 342)
- Literature Minor (p. 388)
- Mathematical Biology Minor (p. 411)
- Mathematics of Finance and Actuarial Science Minor (p. 414)
- Philosophy and Applied Ethics Minor (p. 388)
- Science, Technology & Society Minor (http://humanities.njit.edu/academics/undergraduate)
- Technology, Gender and Diversity Minor (p. 388)
- Theatre Arts and Technology Minor (p. 388)

## Newark College of Engineering

- Biomedical Engineering Minor (p. 469) (for Engineering Science students)
- Chemistry Minor (p. 476) (for Chemical Engineering majors)
- Computer Engineering Minor (p. 497) (not for Electrical Engineering or Computer Science majors)
- Computer Engineering Minor (p. 497) (for Computer Science majors)
- Computer Engineering Minor (p. 498) (for Electrical Engineering majors)
- Electrical Engineering Minor (p. 498) (not for Electrical Engineering or Computer Science majors)
- Electrical Engineering Minor (p. 498) (for Computer Engineering majors)
- Environmental Engineering Minor (p. 484)
- Geosystems Minor (p. 485)
- Industrial Engineering Minor (p. 555)
- Manufacturing Engineering Technology (http://catalog.njit.edu/undergraduate/newark-college-engineering/technology/manufacturing-engineering-technology-minor)
- Materials Engineering Minor (p. 555)
- Nanotechnology Minor (p. 469)

## School of Management

- Business Minor (p. 575)
- Innovation and Entrepreneurship Minor (p. 575) (not for IDS students in the Honors College)
- Innovation and Entrepreneurship Minor (p. 575) (for IDS students in the Honors College)

# General University Requirements

## Philosophy

New Jersey Institute of Technology (NJIT) is dedicated to producing graduates who have the knowledge, skills and motivation necessary to advance the state-of-the-art knowledge in their respective fields. Graduates must understand the complexities of contemporary society and have a deep understanding of and appreciation for science and technology and the ethical and societal issues involved in their pursuit. A fundamental guiding principle in the development of the General University Requirements (GUR) is the formulation of a foundational curriculum encompassing the necessary preconditions for success in undergraduate disciplines, a curriculum that establishes a devotion to lifetime intellectual discovery and personal development. In a larger sense, the GUR are intended to provide an educational grounding for our students, a set of educational experiences harmoniously attuned to the mission of NJIT and its responsibilities to its constituents. In essence, the completion of the GUR is a necessary step in the fulfillment of the implicit intellectual and social contract that NJIT has with its students and its local, national and global communities.

### Computing Sciences

An understanding of the nature of computing, its impact on society and the driving forces behind its pervasive deployment is integral to effective functioning as a professional and as a citizen. Each student should learn to use software and computing systems and to access, store, process and analyze information as an essential aspect of critical thinking and problem solving. Depending on the discipline, the student should also develop an ability to design algorithms, to write programs, and to use software tools.

### Cultural History

All educated individuals are expected to understand and appreciate history and the world’s cultures.

### English

The ability to communicate ideas is an essential characteristic of educated individuals. All students are expected to achieve proficiency in both oral and written English.

### Humanities

The ideals of a liberal education transcend particular major fields and career goals. All students are expected to develop an interest in specific areas within the humanities.

### Management

All students are expected to develop the management skills needed to function effectively in an organizational setting.

### Mathematics

The ability to reason qualitatively and quantitatively, to understand probability, and to apply mathematical models to a variety of circumstances is fundamental to making informed decisions in the modern world. Depending on the discipline, the student should also be able to apply appropriate mathematical concepts and methods to the solution of problems in their professional domain.

### Natural Sciences

The natural sciences provide the basis for our knowledge of the physical universe and for technological progress. All students are expected to develop a thorough understanding of at least one laboratory science.

### Physical Education

Physical education conveys to students the importance of good health and fitness through planned exercise and recreational activities.

### Social Sciences

An understanding of the social sciences is essential in order to understand the economic, social, and political forces at work in our world.

## Specific General University Requirements

Courses that satisfy the General University Requirements are so certified by the Committee on Undergraduate Education at the time they are first approved to be offered.

Each college or department may set additional requirements that exceed the GUR.

All first-time, full-time freshman students are required to attend FRSH SEM Freshman Seminar. This course assists students in adjusting to the academic program and introduces them to university life.

### Computing Sciences

At least three (3) credits in an introductory course in the computing sciences.

| | | |
|---|---|---|
| CS 100 | Roadmap to Computing | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| CS 103 | Computer Science with Business Problems | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |

| | | |
|---|---|---|
| CS 113 | Introduction to Computer Science | 3 |
| CS 115 | Intro. to CS I in C++ | 3 |
| **Total Credits** | | **3** |

## English Composition and Cultural History (lower-level)

| | | |
|---|---|---|
| **English Composition** | | |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| **Cultural History** | | |
| Select at least one of the following: | | 3 |
| HIST 213 | The Twentieth-Century World | |
| HIST 214 | Tech & Cult in Amer History | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| R510 2XX | History course at Rutgers-Newark | |
| R512 2XX | American History course at Rutgers-Newark | |
| **Total Credits** | | **9** |

## Humanities and Social Sciences Electives (upper-level)

| | | |
|---|---|---|
| **LIT, HIST, PHIL, STS** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| R350 3XX | English Literature course at Rutgers-Newark | |
| R350 4XX | English Literature course at Rutgers-Newark | |
| R352 3XX | American Literature course at Rutgers-Newark | |
| R352 4XX | American Literature course at Rutgers-Newark | |
| R510 3XX | History course at Rutgers-Newark | |
| R510 4XX | History course at Rutgers-Newark | |
| R512 3XX | American History course at Rutgers-Newark | |
| R512 4XX | American History course at Rutgers-Newark | |
| R730 3XX | Philosophy course at Rutgers-Newark | |
| R730 4XX | Philosophy course at Rutgers-Newark | |
| **OPEN GUR** | | |
| Select one of the following: | | 3 |
| COM 3XX | Communication course | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| HSS 3XX | Social science course | |
| THTR 3XX | Theatre course | |
| R070 3XX | Anthropology course at Rutgers-Newark | |
| R080 3XX | Art course at Rutgers-Newark | |
| R081 3XX | Course at Rutgers-Newark | |
| R202 3XX | Criminal justice course at Rutgers-Newark | |
| R220 3XX | Economics course at Rutgers-Newark | |
| R350 3XX | English course at Rutgers-Newark | |
| R352 3XX | English, American Literature course at Rutgers-Newark | |

| | | |
|---|---|---|
| R420 3XX | French course at Rutgers-Newark | |
| R510 3XX | History course at Rutgers-Newark | |
| R512 3XX | American History course at Rutgers-Newark | |
| R560 3XX | Italian course at Rutgers-Newark | |
| R570 3XX | Journalism, Media & Writing course at Rutgers-Newark | |
| R700 3XX | Music course at Rutgers-Newark | |
| R701 3XX | Applied Music course at Rutgers-Newark | |
| R370 3XX | Entomology course at Rutgers-Newark | |
| R790 3XX | Political Science course at Rutgers-Newark | |
| R810 3XX | Portuguese course at Rutgers-Newark | |
| R830 3XX | Psychology course at Rutgers-Newark | |
| R861 3XX | Course at Rutgers-Newark | |
| R920 3XX | Sociology course at Rutgers-Newark | |
| R940 3XX | Spanish course at Rutgers-Newark | |
| R965 3XX | Theatre Arts course at Rutgers-Newark | |
| R988 3XX | Women's Studies course at Rutgers-Newark | |
| **HSS CAPSTONE** | | |
| Select one of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 491 | Honors Sem In Humanities | |
| **Total Credits** | | **9** |

No more than three (3) of the nine required credits in this category may be fulfilled with a course that is specifically required by a student's degree program or college.

## Management

| | | |
|---|---|---|
| HRM 301 | Organizational Behavior [1] | 3 |
| MGMT 390 | Principles of Management | 3 |
| ENTR 410 | New Venture Management | 3 |
| IE 492 | Engineering Management | 3 |
| **Total Credits** | | **3** |

[1] Students in the aerospace option take AS 333 Leadership and Management Iand those in the dual degree program between architecture and management take HRM 301 Organizational Behavior.

## Mathematics

| | | |
|---|---|---|
| MATH courses | | 5 |
| Select one of the following: | | 1-4 |
| MATH 105 | Elementary Probability and Statistics | |
| MATH 114 | Finite Mathematics and Calculus II | |
| MATH 120 | Basic Concepts in Statistics | |
| MATH 225 | Survey of Probability and Statistics | |
| MATH 244 | Introduction to Probability Theory | |
| MATH 279 | Statistics and Probability for Engineers | |
| MATH 305 | Statistics for Technology | |
| MATH 333 | Probability and Statistics | |
| IE 331 | Applied Statistical Methods | |
| ECE 321 | Random Signals and Noise | |

| | | |
|---|---|---|
| MNET 315 | Industrial Statistics | |
| **Total Credits** | | **6-9** |

## Natural Sciences

At least seven (7) credits in natural sciences, including a laboratory experience.

| | | |
|---|---|---|
| **Biology Courses** | | |
| R120 101 | General Biology | 4 |
| R120 102 | General Biology | 4 |
| R120 109 | Basic Plant Science | 3 |
| R120 110 | Basic Plant Sci Lab | 1 |
| R120 205 | Environmental Issues | 3 |
| R120 206 | General Horticulture | 3 |
| R120 207 | Horticulture Lab | 1 |
| R120 208 | Human Sexuality | 3 |
| R120 237 | Environmental Microbiology | 4 |
| R120 241 | Anatomy & Physiology | 4 |
| R120 242 | Anatomy & Physiology | 4 |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 125 | General Chemistry I | 3 |
| CHEM 125A | General Chemistry Lab I | 1 |
| CHEM 126 | General Chemistry II | 3 |
| CHEM 126A | Gen Chemistry Lab II | 1 |
| **Physics Courses** | | |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| PHYS 202 | Introductory Astronomy and Cosmology | 3 |
| PHYS 202A | Astronomy and Cosmology Laboratory | 1 |
| PHYS 203 | The Earth in Space | 3 |
| PHYS 203A | The Earth in Space Laboratory | 1 |
| PHYS 204 | Biophysics of Life | 3 |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | 3 |
| R460 103 | Planet Earth | 3 |
| R460 104 | Planet Earth Lab | 1 |
| R460 206 | Env Geology | 3 |
| R460 207 | Env Geology Lab | 1 |
| **Total Credits** | | **13** |

## Physical Education

At least two (2) credits in physical education.  Students who register as full time undergraduates for two or more consecutive semesters must take two PE courses.

| | | |
|---|---|---|
| PE XXX | Physical Education course | 1 |

| | | |
|---|---|---|
| PE 1XX | Physical Education fitness core course | 1 |
| **Total Credits** | | **2** |

## Social Sciences (lower-level)

| | | |
|---|---|---|
| Select two of the following: | | 6 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 201 | Understanding Technological Society | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| R070 203 | Intro Phys Anth & Arch | |
| R070 204 | Intro Cultural Anthro | |
| R202 201 | Intro Criminal Justice | |
| R790 201 | American Government | |
| R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | |
| R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | |
| R920 202 | Sociology II | |
| **Total Credits** | | **6** |

# Course Codes

## Course Code Explanation

### Alphabetical Codes

| | |
|---|---|
| ACCT | Accounting |
| ARCH | Architecture |
| AS | Aerospace Studies |
| ART | Art |
| BIOL | Biology |
| BME | Biomedical Engineering |
| CE | Civil Engineering |
| CET | Construction Engineering Technology |
| CHE | Chemical Engineering |
| CHEM | Chemistry |
| CIS | Computer and Information Sciences |
| CMT | Construction Management Technology |
| COOP | Cooperative Education |
| CPT | Computer Technology |
| ECON | Economics |
| ECE | Electrical and Computer Engineering |
| ECET | Electrical and Computer Engineering Technology |
| EG | Engineering Graphics |
| ENE | Environmental Engineering |
| ENTR | Entrepreneurship |
| ENG | English |
| ESC | Engineering Sciences |

| | |
|---|---|
| EPS | Environmental Policy Studies |
| FED | Fundamentals of Engineering Design |
| FIN | Finance |
| FRSH | Freshmen Seminar |
| HIST | History |
| HRM | Human Resource Management |
| HSS | Humanities and Social Sciences |
| HUM | Humanities |
| IE | Industrial Engineering |
| IM | Industrial Management |
| IT | Information Technology |
| LIT | Literature |
| MATH | Mathematics |
| ME | Mechanical Engineering |
| MECH | Mechanics |
| MET | Mechanical Engineering Technology |
| MGMT | Management |
| MIS | Management Information Systems |
| MNET | Manufacturing Engineering Technology |
| MR | Maintaining Registration |
| MRKT | Marketing |
| MTSE | Materials Science and Engineering |
| OM | Operations Management |
| OPSE | Optical Science and Engineering |
| PE | Physical Education |
| PHIL | Philosophy |
| PHYS | Physics |
| SET | Surveying Engineering Technology |
| SS | Social Sciences and Policy Sciences |
| STS | Science, Technology and Society |
| THTR | Theatre |
| TMT | Telecommunications Management Technology |
| TUTR | Freshman Tutorial |

## Numerical Codes

### Lower Division Courses

Courses numbered between 100 and 199 are normally taken by first-year students.

Courses numbered 200--299 are normally taken by sophomores.

### Upper Division Courses

Courses numbered 300--399 are normally taken by juniors.

Courses numbered 400--499 are normally taken by seniors.

The numbers after each course title (3 credits, 3 contact hours (0;0;3)) indicate the number of credits, the number of contact hours and the nature of the contact hours (Lecture; Laboratory; Other).

## Rutgers-Newark Courses

The current Rutgers-Newark Schedule of Classes (https://sis.rutgers.edu/soc) can be viewed for cross-registration along with the Rutgers catalog (http://catalogs.rutgers.edu) when planning for cross-registration.

# Student Rights and Responsibilities

## Photo ID Card

All students must carry an NJIT identification card while on campus. An ID card must be presented at the request of a university administrator, faculty member or public safety officer. Facilities, parking, building access, and services of the university require presentation of a valid university ID.

Students should obtain an ID card as soon as possible after registration is completed. Photographs for ID cards are taken throughout the semester in the Department of Public Safety, located in the parking facility. Dates and times to obtain an ID are posted at the Campus Center information desk. Proof of registration in the form of a tuition receipt or registrar's receipt is required to obtain an ID card. These receipts also will be accepted as NJIT identification until the ID card is issued. ID validation stickers are issued each semester and are available at the Department of Public Safety or the Campus Center information desk.

Lost or stolen IDs should be reported as soon as possible to the Department of Public Safety. A replacement for a lost card is obtained by paying a $25 charge at the bursar's office cashier's window in the Student Mall and presenting the receipt at the Department of Public Safety where the card will be reissued.

## Property Loss and Damage

NJIT is not responsible for loss of property by fire or theft in its buildings or grounds. NJIT is not responsible for property damaged as the result of vandalism in its buildings or grounds.

## Student Code of Conduct

NJIT requires students to conduct themselves with decorum and to adhere to standards of ethical and professional behavior. NJIT has adopted, and requires all students to comply with, a Student Code of Conduct. The policies and procedures governing this code are contained in a separate publication, available online, and are deemed incorporated into this catalog. A copy of the Code may be obtained from the Office of the Dean of Student Services or online at http://www.njit.edu/handbook/.

## Anti-Discrimination Policy

New Jersey Institute of Technology reaffirms its commitment to a policy of non-discrimination on the basis of race, sex, sexual orientation, age, religion, ethnic origin, handicap or veterans' status in its employment policies, educational programs and activities under university control.

Assuring a climate of equal opportunity is the direct responsibility of all levels of management. Administrative and supervisory personnel are required to comply with applicable government regulations and the affirmative action goals of the university. Among these are Executive Orders 11246 and 11375 (Affirmative action); the Civil Rights Act of 1964, as amended; Title IX of the Education Amendments of 1972 (Sex Discrimination); Section 504 of the Rehabilitation Act of 1973; Americans with Disabilities Act (Non-discrimination on the Basis of Handicap); The New Jersey Law Against Discrimination, Title 10, Chapter 5, 10:5-1 to 10:5-28, NJ Revised Statutes, as amended; and the New Jersey Governor's Code of Fair Practices, Executive Order No. 21 (1965), as amended and Executive Order No. 39 (1991), "Prohibition in State Government of Discrimination Based on Sexual Orientation."

Any reported act of discriminatory behavior will be investigated through the Office of the Dean of Student Services, the Office of Compliance and Community Relations, or Office of General Counsel and Employment Policy Relations.

## Sexual Harassment Policy

It is the continuing objective of the university to offer a work and study environment to its employees and students that rewards career and educational goals based upon relevant factors such as ability and work performance. Sexual harassment of employees and students is unacceptable. It is a barrier to educational and professional development and contrary to law and university policy.

In accordance with the NJIT sexual harassment policy and procedures, persons found to have violated university policy will face investigation, managerial review and possible disciplinary action up to and including employment termination and or dismissal from the university (for students). For a full copy of the university's policy prohibiting sexual harassment, please contact the Office of General Counsel and/or the Office of Compliance and Community Relations. The Sexual Misconduct Policy, governing student behavior, can be found in the Code of Conduct.

## Drug Abuse Prevention Program

New Jersey Institute of Technology prohibits the use of illegal drugs on its premises. University policy concerning possession and consumption of alcoholic beverages on campus subscribes to strict enforcement of the laws of the State of New Jersey, the County of Essex and the City of Newark. In addition, the policy stipulates that any consumption must occur within a responsible social framework wherein beverages are not the focus of the event.

Students with concerns about their own or someone else's use of drugs and/or alcohol can receive information and referral assistance from the Office of the Dean of Student Services, the Counseling Center, the office of Health Services, or the Stop-In Center. The Counseling Center professional staff provides assessment and counseling for some substance abuse problems, relapse prevention support for students in recovery, and referral to off-campus resources as needed. With limited exceptions, services of the Counseling Center are confidential. A full description of confidentiality exceptions is included in the Student Handbook. Questions about confidentiality may be discussed with professional staff prior to receiving services.

In addition, the university, through the Division of Academic Support and Student Affairs, offers a series of educational programs focused on the areas of drug and alcohol information and substance abuse prevention.

## Drug-Free Workplace Policy

Student employees are subject to university policies regarding employment. New Jersey Institute of Technology is committed to maintaining a drug-free workplace in compliance with applicable laws. The university is further committed both to rigorous enforcement of applicable laws and policies and to support for those trying to cope with drug-related problems. The unlawful possession, use, distribution, dispensation, sale, or manufacture of controlled substances is prohibited on university premises. Any NJIT employee determined to have violated this policy or engaged in drug-related problems that have an impact upon the workplace may be subject to disciplinary action up to and including termination. At the discretion of the university, any employee convicted of a drug offense involving the workplace shall be subject to employee discipline (up to and including termination) and/or required to satisfactorily complete a drug rehabilitation program as a condition of continued employment.

The illegal use of controlled substances can seriously injure the health of employees, adversely affect the performance of their responsibilities, and endanger the safety and well-being of fellow employees, students, and members of the general public. Therefore, the university urges employees engaged in the illegal use of controlled substances to seek professional advice and treatment. Anyone who is employed at NJIT who has a drug problem is encouraged to contact the director of the Employee Assistance Program (EAP), who will assist in obtaining available treatment. Employees engaged in contracts with the U.S. Department of Defense are additionally subject to Department of Defense requirements and may be required to submit to tests for the illegal use of controlled substances.

As a condition of employment, an employee of NJIT will notify his/her supervisor if he or she is convicted of a criminal drug offense involving the workplace within five days of the conviction. In the event any such conviction involves an employee working on a federal contract or grant, the university will notify the granting or contracting federal agency within 10 days of receiving notice of a conviction. A copy of this statement shall be given to all employees.

This statement and its requirements are promulgated in accordance with the requirements of the Drug-Free Workplace Act of 1988 enacted by the United States Congress. The university will continue its efforts to maintain a drug-free environment by adhering to the above policy and by providing through the EAP and the offices of Human Resources, and Compliance and Training, ongoing drug awareness programs.

## Family Educational Rights and Privacy Act

The Family Educational Rights and Privacy Act (FERPA) affords eligible students certain rights with respect to their education records. (An “eligible student” under FERPA is a student who is 18 years of age or older or who attends a postsecondary institution.) These rights include:

1. The right to inspect and review the student's education records within 45 days after the day New Jersey Institute of Technology receives a request for access. A student should submit to the registrar a written request that identifies the record(s) the student wishes to inspect. The registrar will make arrangements for access and notify the student of the time and place where the records may be inspected. If the records are not maintained by the registrar, the registrar shall coordinate access to inspect those records.

2. The right to request the amendment of the student’s education records that the student believes is inaccurate, misleading, or otherwise in violation of the student’s privacy rights under FERPA.

A student who wishes to ask New Jersey Institute of Technology to amend a record should write the registrar, clearly identify the part of the record the student wants changed, and specify why it should be changed.

If New Jersey Institute of Technology decides not to amend the record as requested, New Jersey Institute of Technology will notify the student in writing of the decision and the student’s right to a hearing regarding the request for amendment. Additional information regarding the hearing procedures will be provided to the student when notified of the right to a hearing.

3 . The right to provide written consent before New Jersey Institute of Technology discloses personally identifiable information (PII) from the student's education records, except to the extent that FERPA authorizes disclosure without consent. See “Additional Disclosure Information” below.

4. The right to file a complaint with the U.S. Department of Education concerning alleged failures by the New Jersey Institute of Technology to comply with the requirements of FERPA. The name and address of the Office that administers FERPA is:

Family Policy Compliance Office

U.S. Department of Education

400 Maryland Avenue, SW

Washington, DC 20202

**Disclosure of Directory Information**

New Jersey Institute of Technology, at its discretion, may provide directory information, in accordance with the provisions of the law including a student's name, address, telephone listing, date and place of birth, major field of study, participation in officially recognized activities and sports, weight and height of members of athletic teams, dates of attendance, degrees and awards received, and the most recent previous educational agency or institution attended by the student.

Students may request to withhold disclosure of directory information. To ensure that a request is properly processed, it must be submitted on the official ‘Request to Prevent Disclosure of Directory Information Form’, which is available in the Office of the Registrar. Request for non-disclosure will be honored by New Jersey Institute of Technology for one academic year and must be filed again at the beginning of the next academic year. New Jersey Institute of Technology assumes that failure on the part of any student to specifically request on the official form preventing the disclosure of directory information indicates individual approval of disclosure.

**Additional Disclosure Information**

FERPA permits the disclosure of PII from students’ education records, without consent of the student, if the disclosure meets certain conditions found in §99.31 of the FERPA regulations.  Except for disclosures to school officials, disclosures related to some judicial orders or lawfully issued subpoenas, disclosures of directory information, and disclosures to the student, §99.32 of FERPA regulations requires the institution to record the disclosure. Eligible students have a right to inspect and review the record of disclosures.  A postsecondary institution may disclose PII from the education records without obtaining prior written consent of the student –

• To other school officials within New Jersey Institute of Technology whom New Jersey Institute of Technology has determined to have legitimate educational interests.  A school official is a person employed by New Jersey Institute of Technology in an administrative, supervisory, academic, research, or support staff position (including law enforcement unit personnel and health staff); a person serving on the board of trustees; or a student serving on an official committee, such as a disciplinary or grievance committee. A school official has a legitimate educational interest if the official needs to review an education record in order to fulfill his or her professional responsibilities for New Jersey Institute of Technology. This includes contractors, consultants, volunteers, or other parties to whom the school has outsourced institutional services or functions, provided that the conditions listed in §99.31(a)(1)(i)(B)(1) - (a)(1)(i)(B)(2) are met. (§99.31(a)(1))

• To officials of another school where the student seeks or intends to enroll, or where the student is already enrolled if the disclosure is for purposes related to the student’s enrollment or transfer, subject to the requirements of §99.34.  (§99.31(a)(2))

• To authorized representatives of the U. S. Comptroller General, the U. S. Attorney General, the U.S. Secretary of Education, or State and local educational authorities, such as a State postsecondary authority that is responsible for supervising New Jersey Institute of Technology State-supported education programs.  Disclosures under this provision may be made, subject to the requirements of §99.35, in connection with an audit or evaluation of Federal- or State-supported education programs, or for the enforcement of or compliance with Federal legal requirements that relate to those programs.  These entities may make further disclosures of PII to outside entities that are designated by them as their authorized representatives to conduct any audit, evaluation, or enforcement or compliance activity on their behalf.  (§§99.31(a)(3) and 99.35)

• In connection with financial aid for which the student has applied or for which the student has received, if the information is necessary to determine eligibility for the aid, determine the amount of the aid, determine the conditions of the aid, or enforce the terms and conditions of the aid.  (§99.31(a)(4))

• To organizations conducting studies for, or on behalf of, the school, in order to:  (a) develop, validate, or administer predictive tests; (b) administer student aid programs; or (c) improve instruction.  (§99.31(a)(6))

• To accrediting organizations to carry out their accrediting functions.  ((§99.31(a)(7))

• To parents of an eligible student if the student is a dependent for IRS tax purposes.  (§99.31(a)(8))

• To comply with a judicial order or lawfully issued subpoena.  (§99.31(a)(9))

• To appropriate officials in connection with a health or safety emergency, subject to §99.36.  (§99.31(a)(10))

• Information the school has designated as “directory information” under §99.37.  (§99.31(a)(11))

• To a victim of an alleged perpetrator of a crime of violence or a non-forcible sex offense, subject to the requirements of §99.39.  The disclosure may only include the final results of the disciplinary proceeding with respect to that alleged crime or offense, regardless of the finding.  (§99.31(a)(13))

• To the general public, the final results of a disciplinary proceeding, subject to the requirements of §99.39, if the school determines the student is an alleged perpetrator of a crime of violence or non-forcible sex offense and the student has committed a violation of the school’s rules or policies with respect to the allegation made against him or her. (§99.31(a)(14))

• To parents of a student regarding the student’s violation of any Federal, State, or local law, or of any rule or policy of the school, governing the use or possession of alcohol or a controlled substance if the school determines the student committed a disciplinary violation and the student is under the age of 21. (§99.31(a)(15))

## Copyright Ownership

NJIT believes its role as an educational institution is best served by disclosing to the public all academic research, projects, theses and dissertations developed by students during the course of their studies or employment at the university.

Projects, theses and dissertations created by students shall be governed by the following provisions as outlined in NJIT's copyright policy under "Ownership and Disposition of Copyrightable Materials":

**A.** Copyright ownership of projects, theses and dissertations generated by research that is performed in whole or in part by the student with financial support in the form of wages, salaries, stipend, or grant from funds administered by the University shall be determined in accordance with the terms of the support agreement, or in the absence of such terms, shall become the property of the University.

**B.** Copyright ownership of projects, theses and dissertations generated by research performed in whole or in part utilizing equipment or facilities provided to the University under conditions that impose copyright restriction shall be determined in accordance with such restrictions.

**C.** Copyright in projects, theses and dissertations not within the provisions of Categories A and B of this policy shall be the property of the author. However, the student must, as a condition of a degree award, grant royalty-free permission to the University to reproduce and publicly distribute copies of the project, thesis or dissertation.

Requests for permission to publish Category A and B should be addressed to the Office of Intellectual Property.

For further information, call the Office of Intellectual Property, (973) 596-5825.

## Ownership of Intellectual Property

In accordance with university policy, NJIT retains all right, title and interest to any and all intellectual property (i.e., inventions, discoveries, creative works, trade secrets and know-how) developed by NJIT students during the course of their studies or employment at the university or while using university facilities.

To protect against premature disclosure of an invention and/or publication of anything that may be of a proprietary nature, students must immediately report their intent to do so to the Office of Technology Development (see http://www.njit.edu/officetech/). Students must neither publish nor discuss proprietary information with anyone other than the Office of Technology Development or members of the University's Intellectual Property Committee. When a project, thesis or dissertation covers material that is potentially proprietary, both the student and the advisor must report the existence of such material to the Office of Graduate Studies and the Office of Technology Development; so that the University may expedite its review of such material and determine whether or not it is proprietary and should be protected under the University's guidelines for protecting its Intellectual Property. If necessary, the Office of Graduate Studies and the Office of Technology Development will take steps to sequester patentable material in archival documents such as theses and dissertations. If the University applies for a patent, the student will sign an appropriate assignment agreement. All income derived from such intellectual property will be shared between NJIT and the student in accordance with the University's published policy (see http://www.njit.edu/officetech/inventors/).

For further information, call the Office of Intellectual Property, (973) 596-5825.

# Admissions and Financial Aid

If you're looking for an edge, start by enrolling in one of our undergraduate, graduate or continuing education programs and becoming an active participant in the NJIT experience.

Find out what sets NJIT apart (http://www.njit.edu/admissions/whatssospecial) from other schools and what's new on campus and in the classroom. As a public university, our tuition and fees—combined with a generous financial assistance (http://www.njit.edu/financialaid) program—put the edge within your reach.

# Admissions

## Applying for Admission

Students considering applying for admission to any of the undergraduate programs at NJIT should read the detailed requirements and procedures set out on the following pages.

Many NJIT students enroll as freshmen after graduating from high school, but applications are also welcome from transfer students who have completed some college work. The university works closely with community colleges and other institutions to facilitate transfer of students.

Admissions counselors are available to help students define their college plans. They will provide further information about any of the undergraduate programs, and explain the admission requirements for each program. If students are uncertain about which program to take, a counselor can help them make a decision.

The university strongly encourages applicants to visit the campus. The Office of University Admissions will be happy to arrange an interview and a student-guided tour.

An interview may be required as the Office of University Admissions attempts to evaluate each student's ability to complete a program at NJIT.

For further information contact:


- **Office of University Admissions**
- New Jersey Institute of Technology
- University Heights
- Newark, NJ 07102-1982
- (973) 596-3300 or (800) 925-NJIT
- E-mail: admissions@njit.edu


For an online application for admission, see NJIT on the Internet at www.njit.edu/admissions/applyonline.php (http://www.njit.edu/admissions/applyonline.php)

# General Admission Requirements

## All Math/Science/Engineering/Engineering Technology Majors

### High School Units

Applicants for admission must have completed a minimum of 16 secondary school units. Prospective students who have not taken all these units may be required to complete preparatory courses in the summer and/or pursue a modified program in the freshman year.

#### Required Units

| | |
|---|---|
| English | 4 |
| College preparatory mathematics, including algebra, geometry and trigonometry | 4 |
| Lab sciences, chemistry and physics preferred | 2 |
| Other Units | 6 |

### Standardized Examination Requirements

All applicants must take the Scholastic Assessment Test. The American College Test is also accepted.

## Architecture Majors

Same general requirements with the following exception:

| | |
|---|---|
| Lab sciences, physics and biology preferred | 2 |

## History, Business, and Communication Majors

Same general requirements with the following exceptions:

| | |
|---|---|
| College preparatory mathematics | 3 |
| Science including one lab science | 2 |

## Science, Technology and Society Majors

Same general requirements with the following exception:

| | |
|---|---|
| College preparatory mathematics | 3 |

# Freshman Admission

High school graduates who have not previously attended college may apply for admission as freshmen. In lieu of a certificate of graduation from an approved secondary school, a high school equivalency certificate, as issued by the New Jersey State Board of Education or similar state agency, may be submitted.

Home-schooled students should submit a summary transcript of the courses they have completed and the grades or level of achievement attained for each subject.

To apply for admission, you must submit The Common Application (https://www.commonapp.org) and pay a non-refundable application fee. Please review the admissions application for further details. Your application will be considered on the basis of your high school record, your performance on standardized examinations, and other pertinent information.

### Early Admission

Exceptional students who meet the course requirements and standardized examination requirements for a freshman program may begin as freshmen without completing the senior year of high school or receiving a high school diploma. Inquiries should be directed to the Office of University Admissions.

### Advanced Placements

Accepted students may be awarded credit for freshman course work in a number of areas by taking the proper courses in secondary school and/or attaining satisfactory scores on appropriate Advanced Placement (AP) or International Baccalaureate (IB) Examinations. Policies for awarding AP credit may be found at http://www.njit.edu/admissions/docs/AP_CREDIT_2012_SH.pdf (http://www.njit.edu/admissions/docs/APOS.pdf). Policies for awarding IB credit may be found at http://www.njit.edu/admissions/pdf/IBpolicy.pdf.

### Course Placement

Students enter at many levels of achievement. The credentials of all accepted students are reviewed before specific courses are assigned; for details refer to section on Freshman and Transfer Testing in **Academic Policies and Procedures**.

The course work available ranges from the review (refresher)-level to honors-level courses, which provide more challenge for the well-prepared student.

Students for whom review is suggested or required may do such work during summer school or in a modified program during the freshman year.

## Transfer Admission

To be considered for admission as a transfer student applicants must submit an Application for Undergraduate Admission and a non-refundable application fee.

Further details on transcript and standardized examination requirements may be found online.

**NOTE:** Transfer candidates who have completed the equivalent of one or more years of full-time study at an accredited US college or university in the same discipline as the one they plan to enter at NJIT are not required to submit standardized examination results or secondary school records except in cases in which it is deemed necessary by the Office of University Admissions.

Only matriculated students will be considered for transfer credit. Credit will be given only for completed courses that are equivalent to those in the NJIT curriculum. A minimum grade of C is required in order to receive transfer credit. For transfer course equivalencies for New Jersey colleges, visit http://www.njtransfer.org.

### Transfer Technology Majors

Transfer candidates for admission to the program leading to the Bachelor of Science in Engineering Technology may submit a transcript indicating that they hold an associate's degree in technology (AAS) or in related areas. The university will consider applicants who have an educational background equivalent to an appropriate associate's degree but who do not have the degree. Transfer students from engineering programs may be required to complete a minimum number of technology courses in addition to the junior and senior year Bachelor of Science in Engineering Technology program.

The computer technology option is designed as a continuation of an associate's degree program in computer-related areas offered by community colleges or technical institutes.

Students who apply to the construction option must demonstrate successful completion of a two-year program (or an approved equivalent) in one of the following fields of technology: civil engineering, construction, drafting and design, mechanical engineering, or architecture.

Students who apply to the construction management option typically have an associate's degree in engineering technology or other related technical areas.

Students who apply to the electrical option must demonstrate successful completion of a two-year program (or an approved equivalent) in electrical or electronics engineering technologies.

Students who apply to the manufacturing option must have completed a two-year program (or an approved equivalent) in a field of engineering technology.

Students who apply to the mechanical option must have completed a two-year program (or an approved equivalent) in mechanical technology.

Students who apply to the surveying option may have successfully completed a two-year program (or an approved equivalent) in a field of engineering technology, or may begin their studies as first-time freshmen.

# Joint Admissions Agreements with New Jersey Community Colleges

To assure the smooth transition from associate's degree programs offered at New Jersey community colleges to NJIT's bachelor's degree programs, NJIT has a number of Joint Admissions Agreements in place. These agreements specify the courses that community college students should take in order to maximize the number of transferable credits to NJIT. Generally, students electing this option can complete a specific BA or BS degree in four semesters of full-time study.

An important feature of all joint admissions agreements is that high school graduates are simultaneously admitted to both the cooperating community college and NJIT. The NJIT Office of University Admissions monitors the academic progress of students as they pursue the associate's degree. For the most recent list of joint admission/articulation agreements, visit: www.njit.edu/admissions/undergraduate/applying/community-colleges.php (http://www.njit.edu/admissions/undergraduate/applying/community-colleges.php).

# International Student Admission

Students whose native language is not English are required to submit their results from the Test of English as a Foreign Language (TOEFL) examination or the International English Language System (IELTS) and may also be required to take courses in English as a Second Language. The minimum TOEFL score is 550 on the paper-based exam, 213 on the computer-based exam, or 79 on the internet-based exam. The minimum IELTS score is 6.0.

Students who wish to receive transfer credit for course work completed in a country other than the United States are required to have their credentials evaluated by an accredited independent service. NJIT recommends the use of: World Education Services, Inc , Old Chelsea Station, New York, New York 10011. The transcript evaluation will be used to determine the transferability of courses. The cost for the evaluation of foreign records is borne by the student. In some cases, students may also need to be prepared to show course syllabi.  Other acceptable accreditation services may be found at http://www.naces.org.

Students whose native language is not English, who transfer to NJIT from other US colleges or from foreign universities are required to take the English Placement Test. Further details are included with the Application for Undergraduate Admission and in the Academic Policy Section.

All students who will maintain F-1 or J-1 student status while attending NJIT must submit an International Student Financial Statement as part of their application. This form is available on the admissions website: www.njit.edu/admissions/undergraduate/applying/internationalstudents.php (http://www.njit.edu/admissions/undergraduate/applying/internationalstudents.php).

# Special Programs

## Accelerated Seven-year Programs Combining an NJIT Bachelor's Degree with a Medical, Dental, or Optometry Degree

Seven-year programs are available leading to the MD degree from either Rutgers Biomedical and Health Sciences (RBHS). St. George's University School of Medicine (SGUSOM) or American University of Antiqua West Indies. Students spend three years at NJIT in an established accelerated curriculum, followed by either four years at RBHS or two years at SGUSOM followed by two years at St. Michael's Medical Center, Newark. Seven-year programs are available leading to a Dental degree from RBHS following a similar plan. A seven-year program is available leading to the Doctor of Optometry (O.D.) degree from SUNY College of Optometry.

Approved accelerated curricula have been established in Biology, Biomedical Engineering, Chemistry, Communication, Engineering Science, History, Mathematics, Physics and Science, Technology and Society . A Bachelor's degree is awarded by NJIT following successful completion of the first year at the professional school.

## Accelerated Six-Year BS/JD or BA/JD

NJIT and the Seton Hall University School of Law offer a program leading to the Bachelor of Science (BS) or Bachelor of Arts (BA) and the Doctor of Law (JD) following completion of a prescribed six-year course of study, including three years in an accelerated curriculum at NJIT as described above.

## Accelerated BS/DPT in Physical Therapy at NJIT and RBHS

NJIT and RBHS have established an accelerated 6-year program leading to a BS degree from NJIT and a Doctor of Physical Therapy (DPT) degree from RBHS. The program includes three years of undergraduate education at NJIT followed by three years of professional education in physical therapy at RBHS. The senior undergraduate year is also the first year of the doctoral curriculum, so students save time and tuition cost. Students may choose any undergraduate major in the College of Science and Liberal Arts, including biology, chemistry, communications, mathematics, physics, or science, technology and society. Engineering science is also another major that can be selected for this option.

## Accelerated BS/MS in Physician Assistant at NJIT and RBHS

NJIT and RBHS have established a 6-year program leading to a BS degree from NJIT and a Master of Science degree – Physician Assistant from RBHS. The program includes three years of undergraduate education at NJIT followed by three years of professional education in physical therapy at RBHS. The senior undergraduate year is also the first year of the doctoral curriculum, so students save time and tuition cost. Students may choose an undergraduate major in the College of Science and Liberal Arts, including biology, chemistry, or science, technology and society. Engineering science is also another major that can be selected for this option.

## Non-Matriculated Students

Academically qualified students who do not desire to enter a degree program may enroll for credit in certain undergraduate courses. Such students must present transcripts of previous academic work or other appropriate evidence each semester they register in order to indicate adequate preparation for the course work involved. A non-matriculated student fee is required for each semester in which a student registers. Students are limited to 15 credit hours of non-matriculated enrollment.

Official transcripts for non-matriculated students must list subjects completed, grades earned, and credits taken. No grades or academic credits will be awarded for audited courses. Auditors, however, may receive a statement of their attendance in the course.

## Credit by Examination and Transfer Credit

For further information see **Academic Policies and Procedures**.

## College Level Examination Program (CLEP)

Applicants may be granted course credit for non-traditional college education such as independent studies or job-related experiences by successfully passing appropriate CLEP Subject Examinations. Interested candidates should contact the Counseling Center for additional information: (973) 596-3414.

Examinations to earn credit are available in certain courses. Students who believe they have the background covered in a given course should consult with their advisor in the department offering the course to see whether an examination is offered. To receive credit by examination, a student must earn a test score at or above the level designated by that department. Students who have failed or attempted a course at NJIT may not take an examination for credit in that course. A fee is charged for the examination.

## Readmission

Students who have discontinued their studies for one or more semesters must apply for readmission to the Office of University Admissions by the application deadline. A non-refundable application fee must accompany applications. Applicants are subject to all probationary and unmet conditions in force at the time they discontinued their studies. Program requirements at the time of readmission will apply in addition to satisfaction of any prior unmet conditions.

**Application deadlines for academically suspended applicants are:**

| | |
|---|---|
| For the Fall semester | July 1 |
| For the Spring semester | Nov 1 |

**Application deadlines for all other applicants are:**

| | |
|---|---|
| For the Fall semester | August 1 |
| For the Spring semester | December 1 |

The Office of University Admissions will inform applicants of their readmission status.

# Financial Aid

Financial aid is funding for your college education that comes from sources outside your family, such as the federal or state government or an institution. Gift aid, which comes in the form of scholarships and grants, does not have to be repaid. Self-help aid, such as loans and work-study, is either repaid or earned, respectively.

At NJIT, the concept of "financial aid" typically refers to **undergraduate** awards that are offered based on financial need, merit, or both. Any combination of awards is referred to as your "financial aid package," which is calculated based on the information you provide on your Free Application for Federal Student Aid (FAFSA).Specifically, the package is determined by your Cost of Attendance (COA), Expected Family Contribution (EFC), and financial need. As a recipient of undergraduate financial aid, you can receive a combination of grants, scholarships, education loans, and student employment (work-study) in your financial aid package.

Financial aid is also available to **graduate** students in the form of education loans such as a Federal Direct, Perkins, Graduate PLUS, or private loans. To apply, you must file a Free Application for Federal Student Aid (FAFSA) at www.fafsa.ed.gov. In addition to education loans, NJIT offers other sources of graduate financial support. For more information on graduate tuition and stipend support go to: http://catalog.njit.edu/graduate/admissions-financial-support/financial-support/.

You can visit other pages of our website (http://www.njit.edu/financialaid) to learn how eligibility is determined and the variables such as withdrawal, enrollment status, and other special circumstances that affect your financial aid package. Our website is located at: http://www.njit.edu/financialaid/

For more information, you can contact the Office of Student Financial Aid Services at 973-596-3479 or at finaid@njit.edu.

# Tuition and Fees

## 2016-2017 Undergraduate Tuition & Fees

## Tuition and Fees Assessed (per Semester)

### In-State Tuition & Fees

| Credits | Tuition | Fees | Total |
|---|---|---|---|
| 1 | 517.00 | 166.00 | 683.00 |
| 1.5 | 775.50 | 249.00 | 1024.50 |
| 2 | 1034.00 | 332.00 | 1366.00 |
| 3 | 1551.00 | 498.00 | 2049.00 |
| 4 | 2068.00 | 664.00 | 2732.00 |
| 5 | 2585.00 | 830.00 | 3415.00 |
| 6 | 3102.00 | 996.00 | 4098.00 |
| 7 | 3619.00 | 1162.00 | 4781.00 |
| 8 | 4136.00 | 1328.00 | 5464.00 |
| 9 | 4653.00 | 1494.00 | 6147.00 |
| 10 | 5170.00 | 1660.00 | 6830.00 |
| 11 | 5687.00 | 1826.00 | 7513.00 |
| 12-19 (Full-Time) | 6801.00 | 1414.00 | 8215.00 |

### Out-of-State Tuition & Fees

| Credits | Tuition | Fees | Total |
|---|---|---|---|
| 1 | 1206.00 | 166.00 | 1372.00 |
| 1.5 | 1809.00 | 249.00 | 2058.00 |
| 2 | 2412.00 | 332.00 | 2744.00 |
| 3 | 3618.00 | 498.00 | 4116.00 |
| 4 | 4824.00 | 664.00 | 5488.00 |
| 5 | 6030.00 | 830.00 | 6860.00 |
| 6 | 7236.00 | 996.00 | 8232.00 |
| 7 | 8442.00 | 1162.00 | 9604.00 |
| 8 | 9648.00 | 1328.00 | 10976.00 |
| 9 | 10854.00 | 1494.00 | 12348.00 |
| 10 | 12060.00 | 1660.00 | 13720.00 |
| 11 | 13226.00 | 1826.00 | 15092.00 |
| 12-19 (Full-Time) | 14103.00 | 1414.00 | 15517.00 |

**Additional credits** above 19 are assessed at the appropriate per credit rate.

## NOTE: The Schedule of Tuition and Fees has been carefully reviewed and has been subject of a public hearing as required by Law prior to the approval by NJIT's Board of Trustees. All fees are mandatory for Full-Time and Part-Time students and are considered non-negotiable.

## Summer/Winter Session Fees

During the summer & winter sessions there is a flat fee of **$166.00** (University Fee) in lieu of the fees noted below. Full-time Tuition rates do not apply during the summer/winter sessions.

A one-time matriculation fee will be assessed to all new matriculating students (full or part-time) beginning with their first semester registration. Students assessed this fee would not be assessed the commencement fee once they apply for graduation. The commencement fee will continue being assessed to all students who had been previously registered prior to fall 2014 semester.

Full-time students will be assessed a $1338.00 Health Insurance fee in the fall semester.

## Additional Fees

| Fee Amount | Fee Description |
|---|---|
| 75.00 | U/G Application/Readmit/N-Matric |
| 120.00 | Commencement Fee |
| 120.00 | Matriculation Fee |
| 500.00 | Late Payment Penalty Fee |
| 100.00 | Late Registration Fee |
| 100.00 | Payment Plan Late Fee |
| 230.00 | First Year Student Fee |
| 25.00 | Undergraduate Maintaining Registration Fee |
| 30.00 | Transfer Orientation Fee |
| 125.00 | International Student Fee |
| 100.00 | Payment Plan Set Up Fee |
| 285.00 | Full-time Commuter Parking (per semester) |
| 160.00 | Part-time Commuter Parking (per semester) |
| 430.00 | On-Campus Resident Parking (per semester) |
| 7% | Commuter Parking Tax* |
| 200.00 | Optional Practical Training Fee |

* The State of New Jersey mandates a 7% sales tax for commuting students parking on campus.

# Campus Life and Student Services

The Campus Center is the hub of cultural, educational, and social activities for the NJIT community. The Campus Center staff provides students, faculty and staff with a relaxing environment where they can enjoy a meal, attend a meeting, study, watch a film, play a variety of games, participate in the many cultural, social, and educational activities offered, or just socialize with friends.

**Student Services**

The **Division of Academic Support and Student Affairs** (http://www.njit.edu/studentaffairs/welcome.php) consists of a variety of offices and departments that offer a wealth of programming, services, and resources to NJIT students. The common thread that runs through Student Affairs is the commitment to enable all students in our community to fully participate in an engaging, healthy, active learning environment during their time at NJIT.

# Career Services

Career Development Services (http://www.njit.edu/cds) is a value–added contributor to the career planning and preparation of NJIT students and graduates. We are dedicated to continually improving our client services and to assuming leadership in the profession of career development.

## Our Mission is fulfilled through assisting:

- Students in gaining a clear understanding of their career options and workplace requirements, in obtaining experiential learning opportunities in the private and public sectors, in developing job search and interviewing skills, and obtaining employment upon graduation;

- Alumni in refining their job search and interviewing skills, career objectives, gaining a clear understanding of their career options and workplace requirements, and obtaining meaningful employment in a specialty consistent with their education, experience, and personal goals;

- Faculty/staff in understanding the needs of employers and of the academic preparation and associated skills necessary for graduates, and thus influencing curricula content and academic advisement;

- Employers in staffing their organizations with qualified students, graduates, and alumni capable of filling their workforce needs, and in developing closer and more effective relationships with university staff;

- The community in linking students, alumni, faculty, and staff directly to service and civic engagement activities with organizations committed to improving the quality of life for New Jersey residents.

- New Jersey's economic and workforce development efforts through ready access to a highly skilled workforce, thereby reducing company expenses for new employee recruitment, staffing, and training; facilitating the transfer of technological knowledge to the workplace; and through stimulating the creation of new jobs.

# The Digital Campus

Computing has become ubiquitous in 21st century life, changing the way we work and learn, and even the way we interact with each other. The importance and power of information technology are evident in every discipline at NJIT, particularly in the STEM disciplines, where cascading breakthroughs and advances in information technology, have created a new interdependence among engineering, the physical sciences, computer science and math, and the biomedical sciences.  NJIT researchers are leveraging the power of computing and information technologies to meet tomorrow’s challenges, to create the tools to help the digital world function, and to evaluate the impact of new technologies on society.

NJIT has built a 21$^{st}$ century digital campus to support teaching, learning research, and the administration of the university.  At the heart of the digital campus is the NJIT Network, with over 19,000 connections throughout the campus’ 38 buildings, supplemented with the NJIT Wireless Network that blankets the campus, connecting over 22,000 devices each semester.  Both networks provide access to servers, storage arrays, a large software library (http://ist.njit.edu/software), and other IT services within the NJIT Cloud, enabling students to immerse themselves in design, discovery, simulation and modeling, and research questions previously inaccessible.  Examples include:

- Simulating the interaction of biomolecules and identifying promising leads for drug development;
- Modeling the consequences of various transportation and energy systems;
- Studying global social networks;
- Designing and building the next generation of software and applications;
- Practicing computational science alongside traditional approaches;
- Designing buildings and other artifacts that are environmentally responsible and resource efficient.

Highlander Pipeline (http://my.njit.edu), the NJIT Portal, is the entry point for many NJIT Cloud services.  Students conduct most routine business processes online (e.g. register for classes, accept financial aid, pay bills, etc.) via Highlander Pipeline.  The NJIT Library (http://library.njit.edu) provides online access to 27 full-text databases, over 33,500 electronic journals and more than 27,700 electronic books.  A centralized "search all" portal delivers a single search experience of all electronic library resources.

Classrooms and other learning spaces at NJIT are all network enabled and equipped with modern projection devices, display panels, and other collaborative technologies to facilitate engagement and collaboration among faculty and groups of students.  Many classes leverage video conferencing, lecture archival, learning management, and online discussion systems, allowing faculty and students to participate independent of time and place – converging the physical and virtual classrooms.

Students can BYOD (“bring your own device”) or use any of the hundreds of workstations in public-access computer labs or specialized academic department facilities across the campus.  A healthy mix of Windows, Mac, and Linux workstations support the diverse needs of a technological research university.

The Tartan High Performance Computing Initiative provides NJIT researchers the broad range of centralized computational and data storage resources necessary to conduct computationally-intensive research.  With over 3,200 CPU cores and 26,000 GPU cores, Tartan provides researchers with local resources capable of supporting leading edge research.  A separate Hadoop cluster provides the resources for managing and analyzing very large data sets, commonly referred to as “big data.”

For additional information on IT services available at NJIT, visit the Home page of the Information Services & Technology (IST) Division (http://ist.njit.edu).

# Residence Life

Almost 2000 students live on campus in five coed residence halls and the Greek Village. More than 50 percent of first-year students live on campus. First-year students live in Cypress, Honors and Redwood Halls. Upper-class students live in every building. Rooms are fully furnished (bed, desk, chair, closet, dresser), air-conditioned, wireless and wired for Internet and offer cable TV including HBO and Residence Life Cinema (current movie offerings). Each hall has common areas and facilities including lounges, study areas, kitchens and laundry rooms. Snack and soda machines, recreational equipment (pool, pingpong, large screen televisions, etc.), and mail service Monday-Friday are also provided.

**Cypress Hall** is a coed facility that houses 418 first-year, upper-class, and graduate students in single and double rooms. Suites are comprised of two bedrooms and a shared bathroom and foyer.

**Greek Village** is a coed facility that houses 192 upper-class and graduate students in eight houses.  Both fraternity and sorority members and nonmembers live in double rooms.  Suites are comprised of two bedrooms and share bathroom.  The buildings have a kitchen and dining and living area.

**Honors Residence** is a coed facility housing 360 first-year, upper-class and graduate students in single and double rooms. Suites have a shared bathroom. The building features a dining facility, convenience store and fitness center.

**Laurel Hall** is a coed facility that houses 580 upper-class and graduate students in two-room suites. Suites consist of students living in single and double rooms, sharing a bathroom and foyer.

**Oak Hall** is a coed apartment facility that houses 186 full-time upper-class and graduate students in both suite-style rooms and apartments. Each suite-style room is double occupancy with a kitchenette and shared bathroom. Each apartment has a kitchen, living room and bathroom. The eighth floor is designated for graduate students.

**Redwood Hall** is a coed facility that houses 185 first-year and upper-class students living in single and double rooms.

NJIT students use electronic cards for access to the residence halls. Desk attendants are on duty 24 hours a day and provide security for the residence halls by monitoring hall entrances and swiping resident IDs. All guests must have a valid photo ID and must be signed into the residence hall by a resident host. All guests must be accompanied by their hosts at all times.

Residence Life has staff on-duty in each hall during non-business hours. In addition, NJIT's Department of Public Safety Office police and public safety officers patrol campus 24 hours a day. Patrols are conducted on foot, in cars and on bicycles. Additionally, campus emergency phones are located on campus. Rooftop surveillance cameras are mounted throughout campus and monitored around the clock.

Once you have been admitted to NJIT, you can complete the Housing Application and Contract: https://mis3.njit.edu/housingapplication/login.aspx. A $50 nonrefundable deposit may be required and can be paid by check/money order payable to NJIT. Check/money orders must be sent to the Residence Life Office, 180 Bleeker Street, Newark, NJ 07103-3514. You will receive a confirmation in your NJIT email immediately after you submit your application online.

Applications for first-year students received by May 1 are guaranteed housing. After May 1, housing is assigned based on the distance you live from campus, need, and date of application.

For additional information please view our website: http://www.njit.edu/reslife or contact us via email reslife@njit.edu or call 973.596.3039.

## Food Services

The Dining facilities are located in the Campus Center and the first floor of the Honors Residence. NJIT's private food services vendor, Gourmet Dining Services, operates all of the dining options on campus. Meal plan options include both Continuous Dining and Flex Dollar options. The Continuous Dining meal plans, A-E, features continuous dining with unlimited returns during all of the posted hours. Flex dollars can be used at Continuous Dining (for those without meal plans or only have flex), Korner Kilt C Store, Trattoria, Tech Café, Café Spice, Grains, Leafs, Taco Bell, The Grill, Highlander Pub, Village Market, and Warren Street Café. For hours and a complete listing of what is available via flex, please check http://www.gourmetdiningllc.com/campus/njit.

# Library Services

The university's Robert W. Van Houten Library is located in a facility for study, researching, and browsing. The library collection comprises 160,000 volumes of books, conference proceedings, reports, dissertations and theses. In addition, the library receives approximately 1,000 current technical journal titles in printed format and provides customized electronic access to over 10,000 journals in electronic format. Access to journal literature in engineering, science, management, architecture, and other subject areas is provided by a variety of indexing and abstracting services.

# Continuing Professional Education

NJIT's Continuing Professional Education provides enriching career-long learning opportunities through extension programs, Online Learning, graduate certificates, and professional development training for individuals and company employees.

Professional development programs include short courses, certificates and license reviews, with some leading to the award of continuing education units (CEUs). The CEU is used nationally to document the type, quality and duration of study. In general, a CEU is defined as being equal to classroom hours. All professional development courses can be adapted to meet a particular organization's needs and conducted as a custom-designed training program at a company site. For more than 50 years, NJIT has been designing and conducting high-quality professional development programs that meet organizations' business needs. Since 1990, NJIT has trained over 63,000 professionals as part of over 550 training initiatives for 300 different companies conducting business in New Jersey.

For further information contact the Division of Continuing Professional Education at (800) 624-9850 or http://cpe.njit.edu.

# Special Programs

## Academic Support

### Dean of Freshman Studies

The Office of First Year Students supports new students --- freshmen and transfers --- in the completion of their first year of studies at NJIT. The dean works closely with faculty and students to resolve academic concerns or issues that may arise, and coordinates the freshman seminar. For further information, contact the Dean of First Year Students, (973) 596-2981.

### Educational Opportunity Program (EOP)

EOP provides access and comprehensive support services for populations traditionally underrepresented in the disciplines offered at NJIT. Services provided include academic and financial support, career and personal counseling to first-time, full-time freshmen, upper-class students and eligible transfer students who received EOP funding at their previous institutions. The program features support services such as scholarships, grants and loans; an intensive pre-freshman summer academic enrichment program that helps prepare students for success in their first year of college; and access to job and internship opportunities. Further information may be obtained from the EOP office in Campbell Hall, third floor, by calling (973) 596-3690, or by visiting the EOP home page at http://www.njit.edu/eop/index.php.

## University Research Experience (URE)

The Undergraduate Research Experience (URE) Program of EOP encourages students to include graduate and professional studies in their career planning and assists them in preparing for careers in academia by involving them in faculty guided and mentored research activities early in their undergraduate years. Assistance is also provided in the graduate admission process and identification of graduate financial aid. URE, established in September 1990, works in close collaboration with the Graduate Studies Office and the Center for Pre-College Programs at NJIT. This close collaboration affords a number of graduate students the opportunity to finance their education through stipends received as teaching or research assistants on campus and in public schools. This partnership also assists in the encouragement of students to pursue teaching careers, particularly at the university level.

## Air Force ROTC--Aerospace Studies

A commission as a Second Lieutenant in the United States Air Force may be available to the student who completes the aerospace studies program on campus. Students in any bachelor's or master's degree program may pursue this option in conjunction with their normal academic studies. Additionally, students who are undecided about pursuing a career as an Air Force officer may take these courses to fill electives under special student status.

Students who seek a commission may participate in programs ranging from two to four years in length. The most comprehensive program consists of four academic years of AFROTC classes. The courses taken include AS 111 Foundation of the US Air Force and AS 112 The Air Force Today II, introductory courses that explore the mission and organizational structure of the US Air Force; AS 221 Evolution of USAF Air and Space Power and AS 222 Air Power Key To Deterence, the study of the evolution of air power from its earliest beginnings through the present, emphasizing historical events and their impact on the development and deployment of air power; AS 333 Leadership and Management I and AS 334 Leadership and Management II, the study of the concepts and skills required by the successful manager and leader, focusing on organizational and personal ethics, communicative skills, and managerial strategy viewed in the context of the military; and AS 443 National Security Affairs/Prep Act and AS 444 Preparation for Active Duty, a survey of a broad range of topics concerning American civil and military relations and the environment in which US defense policy is formulated, including the role of the professional officer in a democratic society, the requisites for maintaining adequate national security forces, a special study of military justice and its effect on citizenship and preparation for active duty.

The four-year program requires students to participate in leadership laboratory held on Wednesday from 3:00-5:00 p.m.; departmental approval is required. This program also has a field training requirement of four weeks.

Programs of fewer than four years in length require a six-week field training session. During field training, which normally occurs the summer between the sophomore and junior years, students are placed in a variety of leadership positions and are given the opportunity to demonstrate their leadership, managerial, organizational, and physical skills. Upon returning to school for a fall semester, the students resume their aerospace studies with AS 333 Leadership and Management I, followed by AS 334 Leadership and Management II, AS 443 National Security Affairs/Prep Act, and AS 444 Preparation for Active Duty as described above. Further information may be obtained by contacting the Department of Aerospace Studies, (973) 596-3626.

## Cooperative Education and Internships

Cooperative Education (Co-op) and Internship programs offer students the opportunity, prior to graduation, to gain work experience that is related to their major. The Co-op Program provides students with an experiential and applications approach to education. Co-op is available to matriculated students in all majors. The program enhances the education of the student with the introduction of up to two full-time work experiences during which up to 6 additive or degree credits can be earned. In some majors, co-op may be taken on a part-time work schedule.

Co-op enables students to examine a professional field through employment in a major-related job. All co-op students earn a salary that can help defray college and other expenses. Co-op work experiences are scheduled after the completion of the sophomore year; for architecture students, after the completion of the junior year. Requirements for admission into the Co-op Program include good academic standing and a GPA of at least

2.2. **Architecture students are required to have a 2.5 minimum GPA for admission into the Co-op Program.** Full-time undergraduate students completing a full-time co-op work assignment may register for only two courses in addition to their co-op course.

Descriptions for undergraduate co-op work experience courses (Co-op Work Experience I and Co-op Work Experience II) are found in the course listings of the departments offering them. See the list below.

| | | |
|---|---|---|
| ARCH 310 | Co-op Work Experience I | 3 |
| ARCH 410 | Co-op Work Experience II | 3 |
| BIOL 310 | Research and Independent Study | 3 |
| BME 311 | Co-op Work Experience | 3 |
| BME 411 | Co-op Work Experience | 0 |
| CE 311 | Co-op Work Experience I | 0 |
| CE 413 | Co-op Work Experience II | 3 |
| CET 497 | Co-op Work Experience | 3 |
| CHE 310 | Co-op Work Experience I | 3 |
| CHE 311 | Co-op Work Experience II | 0 |
| CHEM 310 | Co-op Work Experience I | 3 |
| CHEM 311 | Co-op Work Experience II | 3 |
| CIMT 497 | Co-op Work Experience I | 3 |
| CS 310 | Co-op Work Experience I | 3 |
| CS 410 | Co-op Work Experience II | 3 |
| CS 485 | Special Topics in Computer Science/Information Systems | 3 |
| CPT 395 | Co-op Work Experience I | 3 |
| ECE 310 | Co-op Work Experience I | 0 |
| ECE 410 | Co-op Work Experience II | 3 |
| ECET 395 | Co-op Work Experience I | 3 |
| ECET 495 | Co-op Work Experience II | 0 |
| ENG 490 | Co-op Work Experience I | 3 |
| ENG 491 | Co-op Work Experience II | 3 |
| ESC 310 | Work Experience I | 3 |
| IE 310 | Co-op Work Experience I | 0 |
| IE 411 | Co-op Work Experience II | 3 |
| IS 310 | Co-op Work Experience I | 3 |
| IS 410 | Co-op Work Experience II | 3 |
| IT 311 | Co-op Work Experience I | 3 |
| IT 411 | Co-op Work Experience | 3 |
| MATH 310 | Co-op Work Experience I | 3 |
| MATH 410 | Co-op Work Experience II | 3 |
| MGMT 310 | Co-op Work Experience I | 3 |
| MGMT 410 | Co-op Work Experience II | 3 |
| ME 310 | Co-op Work Experience I | 0 |
| ME 410 | Co-op Work Experience II | 3 |
| MET 395 | Co-op Work Experience I | 3 |
| MET 495 | Co-op Work Experience II | 3 |
| MNET 395 | Coop Experience I | 3 |
| MNET 495 | Cooperative Experien II | 3 |
| PHYS 311 | Co-op Work Experience I | 3 |
| PHYS 411 | Co-op Work Experience II | 3 |
| STS 311 | Co-op Work Experience I | 3 |
| STS 411 | Co-op Work Experience II | 3 |

Graduate cooperative education courses may be found in the appropriate listing in the **Graduate Catalog**.

## Ronald E. McNair Post Baccalaureate Achievement Program

The Ronald E. McNair Post Baccalaureate Achievement Program at NJIT is a US Department of Education funded program that prepares eligible undergraduate students majoring in Science, Technology, Engineering or Mathematics (STEM) for doctoral studies. Students with a GPA of 3.2 and above, junior or in some cases senior level standing who meet low income and first generation guidelines, or are from groups underrepresented in graduate education, are program eligible. McNair Fellows are engaged in research and other scholarly activities with faculty mentors from the academic community. Results of their research projects are presented at professional meetings and conferences and prepared for publication in peer reviewed and other professional journals. Additionally, McNair Fellows participate in a wide array of workshops and activities to prepare them for doctoral study. A primary goal of the McNair Program is to encourage minorities and individuals underrepresented in science, engineering and mathematics higher education fields to obtain doctorates and diversify the professoriate, thereby becoming role models for others of their background. For more information about the McNair Achievement Program visit the Web site at mcnair.njit.edu (http://mcnair.njit.edu) or call (973) 596-6470 or 5590. Students may also stop by Kupfrian Hall, Room 201A.

## Student Exchange/Study Abroad

NJIT offers a number of international exchange opportunities for undergraduate and graduate students in Europe and the Far East. Through established exchange agreements, participants are provided with opportunities to enhance their technological skills, expand their cultural horizons, and gain educational experience from an international perspective. Students gain firsthand knowledge of political, social, and economic systems of a rapidly changing world.

Students may elect to study for one semester or for a full academic year. NJIT students pay tuition and fees at NJIT and room and board at the host institution. Financial aid may be applied to these expenses.

With the prior written approval of the student's academic advisor, academic credit may be awarded for courses taken while participating in an international exchange program. Some programs may require proficiency in the language of the host country, especially if the language of instruction for course work is not English.

For further information, contact the Office of International Students and Faculty, (973) 596-2451.

## Pre-Professional Programs

### Pre-Law

While students desiring a professional legal career may apply to law school with any NJIT undergraduate course of study, the minor in legal studies is particularly appropriate for this purpose. This interdisciplinary minor introduces students to a wide range of approaches to the study of law. It combines a core course emphasizing skills needed to pursue further study in law with elective courses designed to enhance students' familiarity with the functioning of law, to sharpen their understanding of the historical and cultural dimensions of law, and to improve their grasp of legal issues in technological fields. For more information, contact the faculty coordinator of the legal studies minor.

### Premedical, Pre-Dental or Preoptometric

Students interested in eventually obtaining degrees in medicine, dentistry or optometry may pursue any major at NJIT. Typically, schools of medicine,dentistry and optometry require that students have completed certain courses. For example, most medical schools require 1 year of English, 1 year of general physics with laboratory, 1 year of general biology with laboratory, 1 year of general chemistry with laboratory and 1 year of organic chemistry with laboratory. Some schools may require additional courses. Thus, certain majors at NJIT are especially suitable as they already incorporate most of these courses; these include biology, chemistry, biomedical engineering and chemical engineering. It is also possible to follow a focused four-year pre-medical, pre-dental or pre-optometric option with engineering science. Interested students may obtain further information from the Engineering Science program director.

## Accelerated Programs in Law, Medicine, Dentistry or Optometry

Students may apply for accelerated joint degree programs (http://honors.njit.edu/academics/acceleratedprograms) that offer the BS or BA degree plus the JD (law); the MD (medicine); either the DMD or DDS (dentistry); the OD (optometry); or the DPT (Doctor of Physical Therapy). These programs shorten the total time to the terminal degree by one year.

Students applying for these programs must first apply to, and be accepted by, the Albert Dorman Honors College (http://honors.njit.edu).

### BS/MS, BS/PhD, and Dual Degree Programs

These accelerated dual degree programs permit undergraduates to earn credits toward a master's degree or a doctoral degree. Students in BS/MS take 6 credits of graduate course work in their senior year. These may be counted toward both a bachelor's degree and a following master's degree if enrollment as a graduate student in the master's degree program occurs within two years of completion of the bachelor's degree. After enrollment as a graduate student, those who wish to apply the 6 credits to the graduate degree program should contact the Office of Graduate Studies. Graduate study may be completed full or part-time.

Full-time undergraduate students become eligible to apply for the BS/MS program after they complete at least five courses in their major and have maintained a GPA of 3.0 or better. Students in the Albert Dorman Honors College are pre-approved for the BS/MS program at the time of admission to NJIT but will receive letters about activating their status in BS/MS if their GPA is still above 3.0 and have earned between 57 and 110 undergraduate credits. The activation letter will instruct Honors College students about contacting the Office of Graduate Studies. All other students with a 3.0 or better GPA will have to submit an application for admission to the BS/MS program to the Office of Graduate Studies no later than one year prior to graduation. Applicants must satisfy all university requirements for admission to graduate programs.

Exceptional students may seek to go into an NJIT doctoral program directly through the BS/PhD program and must have a record consistent with university criteria for doctoral study (3.5 GPA or better). Up to 12 graduate credits may be taken in the senior year and applied later toward an NJIT doctoral program. GRE scores are required for doctoral admission

Several other combinations of Bachelor's and Master's degrees exist or are under development. The number of dual-use credits for these combinations may exceed 6 credits in accordance with specific program requirements. An example is the B. Arch/MS in Management program which allows 12 dual-use credits. Information and applications for BS/MS, BS/PhD, and other accelerated dual degree programs can be obtained from the Office of Graduate Studies, Suite 140 Fenster Hall.

## Community and Public Service

NJIT is committed to fostering opportunities for students to share their skills, talents, and enthusiasm through community service and civic engagement. Through both volunteer and paid service opportunities, students assist the public and non-profit sectors in meeting objectives to help improve the quality of life in our communities. Participants in these programs are a valuable resource of both technical and non-technical help for local and regional agencies. The office is open Mondays through Fridays, 8:30 a.m. - 4:30 p.m. during the school year. (Summer hours are 8:30 a.m.-5:00 p.m. Mondays through Thursdays). For more information about the programs described below, contact the Division of Career Development Services, Community and Public Service, (973) 596-3100 or view our website at http://www.njit.edu/CDS.

### NJIT Community of Caring

NJIT "Community of Caring" Volunteers program is a concerted outreach to promote the good work of NJIT students. Annually, we challenge our campus members to provide at least 10,000 hours of service to the citizens, non-profit agencies, and schools in communities throughout New Jersey. Participants contribute service hours through the community connections volunteer referral service or through any of our other CDS civic engagement programs.

### Community Service Work-Study Program

This program offers eligible students the option of working in community-based non-profit agencies, public schools, or governmental agencies to earn a work-study award. CSWS provides students the opportunity to earn part of the funds needed to cover educational cost and offers organizations an economical way to meet short-term staffing goals.

### Wachovia/NJ DCA Housing Scholars and Community Development Program

The Housing Scholars Program continues to engage students in affordable housing and community development projects in New Jersey. This innovative program offered a paid, ten week, full-time summer internship for students attending NJIT and other New Jersey universities or colleges. NJIT students majoring in Architecture, Civil Engineering, and Management are selected to serve as Housing Scholars.

### George Garrison and Sandy Kirk Community Service Scholarship

The George Garrison and Sandy Kirk Community Service Scholarship program promotes civic engagement by recognizing the commitment and outstanding community service contributions of NJIT students each year. One $1,000 scholarship and a $750 scholarship are presented for meritorious community service. The scholarship celebrates the dedication of George Garrison and Sandy Kirk, former CDS staff members, whose work at NJIT furthered the development of quality civic engagement for students.

### NJIT Literacy Corps—America Learns

The NJIT Literacy Corps program is to engage students as tutors in local schools and after-schools sites. Our tutors help children in the greater Newark area to understand math concepts and to read well and independently by the end of the 3rd grade. NJIT students eligible for federal work-study and student volunteers provide one-on-one and group tutoring for children.

### Service Learning Program

The Service Learning Program at NJIT facilitates experiential learning by helping students link academic theory with practical experience in a community service environment. Students participate in service learning internships related to their academic major and career goals. Successful involvement in community-based service experiences not only enhances career preparation but also provides students the opportunity to hone leadership skills in a service environment.

### Athletes in Service to Communities

This program offers NJIT student-athletes the opportunity to provide community service and outreach through team-oriented projects. Team members serve as trainers and coaches for swimming and tennis camps, NJIT Celebrity Readers in our local schools, and coordinators to collect donated sports equipment for underprivileged youth.

### Civic Engagement Computer Center @ NJIT

The Civic Engagement Computer Center @ NJIT is a student-supported resource of technical support through virtual volunteer projects for community agencies. The Center provides an avenue for NJIT students to hone their academic and technical skills through hands-on civic engagement experience. Our technology related majors volunteer or work to produce technical solutions for web design, data management, and basic computer training needs for community organizations and schools in the local and regional area.

## Civic Engagement

NJIT is committed to fostering opportunities for students to share their skills, talents, and enthusiasm through community service and civic engagement. Through both volunteer and paid service opportunities, students assist the public and non-profit sectors in meeting objectives to help improve the quality of life in our communities. Participants in these programs are a valuable resource of both technical and non-technical help for local and regional agencies. The office is open Mondays through Fridays, 8:30 a.m. - 4:30 p.m. during the school year. (Summer hours are 8:30 a.m.-5:00 p.m. Mondays through Thursdays). For more information about the programs described below, contact the Division of Career Development Services, Civic Engagement, (973) 596-3100 or view our website at http://www.njit.edu/CDS.

### Civic Scholars Program

The Civic Scholars program is an innovative civic engagement and leadership development learning experience for Honors College students. Participating students spend at least 25 hours per semester volunteering, as part of a service-learning experience, in a leadership shadowing and mentoring capacity with the Executive Director or senior staff member at a local non-profit or governmental agency.

### NJIT- A.C.E. Mentor Program Partnership

The ACE Mentor Program serves high school youth who are exploring careers in Architecture, Construction, or Engineering. The program is designed to engage, inform, and challenge youth and college students in their pursuit of future careers in these professions. NJIT Collegiate interns assist professional mentors in their work with ACE high school protégés as part of a service-learning experience.

### NJIT – Newark Public Schools – F.I.R.S.T. Robotics Programs

CDS, in collaboration with Pre-College Programs at NJIT, recruits and supervises the work of Honors College and work-study students serving as Technical Mentors/Literacy Tutors in a Robotics program. Mentors/Tutors guide 32 middle and high school teams in building robots to compete in tournaments at NJIT and in New Jersey. They also help teams gain hands-on experience in engineering and computer programming principles.

### NJIT – Newark Public Schools College Tutors Partnership Program

NJIT students work to help 11th and 12th graders prepare for the New Jersey High School Proficiency Assessment Exam (HSPA). Tutors are employed to work 10 to 12 hours per week in the after-school and Saturday sessions in Newark high schools. They assist classroom teachers with providing instruction in Language Arts and Math competencies for over 350 NPS students.

# Albert Dorman Honors College

Students with demonstrated high standards of personal and academic achievement can apply to the Albert Dorman Honors College. Admission depends on an excellent academic record, distinction in school activities, and meaningful service to the community. Additional financial support is available to Albert Dorman Honors Scholars.

The Honors College experience offers challenging courses as well as opportunities for research, leadership activities, and community engagement. Internships, co-op, and study abroad are all important educational milestones that are recognized as part of the individualized development of Albert Dorman Honors scholars.

Students enrolled in the Albert Dorman Honors College can choose to complete any degree program offered by the university; the Honors College additionally offers accelerated pre-health and pre-law programs that are available through selected accelerated majors.

For more information about the Albert Dorman Honors College, including how to apply, please visit honors.njit.edu (http://honors.njit.edu)

# College of Architecture and Design

In 2008, New Jersey School of Architecture was reconstituted as the College of Architecture and Design (CoAD), encompassing the School of Architecture and the newly-created School of Art + Design. The only college in New Jersey to house architecture and multiple design disciplines under one roof, CoAD is renowned for its innovative integration of digital technology into a comprehensive design curriculum. Benefiting from CoAD's close proximity to the cultural mecca that is the New York City metropolitan area—where a plethora of design firms, manufacturing facilities, art galleries and museums abound—students have an abundance of professional opportunities to flourish as independent artists and consultants or as part of a larger design team.

Under the tutelage of diverse, world-renowned architects and designers, CoAD students assume positions of responsibility and leadership in the architectural profession and in developing areas of opportunity in technology and community design. With an emphasis on research, design, technology and culture, which is reinforced by courses in history, building science, aesthetic, design and social concerns, CoAD offers two undergraduate programs: a four-year pre-professional B.S. in architecture and an accredited five-year program leading to a professional B.Arch degree and licensure, and four graduate degree programs: an M.S. in architecture (MSArch), a Master of Architecture and licensure (MArch); Master of Infrastructure and Planning (MIP) and a Ph.D. in urban systems. With its extensive capacity in computer graphics and studio design, the architecture program builds on the strengths of a technological university while challenging students to prepare for their productive years as practitioners, scholars and researchers.

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- Digital Design - B.A. (p. 171)
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- Architecture - B.Arch.and Technology - M.B.A. (p. 148)
- Architecture - B.Arch. and Infrastructure Planning - M.I.P. (p. 152)
- Architecture - B.Arch. and Civil Engineering - M.S. (p. 156)
- Architecture - B.S. and Management - M.S. (p. 141)
- Architecture - B.S. and and Technology - M.B.A. (p. 133)
- Architecture - B.S. and Infrastructure Planning - M.I.P. (p. 136)
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## Programs

- Architecture - M.Arch. (p. 641)
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## **Double Majors** (p. 589)

- Architecture (professional, or post-professional) - M.Arch. and Infrastructure Planning - M.I.P. (p. 646)
- Architecture (professional, or post-professional) - M.Arch. and Management - M.S. (p. 645)
- Architecture (professional, or post-professional) - M.Arch. and Civil Engineering - M.S. (p. 642)

- Urban Systems - Ph.D. (p. 648)

## College of Architecture and Design Courses

**AD 111. Communication in Art and Design - Traditional Media. 3 credits, 6 contact hours (1;0;5).**
This course will explore a range of subjects from object still life to the human figure to landscape and will deal with specific issues of line, value, composition, structure, proportion and perspective. The aim of this course is to achieve a critical approach to hand-eye coordination and ideational sketching, through both direct observation and conceptual diagramming.

**AD 112. Communication in Art and Design - Digital Media. 3 credits, 6 contact hours (1;0;5).**
This course will help students develop a critical attitude and analytical language to explore 3D and 2D issues involved in the study of design ideas but work will be focused primarily on digital techniques and modes of expression. It will cover drawing basics and digital modeling and extracted drawing techniques and critical analysis of these techiques and other methods of graphic (and architectural) representation.

**AD 150. Color and Composition. 3 credits, 5 contact hours (2;3;0).**
Introduction to principles of 2D composition with emphasis on color use and color theory. Students are introduced to traditional media (watercolor and collage) and digital raster graphics (painting, image processing, and compositioning). Applications that include interior design, product/industrial design, advertising, web design, and fine arts are discussed. Concepts include grids and hierarchy, color models and mixing, color interaction, human response to color, printing, etc. Creative projects.

**AD 161. History of Art and Design I. 3 credits, 3 contact hours (3;0;0).**
This foundation history course surveys the principle aesthetic/functional themes and theories of the twentieth century. Students will explore how various individuals have used art and design to develop products that enriched society culturally and/or that resolved particular societal needs. The course will begin with how optics revolutionized painting, sculpture, architecture, film, etc, and explore how the modern movement broke with or reinterpreted the past through a series of flashbacks.

**AD 162. History of Art and Design II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 161. This course explores the major art and design movements and influences of the 20th century post 1930 that set the stage for today's 21st century art and design works that increasingly deal with issues of globalization and technology and ecology. Students will investigate the cultural meaning and historical significance of the art/design product throughout the 20th and 21st century.

**AD 201. Human Factors/Ergonomics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Sophomore level or higher. Through lectures and "hands-on" experiments, this course will challenge the student to explore objects and environments as sensory and psychological experiences that effect human comfort, efficiency, function and emotion. Emphasis will be put on empathizing with the user with particular attention to those individuals with special physical, cognitive or occupational needs.

**AD 325. Entrepreneurship for Designers. 3 credits, 3 contact hours (3;0;0).**

**AD 340. Photography and Imaging. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 150 or (ARCH 155, ARCH 156, ARCH 163, ARCH 164) or permission of instructor. Photography is introduced as an artistic medium in a digital context. General photographic principles and techniques will be discussed including digital flash photography, image processing, in/on-camera filters and post-processing filters, camera controls, and compositional elements. Photographic student projects will be required. Students must provide their own DSLR camera for use throughout the semester.

**AD 463. Collaborative Design Studio. 5 credits, 13 contact hours (1;0;12).**
Prerequisites: (DD 364 or ID 364 or FA 364 or INT 364 or ARCH 364) and PHYS 102. Interdisciplinary and multi-disciplinary design studio where students work both individually and collaboratively on team project(s) that require the integration of different design disciplines.

**AD 490. Special Topics. 3 credits, 3 contact hours (3;0;0).**
Restriction: As determined by individual section and topic. Group investigation of problems or topics of special interest in art and design including, but not limited to, fine arts, industrial design, interior design, and digital design.

**AD 491. Independent Study. 1 credit, 1 contact hour (0;0;1).**
Restriction: Permission of instuctor and departmental/school approval. Individual investigation of problems or topics of special interest in art and design including, but not limited to, fine art, industrial design, interior design, and digital design. Subjects may include the overlap between these areas and related areas including art/architectural history and architecture. Provides opportunities to work on a project with individual guidance from an instructor in the School of Art + Design.

**AD 492. Independent Study. 2 credits, 2 contact hours (0;0;2).**
Restriction: Permission of instuctor and departmental/school approval. Individual investigation of problems or topics of special interest in art and design including, but not limited to, fine art, industrial design, interior design, and digital design. Subjects may include the overlap between these areas and related areas including art/architectural history and architecture. Provides opportunities to work on a project with individual guidance from an instructor in the School of Art + Design.

**AD 493. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Permission of instuctor and departmental/school approval. Individual investigation of problems or topics of special interest in art and design including, but not limited to, fine art, industrial design, interior design, and digital design. Subjects may include the overlap between these areas and related areas including art/architectural history and architecture. Provides opportunities to work on a project with individual guidance from an instructor in the School of Art + Design.

**ARCH 155. Modes of Design Communication I. 3 credits, 6 contact hours (0;0;6).**
Techniques of graphic presentation introduced as a basic language of architecture. Students work with a broad range of graphic presentation methods. Skills developed in drawing and architectural delineation. Fundamentals of perspective drawing, rendering techniques and format layout examined through an array of projects.

**ARCH 156. Modes of Design Communication II. 3 credits, 6 contact hours (2;0;4).**
Prerequisite: Arch 161. Introduction to digital tools in the delinieation, fabrication, and representation of contemporary design.

**ARCH 161. Intro Design and Digital Media. 6 credits, 13.5 contact hours (1.5;12;0).**
This course is an introduction to the fundamental principles and elements of design. Emphasis on design methods, manipulation of form and space, and representation skills using traditional and digital instruments. General design fundamentals and techniques presented in the lecture hour.

**ARCH 163. Introduction to Design I. 5 credits, 12 contact hours (0;0;12).**
Introduction to an array of basic principles and elements of design. Emphasis on design methods, sensitivity to context, manipulation of form and space, and representation skills. General design fundamentals presented in the lecture hour.

**ARCH 164. Introduction to Design II. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 161 A continuation of ARCH 161.

**ARCH 223. Construction I. 3 credits, 3 contact hours (3;0;0).**
This course is an introduction to construction processes, focusing on wood, steel, masonry, concrete materials and their related assemblies.

**ARCH 227. Environmental Control Systems I. 3 credits, 3 contact hours (3;0;0).**
This course introduces passive environmental design emphasizing sun, wind, daylight, heat flow, insulation/mass, visual comfort, thermal comfort, shading, climate, natural ventilation. The course uses ecotect software for thermal analysis.

**ARCH 229. Structures I. 3 credits, 3 contact hours (3;0;0).**
This course begins with the history of building structures, continues by introducing structural behavior, forces and responses in structural systems, and concludes with an introduction to static structural analysis.

**ARCH 251. History of Architecture I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101. Introduces architectural history, theory and design, providing a conceptual framework for looking at the built environment. This course introduces key architectural concepts beginning with the earliest examples of human occupation, the shaping of space, and the transformation of natural landscape. Its geographic scope is global and its chronological scope ranges from prehistory to the middle ages.

**ARCH 252. History of Architecture II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 251. This survey of the social, political, technological, functional, and aesthetic concerns of architectue, urban forms, and built and natural landscapes is a continuation of ARCH 251. It covers the period from the 15th century to 1900 in Europe, the Americas, the Middle East, and Asia. Among its emphases are the impact and significance of absolutism, colonialism, nationalism, humanism, the enlightenment, industrialization and modernity.

**ARCH 263. Architecture Studio I. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 164. Utilizing knowledge and skills gained in Introduction to Design I and II, students learn about architectural design. Examination of the technological, social and environmental issues as they relate to architectural design. Lecture hour used to explore in-depth aspects of architecture.

**ARCH 264. Architecture Studio II. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 263. A continuation of ARCH 263. Lecture hour used to explore in-depth aspects of architectural design.

**ARCH 282. Structural Principles. 3 credits, 3 contact hours (3;0;0).**
Introduces structural statics through timber and steel design. Influences of materials and structural system choice analyzed relative to their impact on building design. Responsibilities of the architect during the structural design phase are introduced.

**ARCH 283. Special Topics. 3 credits, 3 contact hours (3;0;0).**
Investigation of problem of special interest in architecture.

**ARCH 301. Digital Modeling and Fabrication. 3 credits, 3 contact hours (3;0;0).**
The seminar in Digital Modeling and Fabrication is a 3-credit course for upper level students exploring advanced 3-dimensional computer modeling techniques and data export for assembly and fabrication to various computer numerically controlled (CNC) hardware available at the School of Architecture. Specifically, students engage in NURBS and solid modeling using Rhinoceros 3D and export data through various Rhino plug-ins including RhinoCAM, which writes G- and M- Codes for 2 and 3D milling operations. CNC hardware available as of Spring 2010 includes two (2) Universal Laser Cutters, each with 18" x 32" beds; two (2) Z-Corporation Z-310 3 dimensional printers; and a Precix 9100 Industrial CNC Router with a 48" x 96" bed. Students model and fabricate full scale assemblies individually and in teams and contribute to a final exhibition of student work. Familiarity with various software tools available at the College of Architecture and Design is encouraged but not required. Admission to the course to students in their second year of study by discretion of instructor.

**ARCH 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: completion of the third year studio class, approval of the school and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. A designated faculty member monitors and evaluates the student's work and project. Requirements include mandatory participation in seminars and completion of a report and/or project. Apply in third year.

**ARCH 312. Environmental Education I. 3 credits, 5 contact hours (2;3;0).**
Prerequisite: ARCH 264. Involves architecture students in working with grade school or high school students in the solution of a joint environmental design project. Participants first work toward developing their own understanding and sensitivity of the manmade environment. Emphasis on learner-directed and discovery-guided inquiry, and educational methods to increase awareness of the physical settings created for human activities. Projects developed in nearby schools which focus on the interaction of individuals and small groups with the environment.

**ARCH 316. Computer Applications to Architecture. 3 credits, 3 contact hours (3;0;0).**
Introduces both philosophical and technical approaches to the use of the computer in architectural design and analysis. Explores the use of existing computer programs for a variety of applications to achtitectural design and programming, including but not limited to spatial allocation, energy analysis, life cycle costing, problem analysis, computer simulation, digital fabrication, virtual assembly and aggregation, rendering. Particular focus of course may vary from semester to semester.

**ARCH 317. Advanced Architectural Graphics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 264. Gives students advanced techniques for architectural expression in traditional media. A basic knowledge of drawing methods, media, materials and projection techniques is assumed.

**ARCH 323. Construction II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 223. This course surveys enclosure joints and assemblies, including roofing, insulation, doors, windows, glass and hybrid systems. It also focuses on interior and exterior finishes and their construction methodology and documentation, including Building Information Modeling (BIM).

**ARCH 327. Environmental Control Systems II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 227. This course focuses on active mechanical systems related to environmental controls including HVAC, plumbing, electrical and alternative energy systems. Additional areas covered include, elevators, electric lighting and acoustics. The course continues the use of ecotect software as an analytical tool.

**ARCH 329. Structures II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 229. This course examines lateral forces, foundations, stability, deflection, long spans and special case structural systems. Methodology involves advanced static structural analysis.

**ARCH 331. Landscape Architecture. 3 credits, 3 contact hours (3;0;0).**
An overview of the opportunities and constraints of landscape designs. Emphasis on developing a practical understanding of the potentials of earth, water and plants in architecture. Students given an overview of social and ecological determinants of relations between land and buildings.

**ARCH 332. Architecture: Image and Word I. 3 credits, 3 contact hours (3;0;0).**
This course will present films on Architecture in which architects are speaking about and showing their own work. What we think is true about architecture is often wrong. Single images tend to abstract and greatly simplify why and how great architecture is created. Rarely are buildings seen in their content. Rarely are climatic, cultural and technical issues of design illustrated. AS a result, we often speculate about architecture based upon superficial or incomplete information.

**ARCH 333. Architecture: Image and Word II. 3 credits, 5 contact hours (2;3;0).**
This course will present films on Architecture in which architects are speaking about and showing their own work. Theoreticians provide "facts" to create a unified theory of design, which may lie outside the realm of historical reality, or the intention of the architect. The culture of architectural education and the nature of the design studio results in second hand knowledge, and design myth. Surveys of modern architecture leave a fragmentary memory of great works of architecture.

**ARCH 334. Color Theory/Electronic Color. 3 credits, 3 contact hours (3;0;0).**
The multiple-media course includes lectures with supplemental readings, videos, in-class analysis and laboratory work, and homework requiring a variety of media including watercolor and computer graphics - all of which address a range of issues including interaction of color, psychology of color, design for color deficient vision, color mixing and color palettes, color reproduction, color models, color composition in art and architecture, and others. Digital applications are integrated throughout.

**ARCH 335. Digital Tectonics. 3 credits, 3 contact hours (3;0;0).**
This course uses 3D modeling tools to investigate the relationship of digital models to physical construction. The term digital tectonics refers to an idea regarding the qualities of works of contemporary architecture that seem to be influenced by the use of digital tools. In this course, students are asked to investigate this hypothesis by testing structure, skin, assemblage, form and space making methodologies that are aided by digital tools and rationalized through digital operations.

**ARCH 337. Building Information Modeling. 3 credits, 3 contact hours (3;0;0).**
This course explores both technical and philosophical approaches to the use of the computer in architectural analysis, design development, information management, and document delivery. Autodesk Building Systems and Autodesk Revit Building will be used for 3D modeling and 2D documentation employing a systems-approach framework for spatial allocation, energy analysis, and structural considerations. The workings of the foundational information databases of the respective software will be thoroughly explored. Projects requirements will include building program resolution, solar analysis, asset scheduling, document layout, and design visualization. Proficiency with Autodesk Autocad (2D) and understanding of general CAD principles are required prerequisites.

**ARCH 361. Project Based Seminar I. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: Junior Status The Project Based Seminar is the first of two seminars required for completion of the Bachelor of Science in Architecture degree. The sequence of seminars teams advanced students from varying academic backgrounds to take on real-life projects in an experiential learning setting. As part of final deliverables, student teams make presentations and submit hardcopy proposals to interested constituencies.

**ARCH 363. Architecture Studio III. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 264, ARCH 223, ARCH 227 and ARCH 229. This course is a continuation of ARCH 264. Lecture hour explores the nature of technology, environment, and social order as they relate to studio work. Course materials purchase required.

**ARCH 364. Architecture Studio IV. 5 credits, 13 contact hours (0;0;13).**
Prerequisites: ARCH 363. A continuation of ARCH 363. Lecture hour explores in depth the nature of technology, environment, and social order as they relate to studio work. Students will be required to purchase course materials.

**ARCH 381. History of Architecture III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 252. A continuation of ARCH 252, this course surveys global developments in architecture, urban planning, and landscape design in the first half of the 20th century. It examines the continued architectural impact of industrialization and modernization and the geo-political consequences of World War I and World War II on the built environment. The focus is on the development and diffusion of modernism and its relationship to such key concepts as universalism, regionalism, historicism, and utopia.

**ARCH 382. History of Architecture IV. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 381. The last in the sequence of history surveys, this course examines global developments in modern and contemporary architecture and urbanism after World War II and into the 21st century. Social uprisings, economic recessions, post-colonialism, modernization in the developing world, mass production and mass consumption, environmentalism, sustainability, and the computer revolution of the information age provide the historical and cultural framework for the course. The course pays particular attention to early extensions and critiques of modernism, the emergence of postmodernism and current efforts to reevaluate modernism's legacy.

**ARCH 408. Advanced Landscape Architecture. 3 credits, 3 contact hours (3;0;0).**
Introduces the design, construction and management of contemporary landscape projects through case studies, field trips, and personal contact with prominent practicing landscape architects. A historical perspective of landscape architecture is used as a context for discussion.

**ARCH 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ARCH 310 or approval of the school and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. A designated faculty member monitors and evaluates the student's work and project. Requirements include mandatory participation in seminars and completion of a report and/or project.

**ARCH 419. Architectural Photography. 3 credits, 4 contact hours (2;2;0).**
This course is designed for architecture students in using photography to better visualize form in space in a 2-D format, lighting, color, and composition. The course goal is developing their unique expressive abilities in seeing through the camera. Discussions emphasize correlating historical movements in architecture and the visual arts in photography, using relevant text selections, slide presentations, and museum visits for reinforcement.

**ARCH 423. Construction III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 323. This course focuses on non-normative systems, hybrid and integrated assemblies and new materials. An emphasis is placed on systems integration, materials selection, specifications and construction documents associated with the comprehensive design of buildings using Building Information Modeling (BIM).

**ARCH 429. Structures III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 329. This course focuses on wood systems analysis, steel systems analysis, indeterminate systems and integrated structural systems. Methodology involves finite member analysis.

**ARCH 432. P3 Post Presentation Processing. 3 credits, 5 contact hours (2;3;0).**
The project is deemed Architecture, with a capital A, but there remains nagging questions: What would the project be like if viewed stereoscopically? If it were rendered as a 360 degree panoramic view, what would the space be like? If it was accurately superimposed into the site (lighting, color, texture, camera angle), does the design improve when in the context? Would rendering styles using "natural media" be more descriptive? What would the architecture be like at night?.

**ARCH 461. Project Based Seminar II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:Junior status The Project Based Seminar II is the second of two seminars required for completion of the Bachelor of Science in Architecture degree. The sequence of seminars teams advanced students from varying academic backgrounds to take on real-life projects in an experiential learning setting. As part of final deliverables, student teams make presentations and submit hardcopy proposals to interested constituencies.

**ARCH 463. Option Studio 1. 5 credits, 12 contact hours (0;0;12).**
Studio methodology allows the students to select from various building programs, the nature of design dealing with technology, environment and the social order. Lecture hour coordinates with studio subject matter. Course materials purchase required.

**ARCH 464. Option Studio II. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 364. Studio methodology allows students to select from various building programs, the nature of design dealing with technology, environment and the social order.

**ARCH 472. Architectural Programming and Project Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 264. Covers the essentials for programming a building and understanding the full scope of project development that precedes and follows the programming phase. Identify major stakeholders in the building design and production process and examine their roles. Lectures and assignments include: user requirements and client values, methods of pro forma analysis for project development and approval, and how the development process changes over time.

**ARCH 483. ST:. 3 credits, 3 contact hours (3;0;0).**
Group investigation of problem of special interest in architecture.

**ARCH 491. Independent Study. 1 credit, 1 contact hour (0;0;1).**

**ARCH 493. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**DD 275. History of Games. 3 credits, 5 contact hours (2;3;0).**
Prerequisites: AD 111, AD 112 and AD 162 or ARCH 163, ARCH 263 and ARCH 251. A guided exploration through the world of games. Students will experiment, play, and analyze various aspects of games - from early traditional games to current generation electronically-mediated games; from individual games to collaborative online games. Game types will be analyzed with particular attention paid to the virtual environments in which these games take place. The expressive and persuasive aspects of games will also be explored.

**DD 284. Video and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 112 and AD 150 or equivalent with instructor's and program permission. Laboratory course exploring concepts of linear, motion-based two-dimensional media and includes motion graphics, live action filming, particle systems, digital video editing and digital video compression. Projects include the design and production of multiple projects addressing both technical and creative decision making.

**DD 301. Acting Fundamentals for Animators. 3 credits, 3 contact hours (3;0;0).**
Introduction to the historical contexts of acting. Survey of acting techniques and principles and their relationship to successful visual storytelling. Topics covered include movement, empathy and dialogue. Application of acting to two-and three-dimensional animation. Students will study examples from animation as well as film and theater. Required projects include both in-class acting exercises as well as storyboard creation and directed computer graphics character animation.

**DD 303. Foundations of Sound and Music. 3 credits, 3 contact hours (3;0;0).**
A multimedia course to give an understanding of music theory and musicology. Survey of the history of music and musical movements, and the use of music in motion pictures, digital media, and interactive entertainment. An introduction to instrumentation, music notation, music theory world musicology, and ear training as well as the relationship between music and culture. Visual and audio components are included. Digital Design majors only, others by permit.

**DD 320. Computational Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 112, AD 150; or ARCH 155, ARCH 156; or instructor approved equivalents. The course explores methods for algorithmically modeling spatial structures. Through a sequence of scripting exercises in application-specific programming environments, the course further explores rule-based generation of spatial forms and the underlying mathematical principles. Applications of digital fabrication and physical computing are also explored.

**DD 321. Interactive and Reactive Environments. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 112, AD 150 and DD 284, or ARCH 155, ARCH 156, ARCH 263 andARCH 264, or instructor permission. This course will investigate contemporary attitudes toward digital public spaces, from mainstream media facades, interactive art installations, and mobile applications to guerrilla-like techniques such as tactical media, activist gaming, and electronic civil disobedience. Based on their research of relevant precedents, students will design a 2D and/or 3D interactive environment.

**DD 334. Simulated Environments. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: DD 275 and DD 284. Digital Design majors only, all others with permission of the department. This course will explore the application of desktop, non-immersive virtual reality to the representation of architecture. Course exercises and projects are designed to uncover both advantages and limitations of this emerging technology, on both practical and theoretical levels. The major focus of the course will be personal evaluation of these tools in the design of both object-specific and the spatial in architectural problem solving. The collaborative nature of the toolkit will inform design decisions vis-a-vis observation of participant behavior and open discussion with interactive critics.

**DD 363. Digital Design Studio I. 5 credits, 13 contact hours (1;12;0).**
Prerequisites: AD 111, AD 112, AD 150, AD 161, AD 162, DD 284. CO/Prerequisites: DD 275, ARCH 251. Three-dimensional design in a digital milieu. Project-based applications focusing on the design and digital representation of architectural or environmental settings for games, theater, advertisements, books, or similar contexts. Course includes modeling with different geometries (e.g. NURBS, polygonal) and advanced techniques in rendering with lighting and materials as well as issues of production design.

**DD 364. Digital Design Studio II. 5 credits, 12 contact hours (0;0;12).**
Prerequisites: ARCH 251, DD 275, DD 363, IT 201. Design studio focusing on two-and three-dimensional visual communication of data, including interactive and scripted/animated communication as well as still-image utilization. Applications may include website creation, information kiosks, exhibit design, educational videos, scientific visualization, and other graphics-intensive projects.

**DD 403. Digital Sound and Music. 3 credits, 3 contact hours (3;0;0).**
A studio class that provides a baseline understanding of sound design within an animated video and video game environment. Course includes an introduction to sampling, field recording, sound effects, production techniques, and general sound design for the purpose of integrating and managing the integration of audio in motion pictures, television, and video games. Analytical and creative projects are required.

**DD 415. Web/Exhibit Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 150, DD 284, IT 201. Instructor may waive or accept alternate prerequisite(s) based on individual student preparation. Overview of multimedia exhibit design dealing with issues of graphic identity human-computer interactions, and information visualization as tools for comprehension, enhanced communication, and effective decision-making. Exhibit types include educational symposia, museum/gallery shows, and online environments. Analyses and creative project(s) are required.

**DD 442. Visual and Special Effects in Movies. 3 credits, 3 contact hours (3;0;0).**
The creating of narrative-dependent moving images pushes the boundaries of entertainment technology. This class investigates the progress of visual and special effects as viewing moved from the Kinetoscope to 4K digital projection. The use of mirrors, cameras, and other analog devices along with information technology enabled effects including computer generated imagery are studies. Analytical and creative projects are required.

**DD 443. 2-Dimensional Character Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 111, DD 275 and DD 284 This course focuses on the design of charaters for 2-Dimensional media such as graphic novels, 2D video games, model sheets for 3D creation, concept art and so on. Students will create both humanoid and creature-based charaters by using a variety of skillsets, including basic anatomy, illustrating age, acting (through characters), prop and costume design, etc. Students will also learn pre-production tools such as reference gathering, concept sketches and mood boards.

**DD 444. 3-Dimensional Character Devel. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 111, DD 275, DD 284 and DD 301 In-depth exploration of 3D character design, modeling and animation for video games and cinematographic production. Conceptual and technical/production topics are considered. Precedent studies are required from sources including illustration, gaming and video/animation disciplines as well as theatrical and cinematographic choreography including fashion designers and make-up artists. 3D modeling, UV unwrapping, texturing and rigging as well as pipeline production processes are also included.

**DD 449. Imaginary Worlds: Architecture in Motion Pictures. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 112, AD 161, AD 162 and ARCH 382. DD cohort designation for DD majors only. Like childhood photographs in family albums, movies are part of our collective memories and become a unique way of "remembering" an era or place even one that has never existed or could exist. The study of imaginary worlds in motion pictures provides students with opportunities to gain an awareness of architecture and study it from different perspectives. Movies studied will be limited to those that postulate new, or unique, environments rather than those films that faithfully document reality. Discussions will focus on architectural issues raised by the movies studied as well as those found in critical essays.

**DD 464. Digital Design Studio III. 5 credits, 12 contact hours (0;12;0).**
Prerequisite: DD 364. Continuation of Digital Design Studio II with projects of greater complexity requiring the selection and use of multiple media (including time-based media) in the preparation and completion of creative work. Independent research and production by each student is required for all projects. Production of both passive and interactive projects will be part of the studio program.

**ID 203. Past, Present and Future of Design. 3 credits, 3 contact hours (3;0;0).**
Restriction: Sophomore level or higher. Intensive survey course marking pivotal design paradigm shifts from ancient cultures through the industrial revolution, the present day and projecting into the future, this course focuses on the human activity called design. Case studies of selected cultures and designers will expose the student to the forces, history, methods, styles and meanings that shape the human ecology.

**ID 216. Modeling and Prototyping. 3 credits, 3 contact hours (3;0;0).**
Restriction: Sophomore level or higher. Corequisite: ID 263. Introduction to the drafting skills, techniques and methods needed to communicate a design for fabrication as well as the materials, tools and techniques to make full size working prototypes. The drafting component of the course will cover orthographic, isometric, line weight, dimensioning and specifications. Building from the drafting component of the course, the prototypes component will - through work in the model shop - introduce the student to the most common fabrication techniques, tools and methods used to build appearance and working prototypes in various materials.

**ID 217. Modeling and Manufacturing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ID 216. Corequisite: ID 264. This course will build on the computer modeling techniques of the ID 216 course and combine it with the programs, tools and facilities used in Computer-Aided Manufacturing (CAM). The student will take computer-generated designs and feed them directly into the manufacturing system. The course will also explore Computer Aided Manufacturing as a means of facilitating mass customization: the process of creating small batches of products that are custom designed to suit each particular user.

**ID 263. Industrial Design Studio I. 4 credits, 8 contact hours (0;0;8).**
Prerequisite: AD 111 and AD 112. Pre/Corequisite: AD 150. Students are introduced to designing objects, environments and systems through a series of exercises in conceptual, abstract, and strategic thinking as it applies to the small and large-scale artifact. The relationship between function structure materiality, production aesthetics and human needs are introduced and tested.

**ID 264. Industrial Design Studio II. 4 credits, 8 contact hours (0;0;8).**
Prerequisite: AD 150 and ID 263. This course is a continuation of ID 263 with the focus shifting toward selected problems derived from the areas of work, health, education, recreation and communication. Introduction to the case study method of analyzing existing products.

**ID 301. Industrial Design Specialization. 3 credits, 3 contact hours (3;0;0).**
Corequisite: ID 363 (or higher) or INT 363 (or higher). Restriction: Permission of Art + Design Advisor. This project-based course will expose the student to one of many specialties within the Industrial Design profession that may include industry-specific design explorations and case studies in areas that include the design of furniture, consumer products, toys, footwear and apparel, jewelry, lighting, exhibits, way-finding graphics, transportation, etc.

**ID 310. Ethnographic and Marketing Research. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. Research methodologies will be explored and conducted as a means to lend an objective understanding of user needs, desires and motivations. This will occur through well documented interviews, surveys, observations and interventions. The information gathered will be used to shape new products, add value to existing products or give insite to yet unexplored products or marketing opportunities.

**ID 312. Mechanics and Electronics. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. This is an advanced research course that addresses products which employ electronics predominantly as the major factor of design, then products that employ mechanical systems as the major determining factor, finally, the interpolanation of the mechanical with the electronic with a focus on the human interface with these products.

**ID 340. Materials and Processes. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. The student will be introduced to the basic materials and processes used in manufacturing of both short run and mass-produced objects. The course will comprise of lectures, field trips and design exercises employing both traditional and state-of-the-art manufacturing processes.

**ID 341. Sustainable Materials and Processes. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. The course will comprise of lectures and field trips that take a critical look at the traditional materials and processes used in manufacturing and evaluate alternatives based on research and experimentation. Each student will perform a Life Cycle Analysis (LCA) on an existing product by following the products life from the mining of raw materials to disposal taking particular attention to energy usage, use of natural resources, toxicity and decomposition.

**ID 363. Industrial Design Studio III. 4 credits, 8 contact hours (0;0;8).**
Prerequisite: ID 264. This project specific studio will address real-world needs, parameters, and research as it applies to market trends and industry focused development. Companies and entrepreneurs will be invited to submit industry or need specific project briefs to the studio which will become the project for the semester. The students will experience first-hand the challenges of designing, building and testing within a real-life, interdisciplinary framework. The company will participate as sponsor, mentor and partner to the students.

**ID 364. Industrial Design Studio IV. 5 credits, 13 contact hours (0;0;13).**
Pre and Co-requisite: ID 216, ID 363, AD201. A knowledge and evidence-based studio that addresses real-world needs, parameters, and research. Work and product design(s) may be derived from requirements that include governmental and non-governmental not-for-profit organizations as well as from research about needs that can affect the social, physical, and economic health of individuals.

**ID 370. New Product Testing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 201 or permission of instructor. A hybrid course combining hands-on physical testing of products with lectures, readings, and case study presentations (both group and individual- oral and written). Multiple evaluative criteria (e.g safety, value, sustainability) will be discussed, established, and tested on a variety product types. Students may be required to provide/purchase a limited number of items for destructive testing. In-class student participation required.

**ID 410. Professional Practice and Ethics. 3 credits, 3 contact hours (3;0;0).**
Restriction: Senior level. This course covers the concepts of legal rights, copyrights, responsibilities and obligations of the designer, re: liabilities, contract review, patents, royalties, etc. The course also covers areas of responsibility in owner-offices, within corporate offices, working with design consultants and procedures for establishing a professional design practice. The course will also focus on the ethics of practice, research and marketing within a social, political and cultural context.

**ID 463. Industrial Design Studio V. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ID 364. This studio will draw from the vast academic talent at NJIT by partnering Industrial Design students with students in the other colleges and departments on campus such as engineering, architecture, management and computing. The students will develop methodologies for achieving effective collaboration and integration of industrial design with other disciplines, especially in the early phases of product development, through an industry specific design project.

**ID 464. Industrial Design Studio V. 5 credits, 13 contact hours (1;0;12).**
Prerequisites: ID 364 and PHYS 102. A comprehensive studio with projects (including multi-disciplinary projects) of advanced design and complexity. Students will work to initiate research and development of projects within the studio to demonstrate a full range of professional competencies, including but not limited to, the ability to independently critique work in progress. Completed work and presentaion materials are expected to be exhibitable quality.

**INT 221. Building and Interior Systems I. 3 credits, 3 contact hours (3;0;0).**
An introduction to, and overview of, large-scale systems used in and affecting the design of building interiors. The operation and impacts of heating, ventilating, and air conditioning equipment on building space and layout are emphasized. Additional topics include the design of plumbing and waste systems as they affect building planning and the design of related spaces (including kitchens and bathrooms) and the use and design requirements for vertical transportation in building interiors.

**INT 222. Building and Interior Systems II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 102. An introduction to, and overview of, small-scale systems used in and affecting the design of building interiors. The needs and scope of design potentials in electrical systems (including requirements for media installations) and lighting design as they are used in, affect the design of, interiors are emphasized. Also included is an introduction to building acoustics and how basic principles affect design layout and material and furniture selection for a variety of building and construction types.

**INT 263. Interior Design Studio I. 4 credits, 10 contact hours (1;0;9).**
Prerequisites: AD 111, AD 112. Co/prerequisite: AD 150. Corequisite: INT 221. A hands-on studio based introduction to the basic principles and elements of design for interior design students. Emphasis on design methods using multiple media, manipulating form and space. Course includes lectures, readings, analytical exercises, and (primarily three-dimensional) design projects.

**INT 264. Interior Design Studio II. 4 credits, 10 contact hours (1;0;9).**
Prerequisites: AD 150, INT 263. Corequisite: INT 222. A continuation of Interior Design Studio I. A hands-on studio course that expands introductory design problems into commercial interiors and public spaces. Interior design as a knowledge-based discipline is introduced. Emphasis is placed on the development of an iterative and reflective design process as well as the production and presentation of interior design proposals. Preliminary integration of multiple technical variables is included.

**INT 321. Methods and Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 111, AD 112, AD 150 or ARCH 334, AD 161, AD 162 and ARCH 251. The study of materials, products, and assemblies used in interior design. The course covers code requirements and life safety, specification, installation, performance of materials (including fabrics and textiles), and sustainability of material selection and utilization. Also covered are the impacts of materials utilization on health and interior environmental quality.

**INT 322. Contract Documents. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: INT 321, INT 363. Co/prerequisite: ARCH 282. The course addresses issues of standards and methods of ethical and professional practice. It covers the production of contracts between the professional design service provider and clients as well as various project deliverables used in initial design phases through project close out. Document types covered include letters of agreement, contract document drawing sets and addenda sketches, specifications, schedules and budgets.

**INT 350. History of Furniture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 161 and AD 162 or equivalent; or ARCH 251, ARCH 252 and ARCH 381. Survey course studying the history and characteristics of furniture design from antiquity to the present day. Study of social and design forces influencing furniture. Students will analyze furniture in terms of style, aesthetic intent, construction and materials, ergonomics, universal/barrier-free accessibility, sustainability, and technology. Major stylistic movements will be discussed.

**INT 351. Furniture Design. 3 credits, 5 contact hours (2;0;3).**
Prerequisites: INT 264 or ID 264 or DD 364 or FA 264 or ARCH 264. Corequisite: Studio enrollment. This course is an introduction to the concepts, materials and construction technologies involved in the design and fabrication of furniture. It explores the relationship between ergonomics, comfort and function in the design of furniture for both site-specific environments and mass-produced applications. Course includes lectures, field trips and a variety of drawn, modeled, and built design projects.

**INT 363. Interior Design Studio III. 5 credits, 13 contact hours (0;0;5).**
Prerequisites: INT 222, INT 264. CO/Prerequisites: INT 221, INT 321, INT 350. Design studio focusing on residential design. The course includes a study of the relationship of human behavior to design emphasizing dwelling, security, comfort, and home. The correlation between furniture use and selection and residential space is explored. Variables studied include aesthetics and design organization, as well as the link between residential design and interior systems like lighting and plumbing.

**INT 364. Interior Design Studio IV. 5 credits, 13 contact hours (1;0;12).**
Prerequisites: INT 221, INT 222, INT 321, INT 363. Co/prerequisite: ARCH 282. A continuation of the studio sequence with design and space planning projects of increasing complexity selected within the context of commercial and institutional building types - from office environments and healthcare facilities to religious venues and community facilities. Students are expected to further develop skills to simultaneously resolve coneptual, technical, aesthetic, and functional aspects of designs.

**INT 464. Interior Design Studio V. 5 credits, 13 contact hours (0;0;13).**
Prerequisites: ARCH 282, ARCH 337, INT 321, INT 322, INT 364; Co/prerequisite: AD 201. A comprehensive studio with projects of advanced design and programming complexity concentrating on larger multi-level institutional and/or mixed-use building types. Students will work to initiate research and development through all design phases to synthesize the functional, sociological, aesthetic, regulatory, and project-specific technical requirements of their projects as they relate to interior design.

# Architecture

**Accredited by:** The National Architectural Accrediting Board.

In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on the extent of its conformance with established educational standards.

Master's degree programs may consist of a professional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the professional degree is not, by itself, recognized as an accredited degree.

The New Jersey School of Architecture educates students to assume positions of responsibility and leadership in the architectural profession and in developing areas of opportunity in technology and community design related to the discipline of architecture. An emphasis on studio design in the curriculum is reinforced by courses in history, building science and social concerns. A diverse faculty brings its expertise to bear on issues of architecture, technology and culture and challenges students to prepare for their productive years as practitioners, scholars and researchers. The architecture program builds on the strengths of a technological university with its extensive capacity in computer graphics while emphasizing design directed toward the traditional human-centered values of architecture.

The total time needed to earn a Bachelor of Architecture (the first professional degree) at NJIT is five years.

The New Jersey School of Architecture offers a nonprofessional, four-year undergraduate program leading to the Bachelor of Science (B.S.) in Architecture. The B.S. does not lead to licensure as an architect; instead it presents students with a wide array of other options leading to career opportunities within the building industry. Students can be admitted to the B.S. in Architecture program as a freshman or transfer from the B.Arch. program after two years. The B.S. in Architecture program requires 135 credits and is structured as follows:

The first two years of the B.S. in Architecture program are identical to the course of study for the five-year professional program.

In the third year, all B.S. students take ARCH 363 Architecture Studio III followed by a computer elective. Thus every student has at least one full year of computer-based learning. The B.S. in Architecture is designed to lead into a series of accelerated graduate degree programs in fields such as construction management (B.S. in Architecture/M.S. in Civil Engineering), infrastructure planning (B.S. in Architecture/Master in Infrastructure Planning), management (B.S. in Architecture/M.S. in Management; B.S. in Architecture/M.B.A. in Management of Technology), or a professional graduate degree in Architecture (B.S. in Architecture/Master of Architecture) leading to licensure. Graduate-level course descriptions for those listed in the dual degree programs description are located in the NJIT Graduate Catalog.

Course choices are worked out on an individual basis after consultation with the academic advisor to reflect a student's individual interests and career objectives. The B.S. in Architecture provides a wide array of curriculum paths; it is designed to provide a superb general education for all building professionals.

# NJIT Faculty

## A

Alcala, Jose M., University Lecturer

## B

Bales, Ervin, Research Professor

Bess, Mark E., University Lecturer

Brothers, David A., Senior University Lecturer

Burgermaster, Matthew A., Assistant Professor

## C

Cays, John M., Associate Dean for Academics, College of Architecture and Design

Celik, Zeynep, Distinguished Professor

## D

Dart, James, University Lecturer

Decker, Martina, Assistant Professor

De Sousa Santos, Antonio P., Professor Emeritus

## E

Elwell, David H., Associate Professor Emeritus

Esperdy, Gabrielle, Associate Professor

## F

Franck, Karen A., Professor

## G

Garber, Richard J., Associate Professor

Garcia Figueroa, Julio C., University Lecturer

Gauchat, Urs P., Professor

Goldman, Glenn, Professor

Greenfield, Sanford R., Professor Emeritus

## H

Harp, Cleveland J., University Lecturer

Hurtado De Mendoza Wahrolen, Maria A., Associate Professor

## K

Krumwiede, Keith A., Associate Professor

## L

LeCavalier, Jesse, Assistant Professor

### M

Moore, Sandy, Associate Professor

Mostoller, G. Michael, Distinguished Professor

### N

Narahara, Taro, Assistant Professor

Navin, Thomas R., University Lecturer

### O

Ogorzalek, Thomas, University Lecturer

### P

Papademetriou, Peter C., Professor Emeritus

### R

Russo, John Rhett, Associate Professor

### S

Schuman, Anthony W., Associate Professor

Siegel, Joy W., University Lecturer

Sollohub, Darius T., Associate Professor

### T

Taher, Rima, Senior University Lecturer

Theodore, Georgeen, Associate Professor

### W

Wall, Donald R., Associate Professor Emeritus

Weisman, Leslie K., Professor Emeritus

Wendell, Augustus E., University Lecturer

West, Troy, Associate Professor Emeritus

Wood, Timothy Daniel, University Lecturer

### Z

Zarzycki, Andrzej, Associate Professor

Zdepski, Michael, S., Associate Professor

## Programs

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- Architecture - B.Arch.and Management of Technology - M.B.A. (p. 148)
- Architecture - B.Arch. and Infrastructure Planning - M.I.P. (p. 152)
- Architecture - B.Arch. and Civil Engineering - M.S. (p. 156)
- Architecture - B.S. and Management - M.S. (p. 141)
- Architecture - B.S. and and Management of Technology - M.B.A. (p. 133)

- Architecture - B.S. and Infrastructure Planning - M.I.P. (p. 136)
- Architecture - B.S. and Civil Engineering - M.S. (p. 138)

# New Jersey School of Architecture Courses

**ARCH 155. Modes of Design Communication I. 3 credits, 6 contact hours (0;0;6).**
Techniques of graphic presentation introduced as a basic language of architecture. Students work with a broad range of graphic presentation methods. Skills developed in drawing and architectural delineation. Fundamentals of perspective drawing, rendering techniques and format layout examined through an array of projects.

**ARCH 156. Modes of Design Communication II. 3 credits, 6 contact hours (2;0;4).**
Prerequisite: Arch 161. Introduction to digital tools in the delinieation, fabrication, and representation of contemporary design.

**ARCH 161. Intro Design and Digital Media. 6 credits, 13.5 contact hours (1.5;12;0).**
This course is an introduction to the fundamental principles and elements of design. Emphasis on design methods, manipulation of form and space, and representation skills using traditional and digital instruments. General design fundamentals and techniques presented in the lecture hour.

**ARCH 163. Introduction to Design I. 5 credits, 12 contact hours (0;0;12).**
Introduction to an array of basic principles and elements of design. Emphasis on design methods, sensitivity to context, manipulation of form and space, and representation skills. General design fundamentals presented in the lecture hour.

**ARCH 164. Introduction to Design II. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 161 A continuation of ARCH 161.

**ARCH 223. Construction I. 3 credits, 3 contact hours (3;0;0).**
This course is an introduction to construction processes, focusing on wood, steel, masonry, concrete materials and their related assemblies.

**ARCH 227. Environmental Control Systems I. 3 credits, 3 contact hours (3;0;0).**
This course introduces passive environmental design emphasizing sun, wind, daylight, heat flow, insulation/mass, visual comfort, thermal comfort, shading, climate, natural ventilation. The course uses ecotect software for thermal analysis.

**ARCH 229. Structures I. 3 credits, 3 contact hours (3;0;0).**
This course begins with the history of building structures, continues by introducing structural behavior, forces and responses in structural systems, and concludes with an introduction to static structural analysis.

**ARCH 251. History of Architecture I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101. Introduces architectural history, theory and design, providing a conceptual framework for looking at the built environment. This course introduces key architectural concepts beginning with the earliest examples of human occupation, the shaping of space, and the transformation of natural landscape. Its geographic scope is global and its chronological scope ranges from prehistory to the middle ages.

**ARCH 252. History of Architecture II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 251. This survey of the social, political, technological, functional, and aesthetic concerns of architectue, urban forms, and built and natural landscapes is a continuation of ARCH 251. It covers the period from the 15th century to 1900 in Europe, the Americas, the Middle East, and Asia. Among its emphases are the impact and significance of absolutism, colonialism, nationalism, humanism, the enlightenment, industrialization and modernity.

**ARCH 263. Architecture Studio I. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 164. Utilizing knowledge and skills gained in Introduction to Design I and II, students learn about architectural design. Examination of the technological, social and environmental issues as they relate to architectural design. Lecture hour used to explore in-depth aspects of architecture.

**ARCH 264. Architecture Studio II. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 263. A continuation of ARCH 263. Lecture hour used to explore in-depth aspects of architectural design.

**ARCH 282. Structural Principles. 3 credits, 3 contact hours (3;0;0).**
Introduces structural statics through timber and steel design. Influences of materials and structural system choice analyzed relative to their impact on building design. Responsibilities of the architect during the structural design phase are introduced.

**ARCH 283. Special Topics. 3 credits, 3 contact hours (3;0;0).**
Investigation of problem of special interest in architecture.

**ARCH 301. Digital Modeling and Fabrication. 3 credits, 3 contact hours (3;0;0).**
The seminar in Digital Modeling and Fabrication is a 3-credit course for upper level students exploring advanced 3-dimensional computer modeling techniques and data export for assembly and fabrication to various computer numerically controlled (CNC) hardware available at the School of Architecture. Specifically, students engage in NURBS and solid modeling using Rhinoceros 3D and export data through various Rhino plug-ins including RhinoCAM, which writes G- and M- Codes for 2 and 3D milling operations. CNC hardware available as of Spring 2010 includes two (2) Universal Laser Cutters, each with 18" x 32" beds; two (2) Z-Corporation Z-310 3 dimensional printers; and a Precix 9100 Industrial CNC Router with a 48" x 96" bed. Students model and fabricate full scale assemblies individually and in teams and contribute to a final exhibition of student work. Familiarity with various software tools available at the College of Architecture and Design is encouraged but not required. Admission to the course to students in their second year of study by discretion of instructor.

**ARCH 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: completion of the third year studio class, approval of the school and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. A designated faculty member monitors and evaluates the student's work and project. Requirements include mandatory participation in seminars and completion of a report and/or project. Apply in third year.

**ARCH 312. Environmental Education I. 3 credits, 5 contact hours (2;3;0).**
Prerequisite: ARCH 264. Involves architecture students in working with grade school or high school students in the solution of a joint environmental design project. Participants first work toward developing their own understanding and sensitivity of the manmade environment. Emphasis on learner-directed and discovery-guided inquiry, and educational methods to increase awareness of the physical settings created for human activities. Projects developed in nearby schools which focus on the interaction of individuals and small groups with the environment.

**ARCH 316. Computer Applications to Architecture. 3 credits, 3 contact hours (3;0;0).**
Introduces both philosophical and technical approaches to the use of the computer in architectural design and analysis. Explores the use of existing computer programs for a variety of applications to achtitectural design and programming, including but not limited to spatial allocation, energy analysis, life cycle costing, problem analysis, computer simulation, digital fabrication, virtual assembly and aggregation, rendering. Particular focus of course may vary from semester to semester.

**ARCH 317. Advanced Architectural Graphics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 264. Gives students advanced techniques for architectural expression in traditional media. A basic knowledge of drawing methods, media, materials and projection techniques is assumed.

**ARCH 323. Construction II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 223. This course surveys enclosure joints and assemblies, including roofing, insulation, doors, windows, glass and hybrid systems. It also focuses on interior and exterior finishes and their construction methodology and documentation, including Building Information Modeling (BIM).

**ARCH 327. Environmental Control Systems II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 227. This course focuses on active mechanical systems related to environmental controls including HVAC, plumbing, electrical and alternative energy systems. Additional areas covered include, elevators, electric lighting and acoustics. The course continues the use of ecotect software as an analytical tool.

**ARCH 329. Structures II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 229. This course examines lateral forces, foundations, stability, deflection, long spans and special case structural systems. Methodology involves advanced static structural analysis.

**ARCH 331. Landscape Architecture. 3 credits, 3 contact hours (3;0;0).**
An overview of the opportunities and constraints of landscape designs. Emphasis on developing a practical understanding of the potentials of earth, water and plants in architecture. Students given an overview of social and ecological determinants of relations between land and buildings.

**ARCH 332. Architecture: Image and Word I. 3 credits, 3 contact hours (3;0;0).**
This course will present films on Architecture in which architects are speaking about and showing their own work. What we think is true about architecture is often wrong. Single images tend to abstract and greatly simplify why and how great architecture is created. Rarely are buildings seen in their content. Rarely are climatic, cultural and technical issues of design illustrated. AS a result, we often speculate about architecture based upon superficial or incomplete information.

**ARCH 333. Architecture: Image and Word II. 3 credits, 5 contact hours (2;3;0).**
This course will present films on Architecture in which architects are speaking about and showing their own work. Theoreticians provide "facts" to create a unified theory of design, which may lie outside the realm of historical reality, or the intention of the architect. The culture of architectural education and the nature of the design studio results in second hand knowledge, and design myth. Surveys of modern architecture leave a fragmentary memory of great works of architecture.

**ARCH 334. Color Theory/Electronic Color. 3 credits, 3 contact hours (3;0;0).**
The multiple-media course includes lectures with supplemental readings, videos, in-class analysis and laboratory work, and homework requiring a variety of media including watercolor and computer graphics - all of which address a range of issues including interaction of color, psychology of color, design for color deficient vision, color mixing and color palettes, color reproduction, color models, color composition in art and architecture, and others. Digital applications are integrated throughout.

**ARCH 335. Digital Tectonics. 3 credits, 3 contact hours (3;0;0).**
This course uses 3D modeling tools to investigate the relationship of digital models to physical construction. The term digital tectonics refers to an idea regarding the qualities of works of contemporary architecture that seem to be influenced by the use of digital tools. In this course, students are asked to investigate this hypothesis by testing structure, skin, assemblage, form and space making methodologies that are aided by digital tools and rationalized through digital operations.

**ARCH 337. Building Information Modeling. 3 credits, 3 contact hours (3;0;0).**
This course explores both technical and philosophical approaches to the use of the computer in architectural analysis, design development, information management, and document delivery. Autodesk Building Systems and Autodesk Revit Building will be used for 3D modeling and 2D documentation employing a systems-approach framework for spatial allocation, energy analysis, and structural considerations. The workings of the foundational information databases of the respective software will be thoroughly explored. Projects requirements will include building program resolution, solar analysis, asset scheduling, document layout, and design visualization. Proficiency with Autodesk Autocad (2D) and understanding of general CAD principles are required prerequisites.

**ARCH 361. Project Based Seminar I. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: Junior Status The Project Based Seminar is the first of two seminars required for completion of the Bachelor of Science in Architecture degree. The sequence of seminars teams advanced students from varying academic backgrounds to take on real-life projects in an experiential learning setting. As part of final deliverables, student teams make presentations and submit hardcopy proposals to interested constituencies.

**ARCH 363. Architecture Studio III. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 264, ARCH 223, ARCH 227 and ARCH 229. This course is a continuation of ARCH 264. Lecture hour explores the nature of technology, environment, and social order as they relate to studio work. Course materials purchase required.

**ARCH 364. Architecture Studio IV. 5 credits, 13 contact hours (0;0;13).**
Prerequisites: ARCH 363. A continuation of ARCH 363. Lecture hour explores in depth the nature of technology, environment, and social order as they relate to studio work. Students will be required to purchase course materials.

**ARCH 381. History of Architecture III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 252. A continuation of ARCH 252, this course surveys global developments in architecture, urban planning, and landscape design in the first half of the 20th century. It examines the continued architectural impact of industrialization and modernization and the geo-political consequences of World War I and World War II on the built environment. The focus is on the development and diffusion of modernism and its relationship to such key concepts as universalism, regionalism, historicism, and utopia.

**ARCH 382. History of Architecture IV. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 381. The last in the sequence of history surveys, this course examines global developments in modern and contemporary architecture and urbanism after World War II and into the 21st century. Social uprisings, economic recessions, post-colonialism, modernization in the developing world, mass production and mass consumption, environmentalism, sustainability, and the computer revolution of the information age provide the historical and cultural framework for the course. The course pays particular attention to early extensions and critiques of modernism, the emergence of postmodernism and current efforts to reevaluate modernism's legacy.

**ARCH 408. Advanced Landscape Architecture. 3 credits, 3 contact hours (3;0;0).**
Introduces the design, construction and management of contemporary landscape projects through case studies, field trips, and personal contact with prominent practicing landscape architects. A historical perspective of landscape architecture is used as a context for discussion.

**ARCH 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ARCH 310 or approval of the school and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. A designated faculty member monitors and evaluates the student's work and project. Requirements include mandatory participation in seminars and completion of a report and/or project.

**ARCH 419. Architectural Photography. 3 credits, 4 contact hours (2;2;0).**
This course is designed for architecture students in using photography to better visualize form in space in a 2-D format, lighting, color, and composition. The course goal is developing their unique expressive abilities in seeing through the camera. Discussions emphasize correlating historical movements in architecture and the visual arts in photography, using relevant text selections, slide presentations, and museum visits for reinforcement.

**ARCH 423. Construction III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 323. This course focuses on non-normative systems, hybrid and integrated assemblies and new materials. An emphasis is placed on systems integration, materials selection, specifications and construction documents associated with the comprehensive design of buildings using Building Information Modeling (BIM).

**ARCH 429. Structures III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 329. This course focuses on wood systems analysis, steel systems analysis, indeterminate systems and integrated structural systems. Methodology involves finite member analysis.

**ARCH 432. P3 Post Presentation Processing. 3 credits, 5 contact hours (2;3;0).**
The project is deemed Architecture, with a capital A, but there remains nagging questions: What would the project be like if viewed stereoscopically? If it were rendered as a 360 degree panoramic view, what would the space be like? If it was accurately superimposed into the site (lighting, color, texture, camera angle), does the design improve when in the context? Would rendering styles using "natural media" be more descriptive? What would the architecture be like at night?.

**ARCH 461. Project Based Seminar II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:Junior status The Project Based Seminar II is the second of two seminars required for completion of the Bachelor of Science in Architecture degree. The sequence of seminars teams advanced students from varying academic backgrounds to take on real-life projects in an experiential learning setting. As part of final deliverables, student teams make presentations and submit hardcopy proposals to interested constituencies.

**ARCH 463. Option Studio 1. 5 credits, 12 contact hours (0;0;12).**
Studio methodology allows the students to select from various building programs, the nature of design dealing with technology, environment and the social order. Lecture hour coordinates with studio subject matter. Course materials purchase required.

**ARCH 464. Option Studio II. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ARCH 364. Studio methodology allows students to select from various building programs, the nature of design dealing with technology, environment and the social order.

**ARCH 472. Architectural Programming and Project Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ARCH 264. Covers the essentials for programming a building and understanding the full scope of project development that precedes and follows the programming phase. Identify major stakeholders in the building design and production process and examine their roles. Lectures and assignments include: user requirements and client values, methods of pro forma analysis for project development and approval, and how the development process changes over time.

**ARCH 483. ST:. 3 credits, 3 contact hours (3;0;0).**
Group investigation of problem of special interest in architecture.

**ARCH 491. Independent Study. 1 credit, 1 contact hour (0;0;1).**

**ARCH 493. Independent Study. 3 credits, 3 contact hours (0;0;3).**

# B.S. in Architecture

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 155 | Modes of Design Communication I | 3 |
| ARCH 163 | Introduction to Design I | 5 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 107<br>or MATH 113 | University Mathematics BI<br>or Finite Mathematics and Calculus I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| MATH 113<br>or MATH 115 | Finite Mathematics and Calculus I<br>or Elements of Geometry | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 381 | History of Architecture III | 3 |
| MGMT 390 | Principles of Management | 3 |
| Basic Social Science (lower-level) GUR Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |

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|---|---|---|
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Basic Lower Level Social Science (GUR) | | 3 |
| Humanities and Social Sciences Electives (upper-level) GUR Elective | | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| ARCH 361 | Project Based Seminar I | 3 |
| ARCH 382 | History of Architecture IV | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Open GUR Elective | | 3 |
| HSS 4XX- Capstone | | 3 |
| Physical Education GUR Elective | | 1 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ARCH 461 | Project Based Seminar II | 3 |
| PE -Physical Education | | 1 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **133** |

[1] *Social Sciences (lower-level) GUR:* Three credits of the basic social sciences requirement must be taken in economics; acceptable courses are ECON 265 Microeconomics, or ECON 266 Macroeconomics. The remaining 3 credits may be satisfied by EPS 202 Society, Technology, and the Environment, STS 257 Technology, Society and Culture: An American View, or STS 258 Technology, Society and Culture: A Global View. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Architecture** | | |
| ARCH XXX | Any architecture course | |
| **Computing** | | |
| Select in consultation with curriculum advisor | | |
| **Free** | | |
| Select in consultation with curriculum advisor | | |
| **Social Sciences (lower-level) GUR** | | |
| ECON 265 | Microeconomics [1] | 3 |
| or ECON 266 | Macroeconomics | |
| Select one of the following: [2] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |

| | | |
|---|---|---|
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| HSS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Physical Education GUR** [3] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

1. Three credits of the basic social sciences requirement must be taken in economics.
2. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.
3. Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

See the **General University Requirements** for more information on electives.

Graduation is contingent upon the maintenance of a 2.0 average and the successful completion of the minimum credit requirement of prescribed courses within the select curriculum: Bachelor of Science in Architecture (B.S. Arch) requires 135 credits.

# B.S. in Architecture and M.B.A. in Management of Technology

## B.S. in Architecture Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 155 | Modes of Design Communication I | 3 |
| ARCH 163 | Introduction to Design I | 5 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 107<br>or MATH 113 | University Mathematics BI<br>or Finite Mathematics and Calculus I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| MATH 113<br>or MATH 115 | Finite Mathematics and Calculus I<br>or Elements of Geometry | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |

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|---|---|---|
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 381 | History of Architecture III | 3 |
| MGMT 390 | Principles of Management | 3 |
| Basic Social Science (lower-level) GUR Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Basic Lower Level Social Science (GUR) | | 3 |
| Humanities and Social Sciences Electives (upper-level) GUR Elective | | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| ARCH 361 | Project Based Seminar I | 3 |
| ARCH 382 | History of Architecture IV | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Open GUR Elective | | 3 |
| HSS 4XX- Capstone | | 3 |
| Physical Education GUR Elective | | 1 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ARCH 461 | Project Based Seminar II | 3 |
| PE -Physical Education | | 1 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **133** |

[1] *Social Sciences (lower-level) GUR:* Three credits of the basic social sciences requirement must be taken in economics; acceptable courses are ECON 265 Microeconomics, or ECON 266 Macroeconomics. The remaining 3 credits may be satisfied by EPS 202 Society, Technology, and the Environment, STS 257 Technology, Society and Culture: An American View, or STS 258 Technology, Society and Culture: A Global View. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| Code | Title | Credits |
| --- | --- | --- |
| **Architecture** | | |
| ARCH XXX | Any architecture course | |
| **Computing** | | |
| Select in consultation with curriculum advisor | | |
| **Free** | | |
| Select in consultation with curriculum advisor | | |
| **Social Sciences (lower-level) GUR** | | |
| ECON 265 | Microeconomics [1] | 3 |
| or ECON 266 | Macroeconomics | |
| Select one of the following: [2] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| HSS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Physical Education GUR** [3] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

[1] Three credits of the basic social sciences requirement must be taken in economics.

[2] Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

[3] Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

## M.B.A. in Management of Technology Requirements

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| --- | --- | --- |
| **Architectural Management Requirements** | | |
| ARCH 650 | Economy of Building [1] | 3 |
| ARCH 651 | Real Estate Analysis for Architects [1] | 3 |
| ARCH 652 | Architectural Project Management [1] | 3 |
| **Technology Module - Core Courses** | | |
| FIN 516 | Principles of Financial Management | 3 |
| MGMT 620 | Management of Technology | 3 |
| MGMT 625 | Distribution Logistics | 3 |
| MGMT 630 | Decision Analysis | 3 |

| | | |
|---|---|---|
| MGMT 635 or MATH 661 | Data Mining and Analysis or Applied Statistics | 3 |
| MIS 620 | E-Commerce Technologies | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Essential Business Processes - Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |
| FIN 600 | Corporate Finance I | 3 |
| FIN 618 | Public and Private Financing of Urban Areas | 3 |
| HRM 601 | Organizational Behavior | 3 |
| MRKT 620 | Competing in Global Markets | 3 |
| MGMT 680 or MGMT 692 | Entrepreneurial Strategy or Strategic Management | 3 |
| **Total Credits** | | **48** |

[1] The 3 credits for this course may be used toward the 6 total credits allowed toward the B.S. and the M.B.A.

# B.S. in Architecture and M.I.P.

## B.S. in Architecture Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 155 | Modes of Design Communication I | 3 |
| ARCH 163 | Introduction to Design I | 5 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 107 or MATH 113 | University Mathematics BI or Finite Mathematics and Calculus I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| MATH 113 or MATH 115 | Finite Mathematics and Calculus I or Elements of Geometry | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |

| | | |
|---|---|---|
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 381 | History of Architecture III | 3 |
| MGMT 390 | Principles of Management | 3 |
| Basic Social Science (lower-level) GUR Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Basic Lower Level Social Science (GUR) | | 3 |
| Humanities and Social Sciences Electives (upper-level) GUR Elective | | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| ARCH 361 | Project Based Seminar I | 3 |
| ARCH 382 | History of Architecture IV | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Open GUR Elective | | 3 |
| HSS 4XX- Capstone | | 3 |
| Physical Education GUR Elective | | 1 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ARCH 461 | Project Based Seminar II | 3 |
| PE -Physical Education | | 1 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **133** |

1 *Social Sciences (lower-level) GUR:* Three credits of the basic social sciences requirement must be taken in economics; acceptable courses are ECON 265 Microeconomics, or ECON 266 Macroeconomics. The remaining 3 credits may be satisfied by EPS 202 Society, Technology, and the Environment, STS 257 Technology, Society and Culture: An American View, or STS 258 Technology, Society and Culture: A Global View. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Architecture** | | |
| ARCH XXX | Any architecture course | |
| **Computing** | | |
| Select in consultation with curriculum advisor | | |
| **Free** | | |
| Select in consultation with curriculum advisor | | |
| **Social Sciences (lower-level) GUR** | | |
| ECON 265 | Microeconomics [1] | 3 |

| | | |
|---|---|---|
| or ECON 266 | Macroeconomics | |
| Select one of the following: [2] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| HSS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Physical Education GUR** [3] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

1. Three credits of the basic social sciences requirement must be taken in economics.
2. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.
3. Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

## M.I.P. Requirements

| | | |
|---|---|---|
| MIP 601 | Interdisciplinary Infrastructure Studio I | 6 |
| MIP 602 | Interdisciplinary Infrastructure Studio II | 6 |
| MIP 618 | Public and Private Financing of Urban Areas | 3 |
| MIP 631 | History and Theory of Infrastructure [1] | 3 |
| MIP 647 | | 3 |
| MIP 652 | Geographic Information Systems [1] | 3 |
| MIP 655 | Land Use Planning | 3 |
| MIP 674 | Infrastructure and Architecture [1] | 3 |
| MIP 675 | Elements of Infrastructure Planning [1] | 3 |
| MIP 673 | Infrastructure Planning in Practice | 3 |
| **Total Credits** | | **36** |

1. The 3 credits for this course may be used toward the 6 total credits allowed to count toward the B.S. and the M.I.P.

# B.S. in Architecture and M.S. in Civil Engineering

## B.S. in Architecture Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 155 | Modes of Design Communication I | 3 |

| | | |
|---|---|---|
| ARCH 163 | Introduction to Design I | 5 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 107<br>or MATH 113 | University Mathematics BI<br>or Finite Mathematics and Calculus I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| MATH 113<br>or MATH 115 | Finite Mathematics and Calculus I<br>or Elements of Geometry | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 381 | History of Architecture III | 3 |
| MGMT 390 | Principles of Management | 3 |
| Basic Social Science (lower-level) GUR Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Basic Lower Level Social Science (GUR) | | 3 |
| Humanities and Social Sciences Electives (upper-level) GUR Elective | | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| ARCH 361 | Project Based Seminar I | 3 |
| ARCH 382 | History of Architecture IV | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Open GUR Elective | | 3 |
| HSS 4XX- Capstone | | 3 |

| | | |
|---|---|---|
| Physical Education GUR Elective | | 1 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ARCH 461 | Project Based Seminar II | 3 |
| PE -Physical Education | | 1 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **133** |

[1] *Social Sciences (lower-level) GUR:* Three credits of the basic social sciences requirement must be taken in economics; acceptable courses are ECON 265 Microeconomics, or ECON 266 Macroeconomics. The remaining 3 credits may be satisfied by EPS 202 Society, Technology, and the Environment, STS 257 Technology, Society and Culture: An American View, or STS 258 Technology, Society and Culture: A Global View. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Architecture** | | |
| ARCH XXX | Any architecture course | |
| **Computing** | | |
| Select in consultation with curriculum advisor | | |
| **Free** | | |
| Select in consultation with curriculum advisor | | |
| **Social Sciences (lower-level) GUR** | | |
| ECON 265 | Microeconomics [1] | 3 |
| or ECON 266 | Macroeconomics | |
| Select one of the following: [2] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| HSS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |

| | | |
|---|---|---|
| **Physical Education GUR** [3] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

[1] Three credits of the basic social sciences requirement must be taken in economics.

[2] Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

[3] Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

## M.S. in Civil Engineering Requirements

| | | |
|---|---|---|
| **Bridge Courses** [1] | | 10 |
| CE 200 | Surveying | |
| CE 200A | Surveying Laboratory | |
| CE 501 | Introduction to Soil Behavior | |
| MATH 105 | Elementary Probability and Statistics | |
| **Required Courses** [2] | | 12 |
| ARCH 650 | Economy of Building | |
| ARCH 651 | Real Estate Analysis for Architects | |
| ARCH 647 | Special Topics in Computer Applications | |
| or ARCH 675 | Elements of Infrastructure Planning | |
| MIS 645 | Information Systems Principles | |
| **Civil and Environmental Engineering Electives** | | |
| Select two of the following: | | 6 |
| CE 615 | Infrastructure and Facilities Remediation | |
| CE 631 | Advanced Reinforced Concrete Design | |
| CE 642 | Foundation Engineering | |
| CE 702 | Special Topics in Civil Engineering | |
| CE 711 | Methods Improvement in Construction | |
| ENE 662 | Site Remediation | |
| **Total Credits** | | **28** |

[1] Bridge courses are required as prerequisites for admission to the M.S. program. These courses may count as free electives in the B.Arch., but do not count toward the M.S.

[2] These credits count toward both degrees.

# B.S. in Architecture and M.S. in Management

## B.S. in Architecture Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 155 | Modes of Design Communication I | 3 |
| ARCH 163 | Introduction to Design I | 5 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 107<br>or MATH 113 | University Mathematics BI<br>or Finite Mathematics and Calculus I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 120 | Basic Concepts in Statistics | 1 |

| | | |
|---|---|---|
| MATH 113<br>or MATH 115 | Finite Mathematics and Calculus I<br>or Elements of Geometry | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 381 | History of Architecture III | 3 |
| MGMT 390 | Principles of Management | 3 |
| Basic Social Science (lower-level) GUR Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Basic Lower Level Social Science (GUR) | | 3 |
| Humanities and Social Sciences Electives (upper-level) GUR Elective | | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| ARCH 361 | Project Based Seminar I | 3 |
| ARCH 382 | History of Architecture IV | 3 |
| Architecture Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Open GUR Elective | | 3 |
| HSS 4XX- Capstone | | 3 |
| Physical Education GUR Elective | | 1 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ARCH 461 | Project Based Seminar II | 3 |
| PE -Physical Education | | 1 |
| Architecture Elective | | 3 |
| Architecture Elective | | 3 |
| Free Elective | | 3 |

| | | |
|---|---|---|
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **133** |

1 *Social Sciences (lower-level) GUR:* Three credits of the basic social sciences requirement must be taken in economics; acceptable courses are ECON 265 Microeconomics, or ECON 266 Macroeconomics. The remaining 3 credits may be satisfied by EPS 202 Society, Technology, and the Environment, STS 257 Technology, Society and Culture: An American View, or STS 258 Technology, Society and Culture: A Global View. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Architecture** | | |
| ARCH XXX | Any architecture course | |
| **Computing** | | |
| Select in consultation with curriculum advisor | | |
| **Free** | | |
| Select in consultation with curriculum advisor | | |
| **Social Sciences (lower-level) GUR** | | |
| ECON 265 | Microeconomics [1] | 3 |
| or ECON 266 | Macroeconomics | |
| Select one of the following: [2] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| HSS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Physical Education GUR** [3] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

1 Three credits of the basic social sciences requirement must be taken in economics.

2 Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

3 Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

## M.S. in Management Requirements

| | | |
|---|---|---|
| ARCH 650 | Economy of Building | 3 |

| | | |
|---|---|---|
| ARCH 651 | Real Estate Analysis for Architects | 3 |
| ARCH 652 | Architectural Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| FIN 516 | Principles of Financial Management | 3 |
| FIN 600 | Corporate Finance I | 3 |
| FIN 618 | Public and Private Financing of Urban Areas | 3 |
| MIS 620 | E-Commerce Technologies | 3 |
| MGMT 680 | Entrepreneurial Strategy | 3 |
| or MGMT 692 | Strategic Management | |
| Select three of the following: | | 9 |
| ACCT 615 | Management Accounting | |
| FIN 624 | Corporate Finance II | |
| MGMT 640 | New Venture Management | |
| MGMT 645 | New Venture Finance | |
| MIS 645 | Information Systems Principles | |
| MRKT 630 | Models of Consumer Behavior | |
| MRKT 638 | Sales Management for Technical Professionals | |
| **Total Credits** | | **36** |

In addition to existing architecture courses, the M.S. in Management comprises 36 credits. Note: This program was under revision at press time. Students should contact Elly Matzko, student advisor, for the current curriculum.

# Bachelor of Architecture

*The curriculum as described below is for students entering NJIT as freshmen in the fall of 2000 or after that date. Students entering before that date may have a different program and should consult the school to learn which curriculum applies.*

Graduation is contingent upon the maintenance of a 2.0 average and the successful completion of the minimum credit requirement of prescribed courses within the select curriculum: the Bachelor of Architecture (B.Arch) requires 163 credits[1]. Students are required to maintain a 2.0 cumulative studio average to advance to the next studio level each succeeding year.

**Credit distribution for the Bachelor of Architecture (B.Arch)**

| | |
|---|---|
| Required Architecture credits | 99 |
| Architecture Electives | 15 |
| Free Electives | 3 |
| General University Requirements | 46 |
| **Total Credits** [1] | 163 |

[1] The minimum Credit requirement for graduation is the successful completion of 163 credits of prescribed courses within the curriculum; and the maintenance of a 2.0 (C) average. Students are also required to maintain a minimum 2.0 studio cumulative average to advance to each succeeding year of studio. Students must take one upper level studio designated as "comprehensive".

| **First Year** | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| ARCH 161 | Intro Design and Digital Media | 6 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 113 | Finite Mathematics and Calculus I | 3 |
| Physical Education | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |

| | | |
|---|---|---|
| Physical Education | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I [1] | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 327 | Environmental Control Systems II | 3 |
| ARCH 329 | Structures II | 3 |
| ARCH 363 | Architecture Studio III | 5 |
| ARCH 381 | History of Architecture III | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 323 | Construction II | 3 |
| ARCH 364 | Architecture Studio IV | 5 |
| ARCH 382 | History of Architecture IV [1] | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ARCH 423 | Construction III | 3 |
| ARCH 429 | Structures III | 3 |
| ARCH 463 | Option Studio 1 | 5 |
| Design Elective | | 3 |
| Open GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 464 | Option Studio II | 5 |
| ARCH 472 | Architectural Programming and Project Development | 3 |
| Design Elective | | 3 |
| MGMT 390 | Principles of Management | 3 |
| LIT/HIST/PHIL/STS | | 3 |
| | **Term Credits** | **17** |
| **Fifth Year** | | |
| **1st Semester** | | |
| ARCH 563 | Comprehensive Studio I [2] | 5 |

| | | |
|---|---|---|
| ARCH 558 | Professional Architectural Practice | 3 |
| Design Elective | | 3 |
| Design Elective | | 3 |
| HSS 4XX Capstone | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 561 | Integrated Studio Seminar | 3 |
| ARCH 564 | Comprehensive Studio II | 5 |
| Design Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **163** |

[1] ARCH 251 History of Architecture I satisfies 3 credits of the English Composition and Cultural History GUR for B.Arch. majors; ARCH 382 History of Architecture IV satisfies the Open Elective in Humanities and Social Sciences GUR for B.Arch. majors.

[2] To be taken concurrently with comprehensive studio.

[3] ARCH 565 Comprehensive Studio Lab must be taken concurrently with upper level studio ARCH 563 Comprehensive Studio I or ARCH 564 Comprehensive Studio II.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level GUR)** | | |
| Select six credits from the following: | | 6 |
| ECON 265 | Microeconomics | 3 |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | 3 |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| STS 258 | Technology, Society and Culture: A Global View | 3 |
| R070 203 | Intro Phys Anth & Arch | 3 |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | 3 |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | 3 |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | 3 |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | 3 |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Sciences GUR** | | |

| | | |
|---|---|---|
| Select at least seven credits, including a laboratory experience, from the following: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HSS 3XX | Social Sciences course | |
| THTR 3XX | Theater course | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

[1] Students may also take approved introductory courses at Rutgers-Newark.

[2] Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

See the **General University Requirements** section for more information on electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Bachelor of Architecture and M.B.A. in Management of Technology

The New Jersey School of Architecture and the School of Management have established a dual degree program that permits students to obtain a Bachelor of Architecture degree with a Master of Business Administration (M.B.A.) in Management of Technology.

There is no reduction in the degree requirements for the professional degree in architecture. The dual degree program permits students to obtain an M.B.A. in Management of Technology in substantially less time, in some cases with only one additional year of study. Up to 12 credits of graduate-level coursework may be applied to both the B.Arch. and M.B.A.

Students may take additional courses at the graduate level during their undergraduate career, but these courses do not count toward the undergraduate degree requirements and students are charged at the graduate course rate.

Eligible students should contact the Office of Graduate Studies in their junior or third year regarding the process for admission to the dual degree program. The Office of Graduate Studies will coordinate the process with the undergraduate program director in the New Jersey School of Architecture and later with the graduate advisor and the Office of Graduate Admissions as the student nears completion of the undergraduate degree. In order to be eligible for initial and continued participation in the dual degree program, the student must maintain a 3.0 cumulative GPA and take the GMAT during the senior or final undergraduate year. A GMAT score of 550 is required for admission to graduate study in the School of Management.

The M.B.A. in Management of Technology is a 60-credit program. However, 12 credits in management background courses are waived for architecture graduates. Therefore, in addition to completion of the architecture program requirements, the M.B.A. comprises 48 credits. Note: This program was under revision at press time. Students should contact their advisor, for the current curriculum.

## B.Arch. Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 161 | Intro Design and Digital Media | 6 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 113 | Finite Mathematics and Calculus I | 3 |
| Physical Education | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I [1] | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |

| | | |
|---|---|---|
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 327 | Environmental Control Systems II | 3 |
| ARCH 329 | Structures II | 3 |
| ARCH 363 | Architecture Studio III | 5 |
| ARCH 381 | History of Architecture III | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 323 | Construction II | 3 |
| ARCH 364 | Architecture Studio IV | 5 |
| ARCH 382 | History of Architecture IV [1] | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ARCH 423 | Construction III | 3 |
| ARCH 429 | Structures III | 3 |
| ARCH 463 | Option Studio 1 | 5 |
| Design Elective | | 3 |
| Open GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 464 | Option Studio II | 5 |
| ARCH 472 | Architectural Programming and Project Development | 3 |
| Design Elective | | 3 |
| MGMT 390 | Principles of Management | 3 |
| LIT/HIST/PHIL/STS | | 3 |
| | **Term Credits** | **17** |
| **Fifth Year** | | |
| **1st Semester** | | |
| ARCH 563 | Comprehensive Studio I [2] | 5 |
| ARCH 558 | Professional Architectural Practice | 3 |
| Design Elective | | 3 |
| Design Elective | | 3 |
| HSS 4XX Capstone | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 561 | Integrated Studio Seminar | 3 |
| ARCH 564 | Comprehensive Studio II | 5 |
| Design Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **163** |

[1] ARCH 251 History of Architecture I satisfies 3 credits of the English Composition and Cultural History GUR for B.Arch. majors; ARCH 382 History of Architecture IV satisfies the Open Elective in Humanities and Social Sciences GUR for B.Arch. majors.

[2] To be taken concurrently with comprehensive studio.

[3] ARCH 565 Comprehensive Studio Lab must be taken concurrently with upper level studio ARCH 563 Comprehensive Studio I or ARCH 564 Comprehensive Studio II.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level GUR)** | | |
| Select six credits from the following: | | 6 |
| ECON 265 | Microeconomics | 3 |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | 3 |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| STS 258 | Technology, Society and Culture: A Global View | 3 |
| R070 203 | Intro Phys Anth & Arch | 3 |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | 3 |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | 3 |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | 3 |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | 3 |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Sciences GUR** | | |
| Select at least seven credits, including a laboratory experience, from the following: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |

| | | |
|---|---|---|
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HSS 3XX | Social Sciences course | |
| THTR 3XX | Theater course | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

[1] Students may also take approved introductory courses at Rutgers-Newark.

[2] Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

## M.B.A. in Management of Technology Requirements

| | | |
|---|---|---|
| **Architectural Management Requirements** | | |
| ARCH 650 | Economy of Building [1] | 3 |
| ARCH 651 | Real Estate Analysis for Architects [1] | 3 |
| ARCH 652 | Architectural Project Management [1] | 3 |
| **Technology Module - Core Courses** | | |
| FIN 516 | Principles of Financial Management | 3 |
| MGMT 620 | Management of Technology | 3 |
| MGMT 625 | Distribution Logistics | 3 |
| MGMT 630 | Decision Analysis | 3 |
| MGMT 635 | Data Mining and Analysis | 3 |
| or MATH 661 | Applied Statistics | |
| MIS 620 | E-Commerce Technologies | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Essential Business Processes - Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |

| | | |
|---|---|---|
| FIN 600 | Corporate Finance I | 3 |
| FIN 618 | Public and Private Financing of Urban Areas | 3 |
| HRM 601 | Organizational Behavior | 3 |
| MRKT 620 | Competing in Global Markets | 3 |
| MGMT 680 | Entrepreneurial Strategy | 3 |
| or MGMT 692 | Strategic Management | |
| **Total Credits** | | **48** |

1 Nine required credits taken in the New Jersey School of Architecture constitute an area of concentation in architectural management and count toward both the B.Arch. and the M.B.A.

# Bachelor of Architecture and M.I.P.

The New Jersey School of Architecture has established a dual degree program within the school that permits students to obtain a B.Arch. with a Master in Infrastructure Planning (M.I.P.). There is no reduction in the degree requirements for the professional degree in architecture. The dual degree program permits students to obtain an M.I.P. in substantially less time.

Up to 12 credits of graduate-level coursework may be applied to both the B.Arch. and M.I.P. Students may take additional courses at the graduate level during their undergraduate career, but these courses do not count toward the undergraduate degree requirements and students are charged at the graduate course rate.

Eligible students should contact the Office of Graduate Studies in their junior or third year regarding the process for admission to the dual degree program. The Office of Graduate Studies will coordinate the process with the undergraduate program director in the School of Architecture and later with the graduate advisor and the Office of Graduate Admissions as the student nears completion of the undergraduate degree. In order to be eligible for initial and continued participation in the dual degree program, the student must maintain a 3.0 cumulative GPA and take the GRE during the senior or final undergraduate year.

## B.Arch. Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 161 | Intro Design and Digital Media | 6 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 113 | Finite Mathematics and Calculus I | 3 |
| Physical Education | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I [1] | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |

| | | |
|---|---|---|
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 327 | Environmental Control Systems II | 3 |
| ARCH 329 | Structures II | 3 |
| ARCH 363 | Architecture Studio III | 5 |
| ARCH 381 | History of Architecture III | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 323 | Construction II | 3 |
| ARCH 364 | Architecture Studio IV | 5 |
| ARCH 382 | History of Architecture IV [1] | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ARCH 423 | Construction III | 3 |
| ARCH 429 | Structures III | 3 |
| ARCH 463 | Option Studio 1 | 5 |
| Design Elective | | 3 |
| Open GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 464 | Option Studio II | 5 |
| ARCH 472 | Architectural Programming and Project Development | 3 |
| Design Elective | | 3 |
| MGMT 390 | Principles of Management | 3 |
| LIT/HIST/PHIL/STS | | 3 |
| | **Term Credits** | **17** |
| **Fifth Year** | | |
| **1st Semester** | | |
| ARCH 563 | Comprehensive Studio I [2] | 5 |
| ARCH 558 | Professional Architectural Practice | 3 |
| Design Elective | | 3 |
| Design Elective | | 3 |
| HSS 4XX Capstone | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 561 | Integrated Studio Seminar | 3 |
| ARCH 564 | Comprehensive Studio II | 5 |
| Design Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **163** |

[1] ARCH 251 History of Architecture I satisfies 3 credits of the English Composition and Cultural History GUR for B.Arch. majors; ARCH 382 History of Architecture IV satisfies the Open Elective in Humanities and Social Sciences GUR for B.Arch. majors.

[2] To be taken concurrently with comprehensive studio.

[3] ARCH 565 Comprehensive Studio Lab must be taken concurrently with upper level studio ARCH 563 Comprehensive Studio I or ARCH 564 Comprehensive Studio II.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level GUR)** | | |
| Select six credits from the following: | | 6 |
| ECON 265 | Microeconomics | 3 |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | 3 |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| STS 258 | Technology, Society and Culture: A Global View | 3 |
| R070 203 | Intro Phys Anth & Arch | 3 |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | 3 |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | 3 |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | 3 |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | 3 |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Sciences GUR** | | |
| Select at least seven credits, including a laboratory experience, from the following: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |

| | | |
|---|---|---|
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HSS 3XX | Social Sciences course | |
| THTR 3XX | Theater course | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

1. Students may also take approved introductory courses at Rutgers-Newark.
2. Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

## M.I.P. Requirements

| | | |
|---|---|---|
| MIP 601 | Interdisciplinary Infrastructure Studio I | 6 |
| MIP 602 | Interdisciplinary Infrastructure Studio II | 6 |
| MIP 612 | Introduction to Environmental Policy Studies | 3 |
| MIP 615 | | 3 |
| MIP 618 | Public and Private Financing of Urban Areas | 3 |
| MIP 631 | History and Theory of Infrastructure | 3 |
| MIP 652 | Geographic Information Systems | 3 |
| MIP 655 | Land Use Planning | 3 |
| MIP 674 | Infrastructure and Architecture | 3 |
| MIP 675 | Elements of Infrastructure Planning | 3 |
| **Total Credits** | | **36** |

Students in the B.Arch. program may take any four of the required 3-credit courses to count toward both their B.Arch. and M.I.P. Students who have completed a comprehensive options studio and have a superior academic record may take MIP 601 Interdisciplinary Infrastructure Studio I in place of the last options studio in the B.Arch. program. This counts for 6 of the 12 credits counted toward both degrees.

# Bachelor of Architecture and M.S. in Civil Engineering

The New Jersey School of Architecture and the Department of Civil and Environmental Engineering have established a dual degree program that permits students to obtain a B.Arch. and a Master of Science (M.S.) in Civil Engineering with a concentration in construction engineering and management. There is no reduction in the degree requirements for the professional degree in architecture. The dual degree program permits students to obtain an M.S. in Civil Engineering in substantially less time, in some cases with only one additional year of study.

Up to 12 credits of graduate-level coursework may be applied to both the B.Arch. and M.S. Students may take additional courses at the graduate level during their undergraduate career, but these courses do not count toward the undergraduate degree requirements and students are charged at the graduate course rate.

Eligible students should contact the Office of Graduate Studies in their junior or third year regarding the process for admission to the dual degree program. The Office of Graduate Studies will coordinate the process with the undergraduate program director in the School of Architecture and later with the graduate advisor and the Office of Graduate Admissions as the student nears completion of the undergraduate degree. In order to be eligible for initial and continued participation in the dual degree program, the student must maintain a 3.0 cumulative GPA and take the GRE during the senior or final undergraduate year.

## B.Arch. Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 161 | Intro Design and Digital Media | 6 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 113 | Finite Mathematics and Calculus I | 3 |
| Physical Education | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I [1] | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| ARCH 327 | Environmental Control Systems II | 3 |
| ARCH 329 | Structures II | 3 |
| ARCH 363 | Architecture Studio III | 5 |
| ARCH 381 | History of Architecture III | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 323 | Construction II | 3 |
| ARCH 364 | Architecture Studio IV | 5 |
| ARCH 382 | History of Architecture IV [1] | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ARCH 423 | Construction III | 3 |
| ARCH 429 | Structures III | 3 |
| ARCH 463 | Option Studio 1 | 5 |
| Design Elective | | 3 |
| Open GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 464 | Option Studio II | 5 |
| ARCH 472 | Architectural Programming and Project Development | 3 |
| Design Elective | | 3 |
| MGMT 390 | Principles of Management | 3 |
| LIT/HIST/PHIL/STS | | 3 |
| | **Term Credits** | **17** |
| **Fifth Year** | | |
| **1st Semester** | | |
| ARCH 563 | Comprehensive Studio I [2] | 5 |
| ARCH 558 | Professional Architectural Practice | 3 |
| Design Elective | | 3 |
| Design Elective | | 3 |
| HSS 4XX Capstone | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 561 | Integrated Studio Seminar | 3 |
| ARCH 564 | Comprehensive Studio II | 5 |
| Design Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **163** |

[1] ARCH 251 History of Architecture I satisfies 3 credits of the English Composition and Cultural History GUR for B.Arch. majors; ARCH 382 History of Architecture IV satisfies the Open Elective in Humanities and Social Sciences GUR for B.Arch. majors.

[2] To be taken concurrently with comprehensive studio.

[3] ARCH 565 Comprehensive Studio Lab must be taken concurrently with upper level studio ARCH 563 Comprehensive Studio I or ARCH 564 Comprehensive Studio II.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level GUR)** | | |
| Select six credits from the following: | | 6 |
| ECON 265 | Microeconomics | 3 |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | 3 |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| STS 258 | Technology, Society and Culture: A Global View | 3 |
| R070 203 | Intro Phys Anth & Arch | 3 |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | 3 |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | 3 |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | 3 |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | 3 |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Sciences GUR** | | |
| Select at least seven credits, including a laboratory experience, from the following: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |

| | | |
|---|---|---|
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HSS 3XX | Social Sciences course | |
| THTR 3XX | Theater course | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

[1] Students may also take approved introductory courses at Rutgers-Newark.

[2] Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

## M.S. in Civil Engineering Requirements

(30 credits)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| Select 10 credits from the following: [1] | | 10 |
| CE 200 | Surveying | |
| CE 200 | Surveying | |
| CE 200A | Surveying Laboratory | |
| CE 501 | Introduction to Soil Behavior | |
| MATH 105 | Elementary Probability and Statistics | |
| **Courses Counting Toward Both Degrees** | | |
| ARCH 650 | Economy of Building | 3 |
| ARCH 651 | Real Estate Analysis for Architects | 3 |
| ARCH 647 | Special Topics in Computer Applications | 3 |
| or ARCH 675 | Elements of Infrastructure Planning | |
| MIS 645 | Information Systems Principles | 3 |
| **Civil and Environmental Engineering Electives** | | |
| Select two of the following: | | 6 |
| CE 615 | Infrastructure and Facilities Remediation | |
| CE 631 | Advanced Reinforced Concrete Design | |

| | | |
|---|---|---|
| CE 642 | Foundation Engineering | |
| CE 702 | Special Topics in Civil Engineering | |
| CE 711 | Methods Improvement in Construction | |
| ENE 662 | Site Remediation | 3 |
| **Total Credits** | | **31** |

1 Bridge courses are required as prerequisites for admission to the M.S. program. These courses may count as free electives in the B.Arch., but do not count toward the M.S.

# Bachelor of Architecture and M.S. in Management

The New Jersey School of Architecture and the School of Management have established a dual degree program, which permits students to obtain a B.Arch. with a Master of Science (M.S.) in Management.

There is no reduction in the degree requirements for the professional degree in Architecture. The dual degree program permits students to obtain an M.S. in Management in substantially less time, in some cases with only one more semester of study. Up to 12 credits of graduate-level coursework may be applied to both the B.Arch. and M.S. in Management degrees.

Students may take additional courses at the graduate level during their undergraduate career, but these courses do not count toward the undergraduate degree requirements and students are charged at the graduate course rate. Eligible students should contact the Office of Graduate Studies in their junior or third year regarding the process for admission to the dual degree program. The Office of Graduate Studies will coordinate the process with the undergraduate program director in the School of Architecture and later with the graduate advisor and the Office of Graduate Admissions as the student nears completion of the undergraduate degree. In order to be eligible for initial and continued participation in the dual degree program, the student must maintain a 3.0 cumulative GPA and take the GMAT during the senior or final undergraduate year. A GMAT score of 550 is required for admission to graduate study in the School of Management.

## B.Arch. Requirements

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ARCH 161 | Intro Design and Digital Media | 6 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 113 | Finite Mathematics and Calculus I | 3 |
| Physical Education | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| ARCH 156 | Modes of Design Communication II | 3 |
| ARCH 164 | Introduction to Design II | 5 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 223 | Construction I | 3 |
| ARCH 251 | History of Architecture I [1] | 3 |
| ARCH 263 | Architecture Studio I | 5 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ARCH 227 | Environmental Control Systems I | 3 |
| ARCH 229 | Structures I | 3 |
| ARCH 252 | History of Architecture II | 3 |

| | | |
|---|---|---|
| ARCH 264 | Architecture Studio II | 5 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 327 | Environmental Control Systems II | 3 |
| ARCH 329 | Structures II | 3 |
| ARCH 363 | Architecture Studio III | 5 |
| ARCH 381 | History of Architecture III | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 323 | Construction II | 3 |
| ARCH 364 | Architecture Studio IV | 5 |
| ARCH 382 | History of Architecture IV [1] | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ARCH 423 | Construction III | 3 |
| ARCH 429 | Structures III | 3 |
| ARCH 463 | Option Studio 1 | 5 |
| Design Elective | | 3 |
| Open GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 464 | Option Studio II | 5 |
| ARCH 472 | Architectural Programming and Project Development | 3 |
| Design Elective | | 3 |
| MGMT 390 | Principles of Management | 3 |
| LIT/HIST/PHIL/STS | | 3 |
| | **Term Credits** | **17** |
| **Fifth Year** | | |
| **1st Semester** | | |
| ARCH 563 | Comprehensive Studio I [2] | 5 |
| ARCH 558 | Professional Architectural Practice | 3 |
| Design Elective | | 3 |
| Design Elective | | 3 |
| HSS 4XX Capstone | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ARCH 561 | Integrated Studio Seminar | 3 |
| ARCH 564 | Comprehensive Studio II | 5 |
| Design Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **163** |

1. ARCH 251 History of Architecture I satisfies 3 credits of the English Composition and Cultural History GUR for B.Arch. majors; ARCH 382 History of Architecture IV satisfies the Open Elective in Humanities and Social Sciences GUR for B.Arch. majors.

[2] To be taken concurrently with comprehensive studio.
[3] ARCH 565 Comprehensive Studio Lab must be taken concurrently with upper level studio ARCH 563 Comprehensive Studio I or ARCH 564 Comprehensive Studio II.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level GUR)** | | |
| Select six credits from the following: | | 6 |
| ECON 265 | Microeconomics | 3 |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | 3 |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| STS 258 | Technology, Society and Culture: A Global View | 3 |
| R070 203 | Intro Phys Anth & Arch | 3 |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | 3 |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | 3 |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | 3 |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | 3 |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Sciences GUR** | | |
| Select at least seven credits, including a laboratory experience, from the following: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |

| | | |
|---|---|---|
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HSS 3XX | Social Sciences course | |
| THTR 3XX | Theater course | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

[1] Students may also take approved introductory courses at Rutgers-Newark.

[2] Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

## M.S. in Management Requirements

| | | |
|---|---|---|
| ARCH 650 | Economy of Building | 3 |
| ARCH 651 | Real Estate Analysis for Architects | 3 |
| ARCH 652 | Architectural Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| FIN 516 | Principles of Financial Management | 3 |
| FIN 600 | Corporate Finance I | 3 |
| FIN 618 | Public and Private Financing of Urban Areas | 3 |
| MIS 620 | E-Commerce Technologies | 3 |
| MGMT 680 | Entrepreneurial Strategy | 3 |
| or MGMT 692 | Strategic Management | |
| Select three of the following: | | 9 |
| ACCT 615 | Management Accounting | |
| FIN 624 | Corporate Finance II | |
| MGMT 640 | New Venture Management | |

| | | |
|---|---|---|
| MGMT 645 | New Venture Finance | |
| MIS 645 | Information Systems Principles | |
| MRKT 630 | Models of Consumer Behavior | |
| MRKT 638 | Sales Management for Technical Professionals | |
| **Total Credits** | | **36** |

In addition to existing architecture courses, the M.S. in Management comprises 36 credits. Note: This program was under revision at press time. Students should contact Elly Matzko, student advisor, for the current curriculum.

# Art and Design

The School of Art + Design offers a trio of studio-centric four-year bachelor's degree design programs—interior design, digital design and industrial design—and a BFA in fine arts, which provides unique opportunities for aspiring artists to explore the nexus between art and technology, and become part of a the cultural experience that underscores the use of digital media and information technology. With a vibrant assemblage of design disciplines and opportunities for expression, research and independent study, the School of Art + Design provides an exciting environment in which to invent and create.

**Interior Design**

Interior design students have the opportunity to learn from an innovative, creative faculty that participates in all phases of the design and construction process: architects, engineers and interior, product and industrial designers. The robust, studio-centric curriculum fully accredited by the Council for Interior Design Accreditation (CIDA)—is chockfull of design courses such as building and interior systems, history of furniture and building information modeling and prepares students to enter the profession of interior design, first as interns, and ultimately take the National CIDA Qualification examination. More than 90 percent of all graduates are either working in a field related to their study or are in a graduate program within six months of graduation. Students broaden their exposure to a variety of traditional or digital media-based courses or specialize in one or more areas related to a topic of interest.

**Digital Design**

Drawing on NJIT's well-established legacy as a pioneer and innovator in the application of digital and information technology, the Digital Design Program, after a foundation year of exposure to a variety of media, offers students two tracks of study: entertainment and interactive media/production. In addition to a two-year studio sequence, the curriculum provides opportunities for students to take a variety of related classes such as environment design in motion pictures, SFX/VFX in movies, digital audio, history of games, video and animation, 2D and 3D character design and modeling, game level design and more. There is additional flexibility built into the curriculum, allowing students to use free academic and design electives to either broaden their overall education or elect to focus on one or more areas to prepare them for a specialized field or graduate study.

**Industrial Design**

As part of a comprehensive university with a variety of design disciplines, students enrolled in the Industrial Design Program find themselves in a unique and creative environment, where a multi-faceted mission includes the creation of new knowledge while educating future designers in design and preparing them to contribute to 21st century society. In this context, students take advantage of the technological environment of the university to gain a broad understanding of design, materials, methods of production, user needs, and market trends. After completing six semesters of design studio, students take a variety of management, fabrication and design courses, including modeling and prototyping, principles of management, human factors/ergonomics, ethnographic and mechanics and electronics. The program exposes undergraduate students to the various potential fields within the profession and provides them with opportunities to study robotics and advanced materials.

## NJIT Faculty

### A

Alcala, Jose M., University Lecturer

### B

Bales, Ervin, Research Professor

Bess, Mark E., University Lecturer

Brothers, David A., Senior University Lecturer

Burgermaster, Matthew A., Assistant Professor

### C

Cays, John M., Associate Dean for Academics, College of Architecture and Design

Celik, Zeynep, Distinguished Professor

## D

Dart, James, University Lecturer

Decker, Martina, Assistant Professor

De Sousa Santos, Antonio P., Professor Emeritus

## E

Elwell, David H., Associate Professor Emeritus

Esperdy, Gabrielle, Associate Professor

## F

Franck, Karen A., Professor

## G

Garber, Richard J., Associate Professor

Garcia Figueroa, Julio C., University Lecturer

Gauchat, Urs P., Professor

Goldman, Glenn, Professor

Greenfield, Sanford R., Professor Emeritus

## H

Harp, Cleveland J., University Lecturer

Hurtado De Mendoza Wahrolen, Maria A., Associate Professor

## K

Krumwiede, Keith A., Associate Professor

## L

LeCavalier, Jesse, Assistant Professor

## M

Moore, Sandy, Associate Professor

Mostoller, G. Michael, Distinguished Professor

## N

Narahara, Taro, Assistant Professor

Navin, Thomas R., University Lecturer

## O

Ogorzalek, Thomas, University Lecturer

## P

Papademetriou, Peter C., Professor Emeritus

## R

Russo, John Rhett, Associate Professor

## S

Schuman, Anthony W., Associate Professor

Siegel, Joy W., University Lecturer

Sollohub, Darius T., Associate Professor

## T

Taher, Rima, Senior University Lecturer

Theodore, Georgeen, Associate Professor

## W

Wall, Donald R., Associate Professor Emeritus

Weisman, Leslie K., Professor Emeritus

Wendell, Augustus E., University Lecturer

West, Troy, Associate Professor Emeritus

Wood, Timothy Daniel, University Lecturer

## Z

Zarzycki, Andrzej, Associate Professor

Zdepski, Michael, S., Associate Professor

# Programs

- Digital Design - B.A. (p. 171)
- Industrial Design - B.S. (p. 179)
- Interior Design - B.A. (p. 176)

# School of Art + Design Courses

**AD 111. Communication in Art and Design - Traditional Media. 3 credits, 6 contact hours (1;0;5).**
This course will explore a range of subjects from object still life to the human figure to landscape and will deal with specific issues of line, value, composition, structure, proportion and perspective. The aim of this course is to achieve a critical approach to hand-eye coordination and ideational sketching, through both direct observation and conceptual diagramming.

**AD 112. Communication in Art and Design - Digital Media. 3 credits, 6 contact hours (1;0;5).**
This course will help students develop a critical attitude and analytical language to explore 3D and 2D issues involved in the study of design ideas but work will be focused primarily on digital techniques and modes of expression. It will cover drawing basics and digital modeling and extracted drawing techniques and critical analysis of these techiques and other methods of graphic (and architectural) representation.

**AD 150. Color and Composition. 3 credits, 5 contact hours (2;3;0).**
Introduction to principles of 2D composition with emphasis on color use and color theory. Students are introduced to traditional media (watercolor and collage) and digital raster graphics (painting, image processing, and compositioning). Applications that include interior design, product/industrial design, advertising, web design, and fine arts are discussed. Concepts include grids and hierarchy, color models and mixing, color interaction, human response to color, printing, etc. Creative projects.

**AD 161. History of Art and Design I. 3 credits, 3 contact hours (3;0;0).**
This foundation history course surveys the principle aesthetic/functional themes and theories of the twentieth century. Students will explore how various individuals have used art and design to develop products that enriched society culturally and/or that resolved particular societal needs. The course will begin with how optics revolutionized painting, sculpture, architecture, film, etc, and explore how the modern movement broke with or reinterpreted the past through a series of flashbacks.

**AD 162. History of Art and Design II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 161. This course explores the major art and design movements and influences of the 20th century post 1930 that set the stage for today's 21st century art and design works that increasingly deal with issues of globalization and technology and ecology. Students will investigate the cultural meaning and historical significance of the art/design product throughout the 20th and 21st century.

**AD 201. Human Factors/Ergonomics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Sophomore level or higher. Through lectures and "hands-on" experiments, this course will challenge the student to explore objects and environments as sensory and psychological experiences that effect human comfort, efficiency, function and emotion. Emphasis will be put on empathizing with the user with particular attention to those individuals with special physical, cognitive or occupational needs.

**AD 325. Entrepreneurship for Designers. 3 credits, 3 contact hours (3;0;0).**

**AD 340. Photography and Imaging. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 150 or (ARCH 155, ARCH 156, ARCH 163, ARCH 164) or permission of instructor. Photography is introduced as an artistic medium in a digital context. General photographic principles and techniques will be discussed including digital flash photography, image processing, in/on-camera filters and post-processing filters, camera controls, and compositional elements. Photographic student projects will be required. Students must provide their own DSLR camera for use throughout the semester.

**AD 463. Collaborative Design Studio. 5 credits, 13 contact hours (1;0;12).**
Prerequisites: (DD 364 or ID 364 or FA 364 or INT 364 or ARCH 364) and PHYS 102. Interdisciplinary and multi-disciplinary design studio where students work both individually and collaboratively on team project(s) that require the integration of different design disciplines.

**AD 490. Special Topics. 3 credits, 3 contact hours (3;0;0).**
Restriction: As determined by individual section and topic. Group investigation of problems or topics of special interest in art and design including, but not limited to, fine arts, industrial design, interior design, and digital design.

**AD 491. Independent Study. 1 credit, 1 contact hour (0;0;1).**
Restriction: Permission of instuctor and departmental/school approval. Individual investigation of problems or topics of special interest in art and design including, but not limited to, fine art, industrial design, interior design, and digital design. Subjects may include the overlap between these areas and related areas including art/architectural history and architecture. Provides opportunities to work on a project with individual guidance from an instructor in the School of Art + Design.

**AD 492. Independent Study. 2 credits, 2 contact hours (0;0;2).**
Restriction: Permission of instuctor and departmental/school approval. Individual investigation of problems or topics of special interest in art and design including, but not limited to, fine art, industrial design, interior design, and digital design. Subjects may include the overlap between these areas and related areas including art/architectural history and architecture. Provides opportunities to work on a project with individual guidance from an instructor in the School of Art + Design.

**AD 493. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Permission of instuctor and departmental/school approval. Individual investigation of problems or topics of special interest in art and design including, but not limited to, fine art, industrial design, interior design, and digital design. Subjects may include the overlap between these areas and related areas including art/architectural history and architecture. Provides opportunities to work on a project with individual guidance from an instructor in the School of Art + Design.

**DD 275. History of Games. 3 credits, 5 contact hours (2;3;0).**
Prerequisites: AD 111, AD 112 and AD 162 or ARCH 163, ARCH 263 and ARCH 251. A guided exploration through the world of games. Students will experiment, play, and analyze various aspects of games - from early traditional games to current generation electronically-mediated games; from individual games to collaborative online games. Game types will be analyzed with particular attention paid to the virtual environments in which these games take place. The expressive and persuasive aspects of games will also be explored.

**DD 284. Video and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 112 and AD 150 or equivalent with instructor's and program permission. Laboratory course exploring concepts of linear, motion-based two-dimensional media and includes motion graphics, live action filming, particle systems, digital video editing and digital video compression. Projects include the design and production of multiple projects addressing both technical and creative decision making.

**DD 301. Acting Fundamentals for Animators. 3 credits, 3 contact hours (3;0;0).**
Introduction to the historical contexts of acting. Survey of acting techniques and principles and their relationship to successful visual storytelling. Topics covered include movement, empathy and dialogue. Application of acting to two-and three-dimensional animation. Students will study examples from animation as well as film and theater. Required projects include both in-class acting exercises as well as storyboard creation and directed computer graphics character animation.

**DD 303. Foundations of Sound and Music. 3 credits, 3 contact hours (3;0;0).**
A multimedia course to give an understanding of music theory and musicology. Survey of the history of music and musical movements, and the use of music in motion pictures, digital media, and interactive entertainment. An introduction to instrumentation, music notation, music theory world musicology, and ear training as well as the relationship between music and culture. Visual and audio components are included. Digital Design majors only, others by permit.

**DD 320. Computational Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 112, AD 150; or ARCH 155, ARCH 156; or instructor approved equivalents. The course explores methods for algorithmically modeling spatial structures. Through a sequence of scripting exercises in application-specific programming environments, the course further explores rule-based generation of spatial forms and the underlying mathematical principles. Applications of digital fabrication and physical computing are also explored.

**DD 321. Interactive and Reactive Environments. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 112, AD 150 and DD 284, or ARCH 155, ARCH 156, ARCH 263 andARCH 264, or instructor permission. This course will investigate contemporary attitudes toward digital public spaces, from mainstream media facades, interactive art installations, and mobile applications to guerrilla-like techniques such as tactical media, activist gaming, and electronic civil disobedience. Based on their research of relevant precedents, students will design a 2D and/or 3D interactive environment.

**DD 334. Simulated Environments. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: DD 275 and DD 284. Digital Design majors only, all others with permission of the department. This course will explore the application of desktop, non-immersive virtual reality to the representation of architecture. Course exercises and projects are designed to uncover both advantages and limitations of this emerging technology, on both practical and theoretical levels. The major focus of the course will be personal evaluation of these tools in the design of both object-specific and the spatial in architectural problem solving. The collaborative nature of the toolkit will inform design decisions vis-a-vis observation of participant behavior and open discussion with interactive critics.

**DD 363. Digital Design Studio I. 5 credits, 13 contact hours (1;12;0).**
Prerequisites: AD 111, AD 112, AD 150, AD 161, AD 162, DD 284. CO/Prerequisites: DD 275, ARCH 251. Three-dimensional design in a digital milieu. Project-based applications focusing on the design and digital representation of architectural or environmental settings for games, theater, advertisements, books, or similar contexts. Course includes modeling with different geometries (e.g. NURBS, polygonal) and advanced techniques in rendering with lighting and materials as well as issues of production design.

**DD 364. Digital Design Studio II. 5 credits, 12 contact hours (0;0;12).**
Prerequisites: ARCH 251, DD 275, DD 363, IT 201. Design studio focusing on two-and three-dimensional visual communication of data, including interactive and scripted/animated communication as well as still-image utilization. Applications may include website creation, information kiosks, exhibit design, educational videos, scientific visualization, and other graphics-intensive projects.

**DD 403. Digital Sound and Music. 3 credits, 3 contact hours (3;0;0).**
A studio class that provides a baseline understanding of sound design within an animated video and video game environment. Course includes an introduction to sampling, field recording, sound effects, production techniques, and general sound design for the purpose of integrating and managing the integration of audio in motion pictures, television, and video games. Analytical and creative projects are required.

**DD 415. Web/Exhibit Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 150, DD 284, IT 201. Instructor may waive or accept alternate prerequisite(s) based on individual student preparation. Overview of multimedia exhibit design dealing with issues of graphic identity human-computer interactions, and information visualization as tools for comprehension, enhanced communication, and effective decision-making. Exhibit types include educational symposia, museum/gallery shows, and online environments. Analyses and creative project(s) are required.

**DD 442. Visual and Special Effects in Movies. 3 credits, 3 contact hours (3;0;0).**
The creating of narrative-dependent moving images pushes the boundaries of entertainment technology. This class investigates the progress of visual and special effects as viewing moved from the Kinetoscope to 4K digital projection. The use of mirrors, cameras, and other analog devices along with information technology enabled effects including computer generated imagery are studies. Analytical and creative projects are required.

**DD 443. 2-Dimensional Character Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 111, DD 275 and DD 284 This course focuses on the design of charaters for 2-Dimensional media such as graphic novels, 2D video games, model sheets for 3D creation, concept art and so on. Students will create both humanoid and creature-based charaters by using a variety of skillsets, including basic anatomy, illustrating age, acting (through characters), prop and costume design, etc. Students will also learn pre-production tools such as reference gathering, concept sketches and mood boards.

**DD 444. 3-Dimensional Character Devel. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 111, DD 275, DD 284 and DD 301 In-depth exploration of 3D character design, modeling and animation for video games and cinematographic production. Conceptual and technical/production topics are considered. Precedent studies are required from sources including illustration, gaming and video/animation disciplines as well as theatrical and cinematographic choreography including fashion designers and make-up artists. 3D modeling, UV unwrapping, texturing and rigging as well as pipeline production processes are also included.

**DD 449. Imaginary Worlds: Architecture in Motion Pictures. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 112, AD 161, AD 162 and ARCH 382. DD cohort designation for DD majors only. Like childhood photographs in family albums, movies are part of our collective memories and become a unique way of "remembering" an era or place even one that has never existed or could exist. The study of imaginary worlds in motion pictures provides students with opportunities to gain an awareness of architecture and study it from different perspectives. Movies studied will be limited to those that postulate new, or unique, environments rather than those films that faithfully document reality. Discussions will focus on architectural issues raised by the movies studied as well as those found in critical essays.

**DD 464. Digital Design Studio III. 5 credits, 12 contact hours (0;12;0).**
Prerequisite: DD 364. Continuation of Digital Design Studio II with projects of greater complexity requiring the selection and use of multiple media (including time-based media) in the preparation and completion of creative work. Independent research and production by each student is required for all projects. Production of both passive and interactive projects will be part of the studio program.

**ID 203. Past, Present and Future of Design. 3 credits, 3 contact hours (3;0;0).**
Restriction: Sophomore level or higher. Intensive survey course marking pivotal design paradigm shifts from ancient cultures through the industrial revolution, the present day and projecting into the future, this course focuses on the human activity called design. Case studies of selected cultures and designers will expose the student to the forces, history, methods, styles and meanings that shape the human ecology.

**ID 216. Modeling and Prototyping. 3 credits, 3 contact hours (3;0;0).**
Restriction: Sophomore level or higher. Corequisite: ID 263. Introduction to the drafting skills, techniques and methods needed to communicate a design for fabrication as well as the materials, tools and techniques to make full size working prototypes. The drafting component of the course will cover orthographic, isometric, line weight, dimensioning and specifications. Building from the drafting component of the course, the prototypes component will - through work in the model shop - introduce the student to the most common fabrication techniques, tools and methods used to build appearance and working prototypes in various materials.

**ID 217. Modeling and Manufacturing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ID 216. Corequisite: ID 264. This course will build on the computer modeling techniques of the ID 216 course and combine it with the programs, tools and facilities used in Computer-Aided Manufacturing (CAM). The student will take computer-generated designs and feed them directly into the manufacturing system. The course will also explore Computer Aided Manufacturing as a means of facilitating mass customization: the process of creating small batches of products that are custom designed to suit each particular user.

**ID 263. Industrial Design Studio I. 4 credits, 8 contact hours (0;0;8).**
Prerequisite: AD 111 and AD 112. Pre/Corequisite: AD 150. Students are introduced to designing objects, environments and systems through a series of exercises in conceptual, abstract, and strategic thinking as it applies to the small and large-scale artifact. The relationship between function structure materiality, production aesthetics and human needs are introduced and tested.

**ID 264. Industrial Design Studio II. 4 credits, 8 contact hours (0;0;8).**
Prerequisite: AD 150 and ID 263. This course is a continuation of ID 263 with the focus shifting toward selected problems derived from the areas of work, health, education, recreation and communication. Introduction to the case study method of analyzing existing products.

**ID 301. Industrial Design Specialization. 3 credits, 3 contact hours (3;0;0).**
Corequisite: ID 363 (or higher) or INT 363 (or higher). Restriction: Permission of Art + Design Advisor. This project-based course will expose the student to one of many specialties within the Industrial Design profession that may include industry-specific design explorations and case studies in areas that include the design of furniture, consumer products, toys, footwear and apparel, jewelry, lighting, exhibits, way-finding graphics, transportation, etc.

**ID 310. Ethnographic and Marketing Research. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. Research methodologies will be explored and conducted as a means to lend an objective understanding of user needs, desires and motivations. This will occur through well documented interviews, surveys, observations and interventions. The information gathered will be used to shape new products, add value to existing products or give insite to yet unexplored products or marketing opportunities.

**ID 312. Mechanics and Electronics. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. This is an advanced research course that addresses products which employ electronics predominantly as the major factor of design, then products that employ mechanical systems as the major determining factor, finally, the interpolanation of the mechanical with the electronic with a focus on the human interface with these products.

**ID 340. Materials and Processes. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. The student will be introduced to the basic materials and processes used in manufacturing of both short run and mass-produced objects. The course will comprise of lectures, field trips and design exercises employing both traditional and state-of-the-art manufacturing processes.

**ID 341. Sustainable Materials and Processes. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior level or higher. The course will comprise of lectures and field trips that take a critical look at the traditional materials and processes used in manufacturing and evaluate alternatives based on research and experimentation. Each student will perform a Life Cycle Analysis (LCA) on an existing product by following the products life from the mining of raw materials to disposal taking particular attention to energy usage, use of natural resources, toxicity and decomposition.

**ID 363. Industrial Design Studio III. 4 credits, 8 contact hours (0;0;8).**
Prerequisite: ID 264. This project specific studio will address real-world needs, parameters, and research as it applies to market trends and industry focused development. Companies and entrepreneurs will be invited to submit industry or need specific project briefs to the studio which will become the project for the semester. The students will experience first-hand the challenges of designing, building and testing within a real-life, interdisciplinary framework. The company will participate as sponsor, mentor and partner to the students.

**ID 364. Industrial Design Studio IV. 5 credits, 13 contact hours (0;0;13).**
Pre and Co-requisite: ID 216, ID 363, AD201. A knowledge and evidence-based studio that addresses real-world needs, parameters, and research. Work and product design(s) may be derived from requirements that include governmental and non-governmental not-for-profit organizations as well as from research about needs that can affect the social, physical, and economic health of individuals.

**ID 370. New Product Testing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 201 or permission of instructor. A hybrid course combining hands-on physical testing of products with lectures, readings, and case study presentations (both group and individual- oral and written). Multiple evaluative criteria (e.g safety, value, sustainability) will be discussed, established, and tested on a variety product types. Students may be required to provide/purchase a limited number of items for destructive testing. In-class student participation required.

**ID 410. Professional Practice and Ethics. 3 credits, 3 contact hours (3;0;0).**
Restriction: Senior level. This course covers the concepts of legal rights, copyrights, responsibilities and obligations of the designer, re: liabilities, contract review, patents, royalties, etc. The course also covers areas of responsibility in owner-offices, within corporate offices, working with design consultants and procedures for establishing a professional design practice. The course will also focus on the ethics of practice, research and marketing within a social, political and cultural context.

**ID 463. Industrial Design Studio V. 5 credits, 12 contact hours (0;0;12).**
Prerequisite: ID 364. This studio will draw from the vast academic talent at NJIT by partnering Industrial Design students with students in the other colleges and departments on campus such as engineering, architecture, management and computing. The students will develop methodologies for achieving effective collaboration and integration of industrial design with other disciplines, especially in the early phases of product development, through an industry specific design project.

**ID 464. Industrial Design Studio V. 5 credits, 13 contact hours (1;0;12).**
Prerequisites: ID 364 and PHYS 102. A comprehensive studio with projects (including multi-disciplinary projects) of advanced design and complexity. Students will work to initiate research and development of projects within the studio to demonstrate a full range of professional competencies, including but not limited to, the ability to independently critique work in progress. Completed work and presentaion materials are expected to be exhibitable quality.

**INT 221. Building and Interior Systems I. 3 credits, 3 contact hours (3;0;0).**
An introduction to, and overview of, large-scale systems used in and affecting the design of building interiors. The operation and impacts of heating, ventilating, and air conditioning equipment on building space and layout are emphasized. Additional topics include the design of plumbing and waste systems as they affect building planning and the design of related spaces (including kitchens and bathrooms) and the use and design requirements for vertical transportation in building interiors.

**INT 222. Building and Interior Systems II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 102. An introduction to, and overview of, small-scale systems used in and affecting the design of building interiors. The needs and scope of design potentials in electrical systems (including requirements for media installations) and lighting design as they are used in, affect the design of, interiors are emphasized. Also included is an introduction to building acoustics and how basic principles affect design layout and material and furniture selection for a variety of building and construction types.

**INT 263. Interior Design Studio I. 4 credits, 10 contact hours (1;0;9).**
Prerequisites: AD 111, AD 112. Co/prerequisite: AD 150. Corequisite: INT 221. A hands-on studio based introduction to the basic principles and elements of design for interior design students. Emphasis on design methods using multiple media, manipulating form and space. Course includes lectures, readings, analytical exercises, and (primarily three-dimensional) design projects.

**INT 264. Interior Design Studio II. 4 credits, 10 contact hours (1;0;9).**
Prerequisites: AD 150, INT 263. Corequisite: INT 222. A continuation of Interior Design Studio I. A hands-on studio course that expands introductory design problems into commercial interiors and public spaces. Interior design as a knowledge-based discipline is introduced. Emphasis is placed on the development of an iterative and reflective design process as well as the production and presentation of interior design proposals. Preliminary integration of multiple technical variables is included.

**INT 321. Methods and Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: AD 111, AD 112, AD 150 or ARCH 334, AD 161, AD 162 and ARCH 251. The study of materials, products, and assemblies used in interior design. The course covers code requirements and life safety, specification, installation, performance of materials (including fabrics and textiles), and sustainability of material selection and utilization. Also covered are the impacts of materials utilization on health and interior environmental quality.

**INT 322. Contract Documents. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: INT 321, INT 363. Co/prerequisite: ARCH 282. The course addresses issues of standards and methods of ethical and professional practice. It covers the production of contracts between the professional design service provider and clients as well as various project deliverables used in initial design phases through project close out. Document types covered include letters of agreement, contract document drawing sets and addenda sketches, specifications, schedules and budgets.

**INT 350. History of Furniture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AD 161 and AD 162 or equivalent; or ARCH 251, ARCH 252 and ARCH 381. Survey course studying the history and characteristics of furniture design from antiquity to the present day. Study of social and design forces influencing furniture. Students will analyze furniture in terms of style, aesthetic intent, construction and materials, ergonomics, universal/barrier-free accessibility, sustainability, and technology. Major stylistic movements will be discussed.

**INT 351. Furniture Design. 3 credits, 5 contact hours (2;0;3).**
Prerequisites: INT 264 or ID 264 or DD 364 or FA 264 or ARCH 264. Corequisite: Studio enrollment. This course is an introduction to the concepts, materials and construction technologies involved in the design and fabrication of furniture. It explores the relationship between ergonomics, comfort and function in the design of furniture for both site-specific environments and mass-produced applications. Course includes lectures, field trips and a variety of drawn, modeled, and built design projects.

**INT 363. Interior Design Studio III. 5 credits, 13 contact hours (0;0;5).**
Prerequisites: INT 222, INT 264. CO/Prerequisites: INT 221, INT 321, INT 350. Design studio focusing on residential design. The course includes a study of the relationship of human behavior to design emphasizing dwelling, security, comfort, and home. The correlation between furniture use and selection and residential space is explored. Variables studied include aesthetics and design organization, as well as the link between residential design and interior systems like lighting and plumbing.

**INT 364. Interior Design Studio IV. 5 credits, 13 contact hours (1;0;12).**
Prerequisites: INT 221, INT 222, INT 321, INT 363. Co/prerequisite: ARCH 282. A continuation of the studio sequence with design and space planning projects of increasing complexity selected within the context of commercial and institutional building types - from office environments and healthcare facilities to religious venues and community facilities. Students are expected to further develop skills to simultaneously resolve coneptual, technical, aesthetic, and functional aspects of designs.

**INT 464. Interior Design Studio V. 5 credits, 13 contact hours (0;0;13).**
Prerequisites: ARCH 282, ARCH 337, INT 321, INT 322, INT 364; Co/prerequisite: AD 201. A comprehensive studio with projects of advanced design and programming complexity concentrating on larger multi-level institutional and/or mixed-use building types. Students will work to initiate research and development through all design phases to synthesize the functional, sociological, aesthetic, regulatory, and project-specific technical requirements of their projects as they relate to interior design.

# B.A. in Digital Design

The Digital Design curriculum is separated into two tracks: Entertainment Track, and Interactive Media/Production Track. Students will select their track of study in the second year and follow their chosen track to completion. Please refer to the appropriate track for proper curriculum requirements.

Graduation is contingent upon the successful completion of the prescribed courses within the select track of the 135-credit Digital Design curriculum and the maintenance of both a minimum overall cumulative GPA of 2.0 and a minimum 2.0 GPA for all major-specific requirements. Students are required to maintain an annual studio average of 2.0 or higher to advance to the next studio level each succeeding year and to complete the final 4$^{th}$-year studio course sequence.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

(134 credits)

## Entertainment Track

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| AD 150 | Color and Composition | 3 |
| AD 161 | History of Art and Design I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 115 | Elements of Geometry | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Physical Education:GUR | | 1 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| AD 111 | Communication in Art and Design - Traditional Media | 3 |
| AD 112 | Communication in Art and Design - Digital Media | 3 |
| AD 162 | History of Art and Design II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 116 | Mathematics of Design | 3 |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 201 | Understanding Technological Society | |
| ECON 201 | Economics | |
| STS 258 | Technology, Society and Culture: A Global View (or any approved Social Science GUR course) | |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 382 | History of Architecture IV | 3 |
| DD 275 | History of Games | 3 |
| IT 101 | Introduction to Information Technology | 3 |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| DD 284 | Video and Animation | 3 |
| IT 201 | Information Design Techniques | 3 |
| ARCH 282 | Structural Principles | 3 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| AD 201 | Human Factors/Ergonomics | 3 |
| Natural Sciences:GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 434 | 3 | |
| STS 347<br>or DD 303 | Introduction to Music<br>or Foundations of Sound and Music | 3 |
| DD 363 | Digital Design Studio I | 5 |
| IT 265<br>or IT 266 | Game Architecture and Design<br>or Game Modification Development | 3 |
| 300+ Level Humanities and Social Sciences Electives (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| DD 364 | Digital Design Studio II | 5 |
| DD 301 | Acting Fundamentals for Animators | 3 |
| AD/ARCH/DD/ID/FA/INT XXX Design Elective | | 3 |
| ARCH/AD/DD/ID/FA/INT Design Elective | | 3 |
| ENG 369 | Creative Writing | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| AD 463 | Collaborative Design Studio | 5 |
| MGMT 390 | Principles of Management | 3 |
| DD 443<br>or DD 444 | 2-Dimensional Character Design<br>or 3-Dimensional Character Devel | 3 |
| AD/ARCH/DD/FA/ID/INT Design Elective | | 3 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| DD 464 | Digital Design Studio III | 5 |
| DD 403<br>or STS 349 | Digital Sound and Music<br>or Advanced Music Technology | 3 |
| DD 449<br>or DD 442 | Imaginary Worlds: Architecture in Motion Pictures<br>or Visual and Special Effects in Movies | 3 |
| Free Elective | | 3 |
| Humanities and Social Sciences Electives (HSS 400-level) Capstone:GUR Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **135** |

(134 credits)

## Interactive Media/Production Track

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| AD 150 | Color and Composition | 3 |
| AD 161 | History of Art and Design I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 115 | Elements of Geometry | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Physical Education:GUR | | 1 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| AD 111 | Communication in Art and Design - Traditional Media | 3 |
| AD 112 | Communication in Art and Design - Digital Media | 3 |
| AD 162 | History of Art and Design II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 116 | Mathematics of Design | 3 |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 201 | Understanding Technological Society | |
| ECON 201 | Economics | |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| ARCH 382 | History of Architecture IV | 3 |
| DD 275 | History of Games | 3 |
| IT 101 | Introduction to Information Technology | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Physical Education:GUR | | 1 |
| Select one of the following: | | 3 |
| HIST 213 | The Twentieth-Century World | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| DD 284 | Video and Animation | 3 |
| IT 201 | Information Design Techniques | 3 |
| Free Elective | | 3 |
| AD 201 | Human Factors/Ergonomics | 3 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| Natural Sciences:GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ARCH 434 | 3 | |
| DD 363 | Digital Design Studio I | 5 |
| IT 202 | Internet and Applications | 3 |

| | | |
|---|---|---|
| MRKT 330 | Principles of Marketing | 3 |
| Humanities and Social Sciences Electives (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| DD 364 | Digital Design Studio II | 5 |
| MRKT 331 | Consumer and Buyer Behavior | 3 |
| AD/ARCH/FA/DD/ID/INT Design Elective | | 3 |
| Design Elective | | 3 |
| Humanities and Social Sciences Electives (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| AD 463 | Collaborative Design Studio | 5 |
| MGMT 390 | Principles of Management | 3 |
| DD 415 | Web/Exhibit Development | 3 |
| IT 380 | Educational Software Design | 3 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| DD 464 | Digital Design Studio III | 5 |
| AD/ARCH/FA/DD/ID/INT Design Elective | | 3 |
| MRKT 360 | Internet Marketing | 3 |
| Free Elective | | 3 |
| Humanities and Social Sciences (HSS 400-level) Capstone:GUR Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **135** |

| | | |
|---|---|---|
| **Social Sciences (lower-level) GUR** | | |
| Select six credits from the following: | | 6 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 258 | Technology, Society and Culture: A Global View | |
| R070 203 | Intro Phys Anth & Arch | |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences Electives (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT XXX | 300+ level Literature course | |
| HIST XXX | 300+ level History course | |

| | | |
|---|---|---|
| PHIL XXX | 300+ level Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Sciences GUR** | | |
| Select at least seven credits of the following, including a laboratory experience: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences Electives (upper-level)** | | |
| Select one of the following: | | 3 |
| ENG XXX | 300+ level English course | |
| HSS XXX | 300+ level Social Science course | |
| THTR XXX | 300+ level Theater course | |
| LIT XXX | 300+ level Literature course | |
| HIST XXX | 300+ level History course | |
| PHIL XXX | 300+ level Philosophy course | |

| | | |
|---|---|---|
| STS XXX | 300+ level Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

[1] Students may also take approved introductory courses at Rutgers-Newark.

[2] Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

The minimum credit requirement for graduation is the successful completion of 134 credits of prescribed courses within the curriculum and the maintenance of a 2.0 average. Students are required to maintain a 2.0 cumulative studio average to advance to each succeeding year.

# B.A. in Interior Design

Credit distribution for the Bachelor of Art in Interior Design:

| | |
|---|---|
| Required Interior Design Credits | 70 |
| Design Electives | 6 |
| Free Electives | 9 |
| General University Requirements | 46 |
| **Total Minimum Credits** | 131 |

(131 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| AD 150 | Color and Composition | 3 |
| AD 161 | History of Art and Design I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 115 | Elements of Geometry | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Physical Education:GUR | | 1 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| AD 111 | Communication in Art and Design - Traditional Media | 3 |
| AD 112 | Communication in Art and Design - Digital Media | 3 |
| AD 162 | History of Art and Design II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 116 | Mathematics of Design | 3 |
| STS 201 | Understanding Technological Society | 3 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| INT 263 | Interior Design Studio I | 4 |
| INT 221 | Building and Interior Systems I | 3 |
| ARCH 251 | History of Architecture I | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| INT 264 | Interior Design Studio II | 4 |

| | | |
|---|---|---|
| INT 222 | Building and Interior Systems II | 3 |
| ARCH 282 | Structural Principles | 3 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| Natural Sciences:GUR Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| INT 363 | Interior Design Studio III | 5 |
| INT 321 | Methods and Materials | 3 |
| INT 350 | History of Furniture | 3 |
| MGMT 390 | Principles of Management | 3 |
| Humanities and Social Sciences (upper-level) Electives:GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| INT 364 | Interior Design Studio IV | 5 |
| INT 322 | Contract Documents | 3 |
| AD 201 | Human Factors/Ergonomics | 3 |
| INT/DD/ID/FA Design Elective | | 3 |
| Humanities and Social Sciences (upper-level) Electives:GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| AD 463 | Collaborative Design Studio | 5 |
| ARCH 337 | Building Information Modeling | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| INT 464 | Interior Design Studio V | 5 |
| INT/DD/ID/FA Design Elective | | 3 |
| Free Elective | | 3 |
| Humanities and Social Sciences (upper-level) Capstone:GUR Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **132** |

**Social Sciences (lower-level) GUR**

| | | |
|---|---|---|
| Select six credits from the following: | | 6 |
| ECON 201 | Economics | |
| ECON 265<br>or R220 101 | Microeconomics<br>Intro To Econo-Micro | |
| ECON 266<br>or R220 102 | Macroeconomics<br>Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 258 | Technology, Society and Culture: A Global View | |
| R070 203<br>or R070 204 | Intro Phys Anth & Arch<br>Intro Cultural Anthro | |
| R790 201<br>or R790 202 | American Government<br>America & The World | |
| R830 101<br>or R830 102 | Principles Of Psychology I<br>Prin Of Psychology | |

| | | |
|---|---|---|
| R920 201 | Intro Sociology I | |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT XXX | 300+ level Literature course | |
| HIST XXX | 300+ level History course | |
| PHIL XXX | 300+ level Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Science GUR** | | |
| Select at least seven credits from the following, including a laboratory experience: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |

| | | |
|---|---|---|
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| ENG XXX | 300+ level English course | |
| HSS XXX | 300+ level Social Science course | |
| THTR XXX | 300+ level Theater course | |
| LIT XXX | 300+ level Literature course | |
| HIST XXX | 300+ level History course | |
| PHIL XXX | 300+ level Philosophy course | |
| STS XXX | 300+ level Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

1 Students may also take approved introductory courses at Rutgers-Newark.

2 Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 965, 988.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

Students interested in pursuing graduate studies in Architecture (either at NJIT or elsewhere) are strongly advised to take the calculus math sequence (MATH 113 Finite Mathematics and Calculus I, and MATH 114 Finite Mathematics and Calculus II), and one additional Physics course and corresponding lab (PHYS 103 General Physics/PHYS 103A General Physics Laboratory). Students should consult admissions requirements for any program and/or institution they are considering.

The minimum credit requirement for graduation is the successful completion of 128 credits of prescribed courses within the curriculum and the maintenance of a 2.0 average. Students are required to maintain a 2.0 cumulative studio average to advance to each succeeding year.

# B.S. in Industrial Design

Credit distribution for the Bachelor of Science in Industrial Design:

| | |
|---|---|
| Required Industrial Design Credits | 72 |
| Specialization | 3 |
| Design Electives | 9 |
| Free Electives | 9 |
| General University Requirements | 46 |
| **Total Minimum Credits** | **134** |

The curriculum as described below is for students entering NJIT as freshman in the Fall of 2008 or after that date. Students entering before that date may have a different program and should consult the school to learn which curriculum applies.

(136 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| AD 150 | Color and Composition | 3 |
| AD 161 | History of Art and Design I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 115 | Elements of Geometry | 3 |
| CS 104 | Computer Programming and Graphics Problems | 3 |
| Physical Education:GUR | | 1 |
| MATH 120 | Basic Concepts in Statistics | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| AD 111 | Communication in Art and Design - Traditional Media | 3 |

| | | |
|---|---|---|
| AD 112 | Communication in Art and Design - Digital Media | 3 |
| AD 162 | History of Art and Design II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 113 | Finite Mathematics and Calculus I | 3 |
| STS 201 | Understanding Technological Society | 3 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| ID 263 | Industrial Design Studio I | 4 |
| ID 203 | Past, Present and Future of Design | 3 |
| ID 216 | Modeling and Prototyping | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ID 264 | Industrial Design Studio II | 4 |
| AD 201 | Human Factors/Ergonomics | 3 |
| ID 217 | Modeling and Manufacturing | 3 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| Natural Sciences:GUR Elective | | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| ID 363 | Industrial Design Studio III | 4 |
| ID 340 | Materials and Processes | 3 |
| ID 310 | Ethnographic and Marketing Research | 3 |
| MGMT 390 | Principles of Management | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ID 364 | Industrial Design Studio IV | 5 |
| ID 341 | Sustainable Materials and Processes | 3 |
| ID 301 | Industrial Design Specialization | 3 |
| ID 312 | Mechanics and Electronics | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| AD 463 | Collaborative Design Studio | 5 |
| ID 410 | Professional Practice and Ethics | 3 |
| Design Elective: ID/DD/FA/INT XXX | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ID 464 | Industrial Design Studio V | 5 |

| | | |
|---|---|---|
| Design Elective: ID/DD/FA/Int XXX Design Elective | | 3 |
| Design Elective: ID/DD/FA/INT XXX Design Elective | | 3 |
| Humanities and Social Sciences (upper-level) Capstone:GUR Elective | | 3 |
| Free Elective | | 3 |
| **Term Credits** | | **17** |
| **Total Credits** | | **136** |

| | | |
|---|---|---|
| **Social Sciences (lower-level) GUR** | | |
| Select six credits from the following: | | 6 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 258 | Technology, Society and Culture: A Global View | |
| R070 203 | Intro Phys Anth & Arch | |
| or R070 204 | Intro Cultural Anthro | |
| R790 201 | American Government | |
| or R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | |
| or R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | |
| or R920 202 | Sociology II | |
| R202 201 | Intro Criminal Justice | |
| **English Composition and Cultural History (lower-level) GUR** [1] | | |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT XXX | 300+ level Literature course | |
| HIST XXX | 300+ level History course | |
| PHIL XXX | 300+ level Philosophy course | |
| R350 XXX | English Literature (STS approved) course | |
| R352 XXX | American Literature (STS approved) course | |
| R510 XXX | History (STS approved) course | |
| R512 XXX | American History (STS approved) course | |
| R730 XXX | Philosophy (STS approved) course | |
| **Natural Science GUR** | | |
| Select at least seven credits, including a laboratory experience: | | 7 |
| **Biology Courses** | | |
| R120 101 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |
| R120 242 | Anatomy & Physiology | |

| | | |
|---|---|---|
| **Chemistry Courses** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics Courses** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology Courses** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following: | | 3 |
| HSS ENG XXX | 300+ level English course | |
| HSS XXX | 300+ level Social Science course | |
| THTR XXX | 300+ level Theater course | |
| LIT XXX | 300+ level Literature course | |
| HIST XXX | 300+ level History course | |
| PHIL XXX | 300+ level Philosophy course | |
| STS XXX | 300+ level Science, Technology and Society course | |
| Any 300-level Rutgers-Newark courses in humanities, social sciences, fine arts, or performing arts [2] | | |

[1] Students may also take approved introductory courses at Rutgers-Newark.

[2] Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 560, 570, 700, 701, 790, 810, 861, 920, 940, 964, 988.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

The minimum credit requirement for graduation is the successful completion of 134 credits of prescribed courses within the curriculum and the maintenance of a 2.0 average. Students are required to maintain a 2.0 cumulative studio average to advance to each succeeding year.

# Ying Wu College of Computing

The mission of the Ying Wu College of Computing, which was established in 2001, is to bring education in a broad range of computing disciplines to students on campus and at a distance to carry out cutting-edge research while working closely in the industry. Ying Wu College of Computing offers bachelor's, master's and doctoral degrees in multiple fields of computing science, Web and information systems and a multidisciplinary undergraduate degree in information technology.

Ying Wu College of Computing resides on one of the most computing-intensive campuses in the world, helping NJIT educate one of the largest groups of information technology students in the nation in the applications of new technologies as learning tools. Not coincidentally, New Jersey is one of the leading states for computing and high technology businesses. Thirty of the nation's fastest-growing technology companies are based in the state, and New Jersey ranks seventh in the nation as a cyberstate and eighth for venture capital investment— $3.5 billion—in information technology and software. Additionally, New Jersey offers the second-highest wages in the nation for technology workers. Ying Wu College of Computing graduates frequently land creatively satisfying and intellectually challenging jobs at major companies like IBM, Mercedes-Benz and Pfizer.

## Programs

- Bioinformatics - B.S. (p. 203)
- Business and Information Systems - B.S. (p. 221)
- Computer Science - B.A. (p. 201)
- Computer Science - B.S. (p. 205)
- Computing and Business - B.S. (p. 210)
- Human-Computer Interaction - B.S. (p. 224)
- Information Systems - B.A. (p. 217)
- Information Technology - B.S. (p. 238)
- Web & Information Systems - B.S. (p. 230)

## **Accelerated Programs** (p. 92)

- Bioinformatics for Honors Premed Students - Accelerated B.S. (p. 200)
- Information Technology - Accelerated B.S. and J.D. (p. 238) (with Seton Hall School of Law)

## **Double Majors** (p. 92)

- Computer Science and Applied Physics - B.S. (p. 207)
- Computer Science and Mathematical Sciences - B.S (p. 209)
- Science, Technology and Society/Business and Information Systems - B.S. (p. 227)

- Computer Science Minor (p. 212) (not for Computer Engineering majors)
- Computer Science Minor (p. 212) (for Computer Engineering majors)
- Data Analytics (http://catalog.njit.edu/undergraduate/computing-sciences/information-systems/data-analytics-minor)
- Design of the User Experience Minor (p. 232)
- Business and Information Systems Minor (p. 232) (not for Computing Sciences majors)
- Business and Information Systems Minor (p. 233) (for Computing Sciences majors)
- Information Technology Minor (p. 244) (not for Computing Sciences majors)
- Information Technology Minor (p. 244) (for Computing Sciences majors)
- Mobile and Web Minor (p. 233)

## Programs

- Bioinformatics - M.S. (p. 674)
- Business & Information Systems - M.S. (p. 694)
- Computer Science - M.S. (p. 675)
- Computing and Business - M.S. (p. 679)
- Cyber Security and Privacy - M.S. (p. 680)
- Information Systems - M.S. (p. 701)
- Information Technology and Administration Security - M.S. (p. 708)
- Software Engineering - M.S. (p. 683)

## Programs

- Computing Sciences - Ph.D. (p. 684)
- Information Systems - Ph.D. (p. 704)

## Ying Wu College of Computing Courses

**BNFO 135. Programming for Bioinformatics. 3 credits, 3 contact hours (3;0;0).**
The ability to use existing programs and to write small programs to access bioinformatics information or to combine and manipulate various existing bioinformatics programs has become a valuable part of the skill set of anyone working with biomolecular or genetic data. This course provides an unerstanding of the architecture of bioinformatics toolkits and experience in writing small bioinformatics programs using one or more of the scripting ("glue") languages frequently employed for such tasks.

**BNFO 236. Programming For Bioinfo II. 3 credits, 3 contact hours (3;0;0).**

**BNFO 330. Princ of Bioinformatics II. 3 credits, 3 contact hours (3;0;0).**

**BNFO 340. Data Analysis for Bioinformatics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BNFO 240 and R120 101 or equivalent or permission of instructor. Advanced data analysis skills with applications to bioinformatics problems.

**BNFO 482. Databases and Data Mining in Bioinformatics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BNFO 240 or equivalent or permission of instructor. Surveys biological databases and tools for managing them. Covers concepts and principles of data mining in bioinfomratics. Hands-on experience for mining genomic data using ORACLE and SQL.

**BNFO 488. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**BNFO 491. Computer Science Project. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CS 490. Restriction: Senior standing in the Honors College and project proposal approval. A course similar to CS 491, with a project of greater depth and scope.

**CS 100. Roadmap to Computing. 3 credits, 3 contact hours (3;0;0).**
An introduction to programming and problem solving skills using Python or other very high level language. Topics include basic strategies for problem solving, constructs that control the flow of execution of a program and the use of high level data types such as lists, strings and dictionaries in problem representation. The course also presents an overview of selected topics in computing, such as networking and databases.

**CS 101. Computer Programming and Problem Solving. 3 credits, 3 contact hours (3;0;0).**
An introductory course that is designed for engineering freshman. This course introduces students to the engineering problem solving process in the context of MATLAB. The emphasis is on the logical analysis of a problem and the formulation of a computer program leading to its solution. Topics include basic concepts of computer systems, algorithm design, programming languages and data abstraction. At the end of class, a comparison between MATLAB and C/C++ will be discussed in order to provide students a better understand of general concept of computer programming.

**CS 103. Computer Science with Business Problems. 3 credits, 3 contact hours (3;0;0).**
An introductory course in computer science, with applications to business and managerial decision making. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and abstraction, with applications.

**CS 104. Computer Programming and Graphics Problems. 3 credits, 3 contact hours (3;0;0).**
An introductory course in computer science with applications in computer graphics for architecture. Emphasis on programming methodology using a high level language as the vehicle to illustrate the concepts. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications.

**CS 105J. Computer Prog-Java. 1 credit, 1 contact hour (1;0;0).**

**CS 106. Roadmap to Computing Engineers. 3 credits, 3 contact hours (3;0;0).**
An introduction to programming and problem solving skills for engineering majors using Python programming languages. Topics include basic strategies for problem solving, constructs that control the flow execution of a program and the use of high level data types such as lists, strings, and dictionaries in problem representation. The course also presents an overview of selected "big idea" topics in computing.

**CS 107. Computing as a Career. 1 credit, 1 contact hour (1;0;0).**
In this course, students will learn about time management, communication skills, and getting acclimated to NJIT. Through meetings with faculty, upperclassman students and current computing employers, students will explore CCS and learn about many exciting career opportunities within the computing field.

**CS 113. Introduction to Computer Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 100 with a grade C or better. Intensive introduction to computer science. Problem solving decomposition. Writing, debugging, and analyzing computer programs. Introduction to arrays and lists. Iteration and recursion. The Java language is introduced and used to highlight these concepts. A student receiving degree credit for CS 113 cannot receive degree credit for CS 115.

**CS 114. Introduction to Computer Science II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:; CS 113 or completion of a required 100 level GUR course in CIS, plus an approved CIS 105. A study of advanced programming topics with logical structures of data, their physical representation, design and analysis of computer algorithms operating on the structures, and techniques for program development and debugging. Course covers program specifications, correctness and efficiency, data abstraction, basic aspects of simple data structures, internal searching and sorting, recursion and string processing. Algorithmic analysis is also discussed. Students receiving degree credit for CS 114 cannot receive degree credit for CIS 335 or CIS 505.

**CS 115. Intro. to CS I in C++. 3 credits, 3 contact hours (3;0;0).**
Fundamentals of computer science are introduced, with emphasis on programming methodology and problem solving. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications. The high level language C++ is fully discussed and serves as the vehicle to illustrate many of the concepts. CIS majors should enroll in CS 113.

**CS 116. Intro. to Computer Science II/C++. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 115 or completion of a required 100 level GUR course in CS, plus an approved CS 105. A study of advanced programming topics with logical structures of data, their physical representation, design and analysis of computer algorithms operating on the structures, and techniques for program development and debugging. Course covers program specifications, correctness and efficiency, data abstraction, basic aspects of simple data structures, internal searching and sorting, recursion and string processing. Algorithmic analysis is also discussed. Students receiving degree credit for CS 116 cannot receive degree credit for CS 505.

**CS 207. Computing and Effective Communication. 1 credit, 1 contact hour (1;0;0).**
Prerequisites: CS 107. Through encouraging collaboration and communication, this course addresses how to best present oneself via verbal and nonverbal communication. Students will learn how to effectively network, create resumes, interview and best present ideas. The skills learned in this course prepare students for co-op/internship opportunities as well as future employment.

**CS 241. Foundations of Computer Science I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (CS 114 AND MATH 112) OR (CS 114 AND MATH 133). An introduction to the foundations of computer science with emphasis on the development of techniques for the design and proof of correctness of algorithms and the analysis of their computational complexity. Reasoning techniques based on propositional and predicate logic and relational calculus operations with applications to databases will also be introduced. Auxiliary topics such as combinatorics of finite sets, functions and relations, and graph-theory definitions and graph storage alternatives will also be examined.

**CS 252. Computer Organization and Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 113. An introduction to the organization and architecture of computer systems, including the standard Von Neumann model and more recent architectural concepts. Among the topics covered are numeric data representation, assembly language organization, memory addressing, memory systems, both real and virtual, coding and compression, input/output structures treated as programmed, interrupt, and direct memory access, and functional organization of the CPU and the computer system.

**CS 266. Game Modification Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 102 OR IT 114 OR CS 116, OR CS 114. This course introduces students to the basic concepts of game programming and development. Students will learn how to reprogram a professional game engine, or Modification (Mod) development as it is referred to in the industry. Students will work with C extensively. Students will work on their own game projects utilizing the professional game engine.

**CS 276. 2D Game Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 265 and CS 266 or IT 265 and IT 266. This course introduces students to the core concepts and skills necessary for the development of games utilizing 2D graphics. Students will learn how to set up and program their own 2D graphics based game engine. The engine will integrate 2D graphics, audio, input handling and network socket programming. Students will learn how to utilize their own custom 2D graphics and sounds into their projects. Once complete, students will have created two fully functional games.

**CS 280. Programming Language Concepts. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114 OR CS 116 OR IT 114 OR IT 102. Conceptual study of programming language syntax, semantics and implementation. Course covers language definition structure, data types and structures, control structures and data flow, run-time consideration, and interpretative languages.

**CS 288. Intensive Programming in Linux. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114. The course covers Linux programming with Apache Web and MySql database using Php/Python and C as primary languages. It consists of four stages: basic tools such as Bash and C programming; searching trees and matrix computing, end-to-end applications such as one that constantly presents top 100 stocks; and extending the applications to run on multiple machines. The course provides students with hands-on experience for programming relatively large applications.

**CS 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**CS 332. Principles of Operating Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114 OR CS 116 OR IT 114 OR IT 102. Organization of operating systems covering structure, process management and scheduling; interaction of concurrent processes; interrupts; I/O, device handling; memory and virtual memory management and file management.

**CS 333. Introduction to UNIX Operating Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 332 or equivalent and knowledge of C language. The course covers the UNIX system kernel including initialization, scheduling, context switching, process management, memory management, device management, and the file system. The course also includes the organization of shells, editors, utilities, and programming tools of the UNIX operating system.

**CS 337. Performance Modeling in Computing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 114 and (MATH 333 or MATH 341). Introduction to probability models and techniques useful in computer science. Performance evaluation, discrete-event simulation, classification and optimization.

**CS 341. Foundations of Computer Science II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (CS 241 or MATH 226) and CS 280. This course provides an introduction to automata theory, computability theory, and complexity theory. Theoretical models such as finite state machines, push-down stack machines, and Turing machines are developed and related to issues in programming language theory. Also, the course covers undecidability and complexity theory, including the classes P and NP.

**CS 345. Web Search. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 280 and (CS 241 or CS 252). An introductory course on the web searching. The architecture of a search engine. Information vs. data retrieval. Web crawling. Processing text(tokenization, stemming, stopwords, link analysis). The indexing process and inverted indexes. Query processing. Ranking algorithms based on indexes and links (e.g. Kleinberg's HITS, Google's PAGERANK). Retrieval Models. Search engine evaluation. Case studies (e.g. Google cluster architecture).

**CS 356. Introduction to Computer Networks. 3 credits, 3 contact hours (3;0;0).**
Computer Science students should take CS 288 before taking CS 356. This course provides an introduction to computer networks, with a special focus on the Internet architecture and protocols. Topics include layered network architectures, addressing, naming, forwarding, routing, communication reliability, the client-server model, web and email protocols. Besides the theoretical foundations, students aquire practical experience by programming reduced versions of real Internet protocols.

**CS 357. Fundamentals of Network Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 356 or IT 120. This course is designed for Computer Science and Information Technology students. They must have a networking course before taking CS 357. IT students take IT 120 and Computer Science students take CS 356. This course offers an in depth study of network security issues, types of computer and network attacks, and effective defenses. It provides both a theoretical foundation in the area of security and hands-on experience with various attack tools, firewalls, and intrusion detection systems. Topics include: network scanning, TCP/IP stack fingerprinting, system vulnerability analysis, buffer overflows, password cracking, session hijacking, denial of service attacks, intrusion detection.

**CS 366. 3D Game Development. 3 credits, 3 contact hours (3;0;0).**
This course introduces students to the core concepts and skills necessary for the development of games utilizing 3D graphics. Students will learn how to set up and program their own 3D graphics based game engine using OpenGL. Students will learn how to load and display custom 3D models created using existing 3D modeling tools. Once complete, students will have created two fully functional 3D games and tools to work with them.

**CS 370. Introduction to Artificial Intelligence. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: CS 114 and (MATH 226 or CS 241). An exploration of concepts, approaches and techniques of artificial intelligence. Emphasizes both underlying theory and applications. Topics include knowledge representation, parsing language, search, logic, adduction, uncertainty, and learning. LISP and Prolog programming languages used extensively. Students are required to do programming assignments, complete a programming term project and review case studies.

**CS 388. Android Application Developmnt. 3 credits, 3 contact hours (3;0;0).**
This course introduces mobile application development for the Android platform. Students will learn skills necessary for creating and deploying applications with the Android Software Development Kit (SDK). The course is designed to introduce and familiarize students with programming in the Android environment. It starts with an examination of the basic components and concepts that define the Android platform, and then moves on to cover the specific structure that comprises an Android application. An overview of the most common tools and techniques for writing Android applications is included. The Android approach to user interfaces is described along with a discussion of some of the more common user interface elements. Storage strategies for persistent information are also covered, including the use of the available SQLite Database features. The unique characteristics of programming for a mobile environment are introduced and explained. Hands on experience in the form of exercises and programming projects are included throughout the course to reinforce material that has been presented in lecture form.

**CS 407. Professional Development in Computing. 1 credit, 1 contact hour (1;0;0).**
Prerequisites: CS 107 and CS 207.This course is designed for final year students to reflect back on the college experience and to help plan for the future as a computing professional. The course will explore transitional issues that occur during the progression from student to professional through reflection on co-op and/or internship experiences. Through collaborative communication, students will reflect on global issues, explore how to best use new communication technologies and effectively communicate in the workplace.

**CS 408. Cryptography and Internet Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 226 or CS 241. Covers security require-ments for telecommunication over the Internet and other communication networks, various conventional and public-key encryption protocols, digital encryption standard, RSA and ElGamal cryptographic systems, digital signature algorithm and analysis of its cryptoimmunity, and access sharing schemes. Students receiving credit for CS 408 may not enroll in CIS 608.

**CS 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CS 310 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**CS 431. Database System Design and Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114 or equivalent. Database system architecture; data modeling using the entity-relationship model; storage of databases; the hierarchical, network and relational data models; formal and commercial query languages; functional dependencies and normalization for relational database design; relation decomposition; concurrency control and transactions management. Student projects involve the use of a DBMS package.

**CS 433. Introduction to Linux Kernel Programming. 3 credits, 3 contact hours (3;0;0).**
An introductory study of how the Linux operating system is built from scratch. AS a hands-on course, students will perform intensive programming using Linux kernel. The contents include booting, segmentation and paging, creating and destroying processes, process switching and scheduling, handling exceptions and interrupts, software interrupts, creating system calls, creating file systems, networking with TCP/IP, device driver writing and module programming, etc. At the end of the course, students will be able to modify the Linux operating system to create their own.

**CS 434. Advanced Database Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 431. The course covers the basic concepts of traditional files and file processing, provides a "classic" introduction to the relational data model and its languages, and discusses database design methodology and application developments. Students are expected to learn the design of database application systems through a small project and to get some practical hands-on experience with commercial database management systems (DBMS) by writing application programs using the commercial DBMS query languages.

**CS 435. Advanced Data Structures and Algorithm Design. 3 credits, 4 contact hours (3;1;0).**
Prerequisite: CS 241 and CS 288. Advanced topics in data structures and algorithms, involving sequences, sets, and graphs such as searching, sorting, order statistics, balanced search tree operations, hash tables, graph traversals, graph connectivity and path problems. Algebraic and numeric algorithms. Performance measures, analysis techniques, and complexity of such algorithms.

**CS 438. Interactive Computer Graphics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: completion of a 100-level course in CIS, plus knowledge of a higher level language. This course introduces fundamental concepts of interactive graphics oriented toward computer-aided design systems. Such systems emerge in engineering, architecture, and manufacturing. Topics include computer data structures for representation of two- and three-dimensional objects and algorithms for definition, modification, and display of these objects in applications. This course will also discuss a selection of special topics in interactive graphics.

**CS 439. Image Processing and Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 114 and MATH 333. This course is an intensive study of the fundamentals of image processing, analysis and understanding. Topics to be covered include: a brief review of the necessary mathematical tools, human visual perception, sampling and quantization, image transformation, enhancement, restoration, compression, reconstruction, image geometric transformation, matching, segmentation, feature extraction, representation and description, recognition and interpretation.

**CS 440. Computer Vision. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333. This course introduces basic concepts and methodologies of computer vision, and focuses on material that is fundamental and has a broad scope of applications. Topics include contemporary developments in all mainstream areas of computer vision e.g., Image Formation, Feature Representation, Classification and Recognition, Motion Analysis, Camera Calibration, Stereo Vision, Shape From X (shading, texture, motion, etc.), and typical applications such as Biometrics.

**CS 441. Database Programming. 3 credits, 3 contact hours (3;0;0).**
Many technologies have been developed due to the interplay between World-Wide Web Development and Databases on one hand and the growth of Database applications in E-Commerce on the other hand. Today, practically every E-Commerce application has at least a Web component and a Database Component. Many languages have been developed in order to deal with these interactions. The proposed course will focus on accessing databases through the web but also mention new developments in the field.

**CS 458. Technologies-Network Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 356 or CS 456 or IT 420. This course provides both an in depth theoretical study and a practical exposure to technologies which are critical in providing secure communication over the Internet. Topics include: remote access security, web security, wireless security, e-mail security, spam and spam filtering techniques, computer viruses and internet worms, honeypots and honeynets, security liability issues and compliance.

**CS 482. Data Mining. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 431. The course covers the concepts and principles of advanced data mining systems design; presents methods for association and dependency analysis, classification; prediction; and clustering analysis.

**CS 485. Special Topics in Computer Science/Information Systems. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing and/or department approval. The study of new and/or advanced topics in an area of computer science not regularly covered in any other CIS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. A student may register for no more than two semesters of Special Topics.

**CS 486. Topics in Computer Science/Information Systems. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing and/or department approval. A continuation of CS 485.

**CS 488. Independent Study in Computer Science. 3 credits, 0 contact hours (0;0;0).**
Restriction: open only to students in the Honors Program who are computer science majors and who have the prior approval of the department and the CIS faculty member who will guide the independent study. Independent studies, investigations, research, and reports on advanced topics in computer science. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of Independent Study.

**CS 490. Guided Design in Software Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 280 and CS 288. This course focuses on the methodology for developing software systems. Methods and techniques for functional requirements analysis and specifications, design, coding, testing and proving, integration and maintenance are discussed.

**CS 491. Senior Project. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 490, senior standing and project proposal approval. An opportunity for the student to integrate the knowledge and skills gained in previous computer science work into a team-based project. The project involves investigation of current literature as well as computer implementation of either a part of a large program or the whole of a small system.

**IS 117. Introduction to Website Development. 3 credits, 3 contact hours (3;0;0).**
This course discusses the concepts and skills required to plan, design and build websites. It will be taught in a lab to ensure hands-on experience with each of these tasks. The course begins with an overview of web technologies. Students learn to plan websites, which includes determining the business and end-user requirements for the site. Design includes learning to develop "mockups" of how the site will look and how people will use it. The major tools for building websites will be industry standard HTML and XHTML to describe webpage content, and Cascading Style Sheets (CSS) for flexibly formatting the content. Using entire site, as well as "future-proofs" a website, allowing it to be viewed on every major web browser (such as Firefox or Chrome) and easily adapt to changes in future browser technology. The course features substantial hands-on projects comprising websites of several interlinked pages and images, enabling students to thoroughly learn the course's important concepts and skills.

**IS 218. Building Web Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (IS 117 or IT 202) and (CS 100, CS 113, or CS 115). This course provides a critical, hands-on introduction to the design of Web-based Information Systems. We will explore and discuss emerging trends, capabilities, and limitations of web technologies used to capture, store, access, and disseminate information for both businesses and online communities. Students, working in groups, will design and develop different types of web applications, which will then be analyzed and critiqued by the students as to their usability in actual public and private settings. An open-source web content management system will be utilized throughout the course.

**IS 219. Adv Website Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (IS 117 or IT 202) and (CS 100, CS 113, or CS 115). This course discusses the concepts and skills required to plan, design and build advanced websites, with a focus on sophisticated user interaction enabled by programming the web browser (such as Internet Explorer or Chrome). Such programming is known as client-side scripting. These interactive websites utilize forms to gather user inputs, and vary both the content and display of the webpages based on the current user tasks and preferences. This includes designing and dynamically changing tabs and menus, as well as expanding and contracting sections of pages. Students will develop a thorough understanding of website usability (designing effective sites that people like, security and user privacy, browser capability (ensuring websites work on every major web browser), and the tools and skills that web developers use to add interactive features to websites. These skills include Javascript (for programming interactive features), the Document Object Model or DOM (specifying the internal structure of web pages), JQuery (to access information utilizing this internal structure, create animations and generally streamline Javascript), browser variables (providing information about the browser characteristics), HTML input forms, form validation (ensuring correctness of user input), securing user input (to ensure user privacy), cookies (tracking user information), basic communication with the web server (which processes the information users input into forms), and AJAX ( which integrates many of these technologies). The course will be taught in a lab to ensure hands-on experience and will include substantial design and development projects.

**IS 245. Information Technology Systems: Hardware/Software. 3 credits, 3 contact hours (3;0;0).**
This course reviews hardware/software technologies in order to enable system developers to understand tradeoffs in the design of computer architectures for effective computer systems. Also covered are operating systems and systems architecture for networked computing systems. Topics include Hardware (CPU architecture, memory, registers, addressing modes, busses, instruction sets, multi processors versus single processors, and peripheral devices), Operating systems (processes, process management, memory and file system management), and Telecommunications (basic network components, switches, multiplexers and media, installation and configuration of multi-user operating systems).

**IS 247. Designing the User Experience. 3 credits, 3 contact hours (3;0;0).**
This course covers the design and evaluation of the human-computer interface in interactive computer systems. Among the topics covered are approaches to interface design such as menus, commands, direct manipulation; screen layout strategies; metaphor models; models of human information processes; evaluation approaches such as protocol for analysis, interactive monitoring, use of surveys; and requirements for documentation and help. Students are expected to design interface mockups and evaluate them.

**IS 265. Introduction to Information Systems. 3 credits, 3 contact hours (3;0;0).**
Information systems is the study of how organizations use information technology. This course is an overview of the information systems discipline, the role of information systems in organizations, and the changing nature of information technology. Computer tools for analysis and presentation are used.

**IS 270. Designing the Multimedia Experience. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. Multimedia combines text, graphics, sound, video, and animation in a single application. Preparation for creating multimedia information systems, and understanding the crucial issues involving technology, design and effectiveness of multimedia applications. Programming techniques for integrating video, sound, animation, and graphics, and design strategies for multimedia information systems.

**IS 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**IS 322. Mobile Applications: Design, Interface, Implementation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 218, IS 219, or IT 202. This course is a practical introduction to building applications for mobile devices. The course combines hands on design and development experience, with a conceptual overview and discussion of design and practical development issues. Taken into account will be constraints and requirements of devices with small screen sizes, limited battery power, limited computational power, etc. Tools used for building an application in the context of a specific device such as iPhone or an Android based device will be discussed. Students build a mobile application to demonstrate their understanding of mobile web constraints and tools.

**IS 331. Database Design Management and Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IS 218 or IT 202. Businesses use databases extensively for analysis and decision-making because they provide efficient, large-scale information storage and rapid retrieval. Databases support the "back end functionality" of most large web systems. This course gives students extensive, pragmatic experience in designing, building, querying, updating, maintaining and managing relational databases, using the Structured Query Language (SQL). Proper database design principles are emphasized throughout the course, beginning with high level descriptions of relational databases using data modeling tools(such as entity-relationship or ER diagrams)and progressing to relational database design principles based on higher order normalizations. We will examine some poorly designed and show how theses can be transformed into well designed databases. SQL will be extensively covered, and students will design implement sophisticated SQL queries invoking self-joins, outer joins, correlated subqueries and related concepts. Students will explore and utilize design methodologies for input data validation and maintaining database integrity, and study issues of database privacy and security. Advanced topics to be discussed include the role of the Database Administrator (DBA), database life cycle activities, database denormalization, read-only database and data warehouses. Hands-on experience will be gained by with actual database using industry-standard database management systems such as Oracle.

**IS 333. Social Network Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Completion of computing GUR (CS 100, CS 101, CS 103, CS 104, CS 111, CS 113, CS 115 or BNFO 135) AND statistical GUR (MATH 105, MATH 120, MATH 225, MATH 244, MATH 279, MATH 305, MATH 333, IE 331, ECE 321 or MNET 315). In this intensive hands-on course, students will learn how to design computer programs to “grab” information from social networking systems such as Facebook, and analyze this to reveal useful but hidden information about the users and their interconnections. Since math is the only language that computers understand, the goal of this class is to build connections between the human language one finds in social network postings and profiles, and mathematical formulas. The skills and techniques utilized in the course will prepare students for advanced courses in data mining and business analytics. This course requires basic statistical knowledge and Java programming skills.

**IS 344. Computing Applications in Business. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MIS 245 or IS 265 or Acct 115 or Acct 117 or MGMT 390 A comprehensive overview of the various types of computing applications used by businesses in order to run effectively and efficiently. All the major functional departments within organizations are examined and evaluated to see how applications are integrated to implement "business processes" that flow across department boundaries, and from suppliers to customers. The modeling of business situations and the design of applicable software solutions. A full-semester hands-on student project will provide experience in designing solutions to changes in the business environment.

**IS 350. Computers, Society and Ethics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: GUR (CS 100, CS 101, CS 103, CS 104, CS 111, CS 113, CS 115, or BNFO 135), AND one basic social science course (STS 201, ECON 201, ECON 265, ECON 266, EPS 202, STS 257 or STS 258), AND HUM 101. Examines the historical evolution of computer and information systems and explores their implications in the home, business, government, medicine and education. Topics include automation and job impact, privacy, and legal and ethical issues. Co-listed as STS 350.

**IS 373. Content Management Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 117 or IT 202. This course provides a hands-on introduction to the design and implementation of enterprise-scale web systems built upon web based content management systems (CMS). CMS manage the creation, storage, retrieval, dissemination, and collection of information in order to meet the needs of businesses, organizations and individuals. Students learn to how to create blogs, discussion boards, wiki, intranets, and dynamic websites using popular CMS packages such as Wordpress and Drupal. Throughout the course students learn how to overcome common challenges that impact the design of these systems such as security for multi-user systems, content strategy, marketing and performance.

**IS 375. Discovering User Needs to Enhance User eXperience. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: none What new digital products or services needs to be developed? How do you anticipate someone’s needs before they do? How do you understand how people interact with products? These are key questions that both interaction designers and start-up entrepreneurs need to answer. It’s all about the understanding the user. We need to work with users to investigate or "research" their needs and how they interact with the product or service. In this course, we take a deep dive into qualitative user experience (UX) research. UX research is the process of understanding why and how people use products and services. This course will teach you a set of research tools to discover user needs, investigate the user experience, and enhance the user experience by deriving design recommendations. We will cover techniques like ethnography, focus groups, interviewing, and analyzing qualitative data. We will be talking with user experience researchers at major companies and getting involved with actual user research. This practical, hands-on course will give you an insight into the psychology of user behavior and lay the foundation for students who are pursuing careers designing, evaluating, or marketing products for people.

**IS 385. Special Topics in IS. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of information systems and the computing sciences not regularly covered in any other IS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**IS 390. Requirements Analysis and Systems Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 103, CS 113, CS 115, IS 218 or IT 202 A study of the information systems development life-cycle, from the initial stages of information requirements analysis and determination to the ultimate activities involving systems design. Theory, methodologies and strategies for information requirements analysis, including the assessment of transactions and decisions, fact-finding methodologies, structured analysis development tools, strategies of prototype development, and an overview of computer-aided software engineering (CASE) tools. Theory, methodologies and strategies for systems design, including design of user-interfaces, particularly menu-driven and keyword dialogue strategies, and issues in the proper design of computer output.

**IS 392. Web Mining and Information Retrieval. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 218, IT 114, or CS 114. This course introduces the design, implementation and evaluation of search engines and web mining applications. Topics include: automatic indexing, natural language processing, retrieval algorithms, web page classification and clustering, information extraction, summarization, search engine optimization, and web analytics. Students will gain hands-on experience applying theories in case studies.

**IS 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: IS 310 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**IS 421. Advanced Web Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: IS 219 and (IS 331 or CS 431). This course focuses on the design, development, and management of cloud-based web information systems, within the context of startup companies and established organizations. Within the course, we examine business, organizational and technical challenges faced by developers, project managers, and the business development professionals that create web-based software products. The course consists of readings, discussions, and a final team project that demonstrates modular design, planned scalability, maintainability, and the creation of a set of organizational processes that supports the continued support and development of the application. Some of the topics covered in the course are: continuous deployment, continuous integration, automated unit testing, modular design, software team management, agile development, Kanban, customer focused development, and the technologies used to scale cloud applications.

**IS 448. Usability & Measuring UX. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: Statistics GUR (MATH 105, MATH 120, MATH 225, MATH 244, MATH 279, MATH 305, MATH 333, IE 331, ECE 321 or MNET 315). User experience research is the process of understanding why and how people use products and services. Usability refers to the ease of use and learnability of such a product or service. The primary function of usability is to be able to measure and assess the optimal use of a product from the perspective of the user. This course will teach students a set of quantitative tools to understand user needs, derive design recommendations, and evaluate the user experience. Students will receive an overview of the different quantitative methods being used in industry and academia, such as eye-tracking, big social media data analysis, and physiological tests. They will then get an in-depth knowledge of how to design, execute, and analyze data from experiments and surveys using both descriptive and inferential statistics. The course will incorporate a hands-on approach and be comprised completely of individual and group project assignments.

**IS 455. IS Mgmt & Business Processes. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 344 and (IS 265 or MIS 245). Grade of C or better. This course will emphasize how information systems enable core and supportive business processes, as well as those that interface with suppliers, partners and customers. It will discuss basic administrative, management and policy issues associated with the impact of information systems on the user and organization. The second part of the course looks at business processes in organizations: what the business process view is and why it is important, how information systems can improve processes, and how Enterprise Resource Planning systems help with that improvement. Hands-on use of a major ERP system (SAP) is included.

**IS 461. Systems Simulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: completion of a 100-level GUR course in computing; MATH 333. This course introduces computer simulation as an algorithmic problem solving technique. Includes discrete simulation models, elementary theory, stochastic processes, use of simulation languages, random number generators, simulation of probabilistic processes, design of simulation experiments, validation of models, queueing systems, and applications to the design and analysis of operational systems. The GPSS language is covered in detail.

**IS 465. Advanced Information Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: statistical GUR (MATH 105, MATH 120, MATH 225, MATH 244, MATH 279, MATH 305, MATH 333, IE 331, ECE 321 or MNET 315), and (IS 265 or MIS 245) and IS 344, and (IS 331 or CS 431). Design and programming concepts are presented for automation of management information systems. Includes the organization of files and techniques for processing information based upon organizational requirements and available hardware and software. Some case studies are presented.

**IS 485. Special Topics in Information Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: junior standing and/or department approval. The study of new and/or advanced topics in an area of IS not regularly covered in any other IS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. A student may register for no more than two semesters of Special Topics.

**IS 486. Topics in Information Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Same as for IS 485. A continuation of IS 485.

**IS 488. Independent Study in Information Systems. 3 credits, 0 contact hours (0;0;0).**
Prerequisites: Open only to students in the Albert Dorman Honors College or to any student who intends to apply to the IS Undergraduate Thesis program. Students need approval from the IS department and the IS faculty member who will guide the independent study. Independent studies, investigations, research, and reports on advanced topics in IS. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of Independent Study.

**IS 489. IS Undergrad Thesis Research. 3 credits, 3 contact hours (3;0;0).**
Students continue their research in preparation for completing a Research Thesis.

**IS 491. Senior Project. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: IS 331, IS 431, or CS 431, and senior standing. Integration of knowledge and skills gained in previous information systems courses into an individual research project. The project entails investigation of current literature and the design, implementation and evaluation of an information system.

**IT 101. Introduction to Information Technology. 3 credits, 3 contact hours (3;0;0).**
The foundations of information technology (IT), including basic computer architecture, various kinds of computer hardware, and networking technology, are introduced. Various data representation schemes, such as the binary number systems, are covered. Different levels of software are examined, including aspects of the operating systems from the perspective of the IT professional. The software development process is discussed. Database management software and SQL are dealt with, as are applications and languages developed around the internet and Web infrastructure. Overall, fundamental knowledge required of today's IT professional is obtained along with an appreciation of IT's impact on business and society. Hands-on experience with some important elements of the IT field is gained through various laboratory assignments.

**IT 114. Advanced Programming for Information Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites CS 113 or CS 115. Problem solving techniques and program design knowledge are expanded with an eye toward IT-related applications. Various kinds of data structures are introduced, including classic containers such as lists, stacks, queues, and trees. Sorting and searching techniques are examined. The fundamentals of client/server programming and the use of sockets are covered. Recursion and its various applications are studied. The built-in class library features of an object-oriented programming language are exploited throughout.

**IT 120. Introduction to Network Technology. 3 credits, 3 contact hours (3;0;0).**
An introduction to the basics of networking in a modern operating system environment. Emphasis is placed on the application and management of networking technology. Topics to be covered include: the OSI model, network hardware and technologies, network protocols, wired and wireless networks, TCP/IP. Whenever possible, concepts will be explained through the use of hands-on exercises that reinforce the lecture material.

**IT 201. Information Design Techniques. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 101. This course presents an introduction to the theory and practice of information design. Topics covered include the theoretical foundations of information design, graphic design, content design, interaction design, usability, multimedia design, sound and video, animation, and an introduction to 3D modeling.

**IT 202. Internet and Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 100 or CS 113 or CS 115 or a course in a high-level programming language as approved by department. This course presents the concepts and software technologies that underline web-oriented, three-tier software architectures and applications. The enabling software mechanism include the markup languages (HTML5 and CSS3) used by browsers, client-side scripting languages and libraries (Javascript and AJAX), web servers and server-side-scripting languages (Apache, PHP, HTTP protocol), and background databases (SQL, MySQL). The course uses a hands-on, guided development approach with substantial assignments to illustrate the fundamental computing concepts systems, and technologies considered and to provide direct experience in their use.

**IT 220. Wireless Networks. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 120. This course introduces the students to the applied topic of Wireless Networks, focusing on applied methods, tools and technologies, as well as practical experience in designing & implementing wireless networks. Topics include hardware, software, data, applications, communication, design & installation of wireless networks, together with the implementation, performance, security and limitations of such systems.

**IT 230. Computer and Network Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 120. This course introduces the applied topic of Computer Security, presenting the evolution of computer security, the main threats, attacks & mechanisms, applied computer operations & security protocols, main data transmission & storage protection methods via cryptography, ways of identifying, understanding & recovery from attacks against computer systems, various methods of security breach prevention, network systems availability, applications security, recovery & business continuation procedures and counter systems penetrations techniques and the role of the US Government in security of national computer infrastructure.

**IT 240. Scripting for System Administration. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 113 or CS 111 or CS 115. This course will introduce task automation using shell scripting in a multi-OS environment using the Shell and the Perl programming languages. Topics covered will include scripting commands, control structures, functions, scalar data and lists, regular expressions, hashing, automating administration functions and debugging. Lessons will be enhanced through the use of hands-on exercises to strengthen comprehension.

**IT 265. Game Architecture and Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201 or equivalent. Course introduces students to the core concepts and design methodologies integral to designing and developing games and other Entertainment Software.

**IT 266. Game Modification Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 102 or IT 114 or CS 116 or CS 114. This course introduces students to the basic concepts of game programming and development. Students will learn how to reprogram a professional game engine, or Modification (Mod) development as it is referred to in the industry. Students will work with C intensively. Students will work on their own game projects utilizing the professional game engine.

**IT 276. Game Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 265 and IT 266, or, CS 265 and CS 266. This course introduces students to the core concepts and skills necessary for the development of games utilizing 2D graphics. Students will learn how to set up and program their own 2D graphics based game engine. The engine will integrate 2D graphics, audio, input handling and network socket programming. Students will learn how to utilize their own custom 2D graphics and sounds into their projects. Once complete, students will have created two fully functional games.

**IT 286. Foundations of Game Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 202 and IT 265. This class introduces students to many of the tools and design methodologies needed for electronic game production. This class will focus heavily on scripting, level design and content control as applied to game development. Students will learn a few scripting languages that are used in the games industry such as Unreal Script and Python. Students will work on projects to develop the levels, controls and scripts in order to create a new game experience with a professional game.

**IT 287. Advanced Game Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 286 or COM 266. This course will build on tools and techniques presented in Foundations of Game Production and guide students through the development cycle of game levels. This will be a hands-on class that will teach students the development styles and revision techniques used in the professional game industry. Upon completion of the course, students will have first hand experience producing professional quality content for electronic games and a portfolio of work.

**IT 302. Advanced Internet Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 202 or IS 217. This course covers Internet-related software technologies in a more comprehensive, in-depth manner than IT 202. Topics considered include: client-side technologies like HTML5 and jQuery, JQuery UI (user interface) library, jQuery Mobile, CSS3 (transitions, animations), feature detection and polyfills using jQuery UI and Modernizr, advanced Javascript DOM and JSON (Javascript Object Notation), basic web services applications, JSONP. Advanced PHP topics considered include: sessions, cookies, HTTP exchanges, encryption, graphics library (CAPTCHA?s), and as time permits regular expressions and remote file access. An introduction to the Model-View-Controller (MVC) paradigm is presented using Ruby-on-Rails environment. Programming assignments are required which provide experience with the concepts covered.

**IT 303. Model View Controller Software Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 202 or instructor approval. The Model View Controller(MVC) software architecture or pattern separates the concerns of application or domain logic, interface design, and the view of the system presented to the user, with the objective of more effective design, development and testing. This course covers environments and frameworks for modeling, developing and programming Internet Applications with emphasis on the Model View Controller paradigm. Design and development, applicability of principles, integrated test-driven development applicability of major external libraries like JQuery and Prototype, deployment, scaling and security issues will be examined. Case studies will be used to illustrate the concepts and frameworks considered. A substantial development project will be required.

**IT 310. E-commerce Technology. 3 credits, 3 contact hours (3;0;0).**
An overview of the technologies relevant to electronic commerce. Communications and networking, web authoring tools, system security, databases and archiving, EDI, transaction processing, and factory/warehouse data networks. Provides competency to appraise tools such as HTTP servers, secure transaction software and firewalls, low and high-end database systems, heterogeneous networks, NNTP Servers, client software, procurement systems, and intelligent agents. Covers e-commerce models including agent-based and Java-based, electronic contracts and the electronic exchange of technical data, electronic cash systems and user security.

**IT 311. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Completion of the sophomore year, approval of the program coordinator, and permission of the Office of Cooperative Education and Internship. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**IT 320. Virtual Instrumentation. 3 credits, 3 contact hours (3;0;0).**
Cross-listed with OPSE 310. Prerequisite: CS 113 or CS 115. Covers the basics of virtual instrumentation including use of IEEE GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform such as National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisition and instrument control, instrument status, and acquisition speed.

**IT 330. Computer Forensic. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 230. This course introduces students to the applied topic of Computer Forensic, the study of obtaining and analyzing digital information from computers that have been used to commit illegal actions (computer crime), for use as evidence in civil, criminal, or administrative cases.

**IT 331. Privacy and Information Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Computing GUR. This course will introduce the legal, social and technical issues involving information privacy. Topics covered will include the historical development of information privacy law; law enforcement, technology and surveillance; government databases and records; privacy and business records and financial information; privacy and the media; health and genetic privacy and international privacy law.

**IT 332. Digital Crime. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Computing GUR. Comprehensive, multidisciplinary overview of the methods and means by which technology is used by the criminal in today's society. An examination of the historical, legal, technological and sociological aspects of cybercrime. The course covers the challenges of a new era of technology has brought to combating crime of all types, including terrorism. Topics covered will include: the sociology of the white collar criminal, the criminal justice system and law enforcement, computer security and deterrence/prevention.

**IT 335. Introduction to .NET Framework. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 202 or equivalent. This course introduces students to .NET Framework, a new computational environment that supports more than 25 programming languages and is platform and device independent. Problem solving and system development topics are integrated into the course by using C# languages as a vehicle to illustrate the concepts.

**IT 340. Introduction to System Administration. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 120. This course will introduce the tasks and techniques required to perform as a system administrator of Linux systems. Topics to be covered include: booting, process control, the file system, managing users and resources, backups, configuration management, networking, the network file system, email servers, security, hardware devices, interoperability and daemons. Whenever possible, lectures will be augmented with hands-on exercises.

**IT 360. Programming for Computer Graphics. 3 credits, 3 contact hours (3;0;0).**
Introduction to programming graphics and animation through the use of an appropriate application interface such as openGL. Topics include 2D and 3D graphics with mappings from the real world coordinates to graphics display. Perspective display will be provided by an interface. Basic vector and matrix operations which underlie the concepts of perspective will be covered.

**IT 380. Educational Software Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201. Educational Media Design employs the instructional principles of constructivist pedagogy as the process used to develop a solution to develope courseware for K-12 audience. The course builds on the participatory design model of software engineering in order to develop integrated learning environments that support visual and verbal literacy; enables student to be able to plan, organize, and systematically develop instructional materials. This course implements instructional design theory and pedagogy in order to create an actual application for a computer-based environment. Same as STS 318.

**IT 386. 3D Modeling and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201. This class introduces students to the concepts of 3D modeling and animation, and putting those concepts into action by working with software. This class will be a hands-on, project focused course, using 3D modeling packages, taking students from design to final render.

**IT 400. Information Technology and the Law. 3 credits, 3 contact hours (3;0;0).**
This course will provide an introduction to legal concepts, principles and terminology as applied to modern information technology. The historical background and foundations of the various principles of U.S. Statutory and Common Law will be considered and will be used to explore how such principles may be applied to encompass and govern modern legal interactions in the U.S. and internationally. Through assignments and class discussion, which will often involve the Socratic Method, students will be expected to spot potential legal issues and make logical arguments for and against various legal propositions.

**IT 411. Co-op Work Experience. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Completion of the sophomore year, approval of the program coordinator, and permission of the Office of Cooperative Education and Internship. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**IT 420. Computer Systems and Networks. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 120 and either CS 113 or CS 115. This course provides students with an understanding of methods, tools and technologies required to work with computer systems and networks. It includes a detailed discussion of Internet/intranet issues, including standards, connectivity, performance, protocols, network configurations, network design, wireless technology, management and simulation through practical cases, covering both hardware and software systems.

**IT 430. Ethical Hacking for System Administrators. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 340 or equivalent. This course will explore the various means that an intruder has available to gain access to computer resources. Traditional security analysis often falls short due to the rapidly evolving threats that exist. The course was developed to teach how system and network vulnerabilities are found and exploited and what steps can be taken to mitigate the risk.

**IT 485. Special Topics in Information Technology I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: junior standing and/or advisor approval. The study of new and/or advanced topics in an area of information technology and its application not regularly covered in any other IT course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. A student may register for no more than two semesters of special topics courses.

**IT 486. Special Topics in Information Technology II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: same as for IT 485. A continuation of IT 485.

**IT 488. Independent Study in Information Technology. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: open only to Information Technology majors who have the prior approval of the program director and the IT faculty who will guide the independent study taking the form of investigations, research, and reports on advanced topics in information technology. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the program director and the faculty mentor. A student may register for no more than one semester of independent study.

**IT 490. Systems Integration. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 420. The course will introduce the major design, implementation & distributed deployment issues regarding system integration, Network Operating Systems (NOS), cross platform database integration, e-commerce and e-business applications implementation, cross-servers & multiple locations e-sessions migration and the related communications security.

**IT 491. IT Capstone Project. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: senior standing. An opportunity for students to integrate the knowledge and skills gained in previous information technology work into a team research project. The project involves investigation of current literature as well as implementation of either a part of a large application or the whole of a small system.

# Computer Science

As the largest computer science department among research universities in the New York metropolitan area, the Department of Computer Science is a bustling stomping ground for students looking to explore computer science on both a technical and liberal arts level.

The department offers B.S., B.A., M.S. and Ph.D. degree programs in computer science and evolving interdisciplinary programs like telecommunication, bioinformatics and computing and business. The B.S. provides a more technical exploration of computer science and is excellent for students planning to pursue advanced study in computer science while the B.A. program is designed for students interested in liberal arts or management. There's also the opportunity to learn beyond the classroom via the Senior Capstone Program, a semester-long course that gives students the chance to draw on their years of studying and apply said knowledge to one of NJIT's 200 industry sponsors and partners, which include Microsoft, Johnson & Johnson and NASA.

## NJIT Faculty

### B

Baltrush, Michael A., Associate Professor

Blank, George, University Lecturer

Borcea, Cristian M., Professor

### C

Calvin, James M., Professor

Cohen, Barry, Associate Dean, College of Computing Sciences

Curtmola, Reza, Associate Professor

### D

Ding, Xiaoning, Assistant Professor

### E

Eljabiri, Osama, Senior University Lecturer

### G

Gehani, Narain, Professor

Geller, James, Professor

Gerbessiotis, Alexandros, Associate Professor

### H

Hung, Daochuan, Associate Professor

### K

Kapleau, Jonathan, J., University Lecturer

Karvelas, Dionissios, Senior University Lecturer

Kwestel, Morty D., Senior University Lecturer

### L

Leung, Joseph Y., Distinguished Professor

Liu, Chengjun, Professor

## M

McHugh, James, Professor

Mili, Ali, Professor

## N

Nakayama, Marvin K., Professor

Nassimi, David, Associate Professor

Neamtiu, Iulian, Associate Professor

Nicholson, Theodore L., Senior University Lecturer

## O

Oria, Vincent, Professor

## P

Perl, Yehoshua, Professor

## R

Rohloff, Kurt, Associate Professor

Roshan, Usman W., Associate Professor

Rusinkiewicz, Marek E., Professor

Rutkowski, Wallace, Senior University Lecturer

Ryan, Gerard W., Senior University Lecturer

## S

Shih, Frank Y., Professor

Sohn, Andrew, Associate Professor

Spirollari, Junilda, Senior University Lecturer

## T

Theodoratos, Dimitrios, Associate Professor

## V

Vaks, Leon, University Lecturer

## W

Wang, Jason, T., Professor

Wang, Guiling (Grace), Professor

Wei, Zhi, Associate Professor

Wu, Chase Q., Associate Professor

# Programs

## Accelerated Programs (p. 92)

- Bioinformatics for Honors Premed Students - Accelerated B.S. (p. 200)

## Double Majors (p. 92)

- Computer Science and Applied Physics - B.S. (p. 207)
- Computer Science and Mathematical Sciences - B.S. (p. 209)

- Computer Science Minor (p. 212) (not for Computer Engineering majors)
- Computer Science Minor (p. 212) (for Computer Engineering majors)

## Computer Science Courses

**BNFO 135. Programming for Bioinformatics. 3 credits, 3 contact hours (3;0;0).**
The ability to use existing programs and to write small programs to access bioinformatics information or to combine and manipulate various existing bioinformatics programs has become a valuable part of the skill set of anyone working with biomolecular or genetic data. This course provides an unerstanding of the architecture of bioinformatics toolkits and experience in writing small bioinformatics programs using one or more of the scripting ("glue") languages frequently employed for such tasks.

**BNFO 236. Programming For Bioinfo II. 3 credits, 3 contact hours (3;0;0).**

**BNFO 330. Princ of Bioinformatics II. 3 credits, 3 contact hours (3;0;0).**

**BNFO 340. Data Analysis for Bioinformatics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BNFO 240 and R120 101 or equivalent or permission of instructor. Advanced data analysis skills with applications to bioinformatics problems.

**BNFO 482. Databases and Data Mining in Bioinformatics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BNFO 240 or equivalent or permission of instructor. Surveys biological databases and tools for managing them. Covers concepts and principles of data mining in bioinfomratics. Hands-on experience for mining genomic data using ORACLE and SQL.

**BNFO 488. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**BNFO 491. Computer Science Project. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CS 490. Restriction: Senior standing in the Honors College and project proposal approval. A course similar to CS 491, with a project of greater depth and scope.

**CS 100. Roadmap to Computing. 3 credits, 3 contact hours (3;0;0).**
An introduction to programming and problem solving skills using Python or other very high level language. Topics include basic strategies for problem solving, constructs that control the flow of execution of a program and the use of high level data types such as lists, strings and dictionaries in problem representation. The course also presents an overview of selected topics in computing, such as networking and databases.

**CS 101. Computer Programming and Problem Solving. 3 credits, 3 contact hours (3;0;0).**
An introductory course that is designed for engineering freshman. This course introduces students to the engineering problem solving process in the context of MATLAB. The emphasis is on the logical analysis of a problem and the formulation of a computer program leading to its solution. Topics include basic concepts of computer systems, algorithm design, programming languages and data abstraction. At the end of class, a comparison between MATLAB and C/C++ will be discussed in order to provide students a better understand of general concept of computer programming.

**CS 103. Computer Science with Business Problems. 3 credits, 3 contact hours (3;0;0).**
An introductory course in computer science, with applications to business and managerial decision making. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and abstraction, with applications.

**CS 104. Computer Programming and Graphics Problems. 3 credits, 3 contact hours (3;0;0).**
An introductory course in computer science with applications in computer graphics for architecture. Emphasis on programming methodology using a high level language as the vehicle to illustrate the concepts. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications.

**CS 105J. Computer Prog-Java. 1 credit, 1 contact hour (1;0;0).**

**CS 106. Roadmap to Computing Engineers. 3 credits, 3 contact hours (3;0;0).**
An introduction to programming and problem solving skills for engineering majors using Python programming languages. Topics include basic strategies for problem solving, constructs that control the flow execution of a program and the use of high level data types such as lists, strings, and dictionaries in problem representation. The course also presents an overview of selected "big idea" topics in computing.

**CS 107. Computing as a Career. 1 credit, 1 contact hour (1;0;0).**
In this course, students will learn about time management, communication skills, and getting acclimated to NJIT. Through meetings with faculty, upperclassman students and current computing employers, students will explore CCS and learn about many exciting career opportunities within the computing field.

**CS 113. Introduction to Computer Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 100 with a grade C or better. Intensive introduction to computer science. Problem solving decomposition. Writing, debugging, and analyzing computer programs. Introduction to arrays and lists. Iteration and recursion. The Java language is introduced and used to highlight these concepts. A student receiving degree credit for CS 113 cannot receive degree credit for CS 115.

**CS 114. Introduction to Computer Science II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:; CS 113 or completion of a required 100 level GUR course in CIS, plus an approved CIS 105. A study of advanced programming topics with logical structures of data, their physical representation, design and analysis of computer algorithms operating on the structures, and techniques for program development and debugging. Course covers program specifications, correctness and efficiency, data abstraction, basic aspects of simple data structures, internal searching and sorting, recursion and string processing. Algorithmic analysis is also discussed. Students receiving degree credit for CS 114 cannot receive degree credit for CIS 335 or CIS 505.

**CS 115. Intro. to CS I in C++. 3 credits, 3 contact hours (3;0;0).**
Fundamentals of computer science are introduced, with emphasis on programming methodology and problem solving. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications. The high level language C++ is fully discussed and serves as the vehicle to illustrate many of the concepts. CIS majors should enroll in CS 113.

**CS 116. Intro. to Computer Science II/C++. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 115 or completion of a required 100 level GUR course in CS, plus an approved CS 105. A study of advanced programming topics with logical structures of data, their physical representation, design and analysis of computer algorithms operating on the structures, and techniques for program development and debugging. Course covers program specifications, correctness and efficiency, data abstraction, basic aspects of simple data structures, internal searching and sorting, recursion and string processing. Algorithmic analysis is also discussed. Students receiving degree credit for CS 116 cannot receive degree credit for CS 505.

**CS 207. Computing and Effective Communication. 1 credit, 1 contact hour (1;0;0).**
Prerequisites: CS 107. Through encouraging collaboration and communication, this course addresses how to best present oneself via verbal and nonverbal communication. Students will learn how to effectively network, create resumes, interview and best present ideas. The skills learned in this course prepare students for co-op/internship opportunities as well as future employment.

**CS 241. Foundations of Computer Science I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (CS 114 AND MATH 112) OR (CS 114 AND MATH 133). An introduction to the foundations of computer science with emphasis on the development of techniques for the design and proof of correctness of algorithms and the analysis of their computational complexity. Reasoning techniques based on propositional and predicate logic and relational calculus operations with applications to databases will also be introduced. Auxiliary topics such as combinatorics of finite sets, functions and relations, and graph-theory definitions and graph storage alternatives will also be examined.

**CS 252. Computer Organization and Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 113. An introduction to the organization and architecture of computer systems, including the standard Von Neumann model and more recent architectural concepts. Among the topics covered are numeric data representation, assembly language organization, memory addressing, memory systems, both real and virtual, coding and compression, input/output structures treated as programmed, interrupt, and direct memory access, and functional organization of the CPU and the computer system.

**CS 266. Game Modification Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 102 OR IT 114 OR CS 116, OR CS 114. This course introduces students to the basic concepts of game programming and development. Students will learn how to reprogram a professional game engine, or Modification (Mod) development as it is referred to in the industry. Students will work with C extensively. Students will work on their own game projects utilizing the professional game engine.

**CS 276. 2D Game Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 265 and CS 266 or IT 265 and IT 266. This course introduces students to the core concepts and skills necessary for the development of games utilizing 2D graphics. Students will learn how to set up and program their own 2D graphics based game engine. The engine will integrate 2D graphics, audio, input handling and network socket programming. Students will learn how to utilize their own custom 2D graphics and sounds into their projects. Once complete, students will have created two fully functional games.

**CS 280. Programming Language Concepts. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114 OR CS 116 OR IT 114 OR IT 102. Conceptual study of programming language syntax, semantics and implementation. Course covers language definition structure, data types and structures, control structures and data flow, run-time consideration, and interpretative languages.

**CS 288. Intensive Programming in Linux. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114. The course covers Linux programming with Apache Web and MySql database using Php/Python and C as primary languages. It consists of four stages: basic tools such as Bash and C programming; searching trees and matrix computing, end-to-end applications such as one that constantly presents top 100 stocks; and extending the applications to run on multiple machines. The course provides students with hands-on experience for programming relatively large applications.

**CS 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**CS 332. Principles of Operating Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114 OR CS 116 OR IT 114 OR IT 102. Organization of operating systems covering structure, process management and scheduling; interaction of concurrent processes; interrupts; I/O, device handling; memory and virtual memory management and file management.

**CS 333. Introduction to UNIX Operating Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 332 or equivalent and knowledge of C language. The course covers the UNIX system kernel including initialization, scheduling, context switching, process management, memory management, device management, and the file system. The course also includes the organization of shells, editors, utilities, and programming tools of the UNIX operating system.

**CS 337. Performance Modeling in Computing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 114 and (MATH 333 or MATH 341). Introduction to probability models and techniques useful in computer science. Performance evaluation, discrete-event simulation, classification and optimization.

**CS 341. Foundations of Computer Science II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (CS 241 or MATH 226) and CS 280. This course provides an introduction to automata theory, computability theory, and complexity theory. Theoretical models such as finite state machines, push-down stack machines, and Turing machines are developed and related to issues in programming language theory. Also, the course covers undecidability and complexity theory, including the classes P and NP.

**CS 345. Web Search. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 280 and (CS 241 or CS 252). An introductory course on the web searching. The architecture of a search engine. Information vs. data retrieval. Web crawling. Processing text(tokenization, stemming, stopwords, link analysis). The indexing process and inverted indexes. Query processing. Ranking algorithms based on indexes and links (e.g. Kleinberg's HITS, Google's PAGERANK). Retrieval Models. Search engine evaluation. Case studies (e.g. Google cluster architecture).

**CS 356. Introduction to Computer Networks. 3 credits, 3 contact hours (3;0;0).**
Computer Science students should take CS 288 before taking CS 356. This course provides an introduction to computer networks, with a special focus on the Internet architecture and protocols. Topics include layered network architectures, addressing, naming, forwarding, routing, communication reliability, the client-server model, web and email protocols. Besides the theoretical foundations, students aquire practical experience by programming reduced versions of real Internet protocols.

**CS 357. Fundamentals of Network Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 356 or IT 120. This course is designed for Computer Science and Information Technology students. They must have a networking course before taking CS 357. IT students take IT 120 and Computer Science students take CS 356. This course offers an in depth study of network security issues, types of computer and network attacks, and effective defenses. It provides both a theoretical foundation in the area of security and hands-on experience with various attack tools, firewalls, and intrusion detection systems. Topics include: network scanning, TCP/IP stack fingerprinting, system vulnerability analysis, buffer overflows, password cracking, session hijacking, denial of service attacks, intrusion detection.

**CS 366. 3D Game Development. 3 credits, 3 contact hours (3;0;0).**
This course introduces students to the core concepts and skills necessary for the development of games utilizing 3D graphics. Students will learn how to set up and program their own 3D graphics based game engine using OpenGL. Students will learn how to load and display custom 3D models created using existing 3D modeling tools. Once complete, students will have created two fully functional 3D games and tools to work with them.

**CS 370. Introduction to Artificial Intelligence. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: CS 114 and (MATH 226 or CS 241). An exploration of concepts, approaches and techniques of artificial intelligence. Emphasizes both underlying theory and applications. Topics include knowledge representation, parsing language, search, logic, adduction, uncertainty, and learning. LISP and Prolog programming languages used extensively. Students are required to do programming assignments, complete a programming term project and review case studies.

**CS 388. Android Application Developmnt. 3 credits, 3 contact hours (3;0;0).**
This course introduces mobile application development for the Android platform. Students will learn skills necessary for creating and deploying applications with the Android Software Development Kit (SDK). The course is designed to introduce and familiarize students with programming in the Android environment. It starts with an examination of the basic components and concepts that define the Android platform, and then moves on to cover the specific structure that comprises an Android application. An overview of the most common tools and techniques for writing Android applications is included. The Android approach to user interfaces is described along with a discussion of some of the more common user interface elements. Storage strategies for persistent information are also covered, including the use of the available SQLite Database features. The unique characteristics of programming for a mobile environment are introduced and explained. Hands on experience in the form of exercises and programming projects are included throughout the course to reinforce material that has been presented in lecture form.

**CS 407. Professional Development in Computing. 1 credit, 1 contact hour (1;0;0).**
Prerequisites: CS 107 and CS 207.This course is designed for final year students to reflect back on the college experience and to help plan for the future as a computing professional. The course will explore transitional issues that occur during the progression from student to professional through reflection on co-op and/or internship experiences. Through collaborative communication, students will reflect on global issues, explore how to best use new communication technologies and effectively communicate in the workplace.

**CS 408. Cryptography and Internet Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 226 or CS 241. Covers security require-ments for telecommunication over the Internet and other communication networks, various conventional and public-key encryption protocols, digital encryption standard, RSA and ElGamal cryptographic systems, digital signature algorithm and analysis of its cryptoimmunity, and access sharing schemes. Students receiving credit for CS 408 may not enroll in CIS 608.

**CS 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CS 310 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**CS 431. Database System Design and Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 114 or equivalent. Database system architecture; data modeling using the entity-relationship model; storage of databases; the hierarchical, network and relational data models; formal and commercial query languages; functional dependencies and normalization for relational database design; relation decomposition; concurrency control and transactions management. Student projects involve the use of a DBMS package.

**CS 433. Introduction to Linux Kernel Programming. 3 credits, 3 contact hours (3;0;0).**
An introductory study of how the Linux operating system is built from scratch. AS a hands-on course, students will perform intensive programming using Linux kernel. The contents include booting, segmentation and paging, creating and destroying processes, process switching and scheduling, handling exceptions and interrupts, software interrupts, creating system calls, creating file systems, networking with TCP/IP, device driver writing and module programming, etc. At the end of the course, students will be able to modify the Linux operating system to create their own.

**CS 434. Advanced Database Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 431. The course covers the basic concepts of traditional files and file processing, provides a "classic" introduction to the relational data model and its languages, and discusses database design methodology and application developments. Students are expected to learn the design of database application systems through a small project and to get some practical hands-on experience with commercial database management systems (DBMS) by writing application programs using the commercial DBMS query languages.

**CS 435. Advanced Data Structures and Algorithm Design. 3 credits, 4 contact hours (3;1;0).**
Prerequisite: CS 241 and CS 288. Advanced topics in data structures and algorithms, involving sequences, sets, and graphs such as searching, sorting, order statistics, balanced search tree operations, hash tables, graph traversals, graph connectivity and path problems. Algebraic and numeric algorithms. Performance measures, analysis techniques, and complexity of such algorithms.

**CS 438. Interactive Computer Graphics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: completion of a 100-level course in CIS, plus knowledge of a higher level language. This course introduces fundamental concepts of interactive graphics oriented toward computer-aided design systems. Such systems emerge in engineering, architecture, and manufacturing. Topics include computer data structures for representation of two- and three-dimensional objects and algorithms for definition, modification, and display of these objects in applications. This course will also discuss a selection of special topics in interactive graphics.

**CS 439. Image Processing and Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 114 and MATH 333. This course is an intensive study of the fundamentals of image processing, analysis and understanding. Topics to be covered include: a brief review of the necessary mathematical tools, human visual perception, sampling and quantization, image transformation, enhancement, restoration, compression, reconstruction, image geometric transformation, matching, segmentation, feature extraction, representation and description, recognition and interpretation.

**CS 440. Computer Vision. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333. This course introduces basic concepts and methodologies of computer vision, and focuses on material that is fundamental and has a broad scope of applications. Topics include contemporary developments in all mainstream areas of computer vision e.g., Image Formation, Feature Representation, Classification and Recognition, Motion Analysis, Camera Calibration, Stereo Vision, Shape From X (shading, texture, motion, etc.), and typical applications such as Biometrics.

**CS 441. Database Programming. 3 credits, 3 contact hours (3;0;0).**
Many technologies have been developed due to the interplay between World-Wide Web Development and Databases on one hand and the growth of Database applications in E-Commerce on the other hand. Today, practically every E-Commerce application has at least a Web component and a Database Component. Many languages have been developed in order to deal with these interactions. The proposed course will focus on accessing databases through the web but also mention new developments in the field.

**CS 458. Technologies-Network Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 356 or CS 456 or IT 420. This course provides both an in depth theoretical study and a practical exposure to technologies which are critical in providing secure communication over the Internet. Topics include: remote access security, web security, wireless security, e-mail security, spam and spam filtering techniques, computer viruses and internet worms, honeypots and honeynets, security liability issues and compliance.

**CS 482. Data Mining. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 431. The course covers the concepts and principles of advanced data mining systems design; presents methods for association and dependency analysis, classification; prediction; and clustering analysis.

**CS 485. Special Topics in Computer Science/Information Systems. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing and/or department approval. The study of new and/or advanced topics in an area of computer science not regularly covered in any other CIS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. A student may register for no more than two semesters of Special Topics.

**CS 486. Topics in Computer Science/Information Systems. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing and/or department approval. A continuation of CS 485.

**CS 488. Independent Study in Computer Science. 3 credits, 0 contact hours (0;0;0).**
Restriction: open only to students in the Honors Program who are computer science majors and who have the prior approval of the department and the CIS faculty member who will guide the independent study. Independent studies, investigations, research, and reports on advanced topics in computer science. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of Independent Study.

**CS 490. Guided Design in Software Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 280 and CS 288. This course focuses on the methodology for developing software systems. Methods and techniques for functional requirements analysis and specifications, design, coding, testing and proving, integration and maintenance are discussed.

**CS 491. Senior Project. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 490, senior standing and project proposal approval. An opportunity for the student to integrate the knowledge and skills gained in previous computer science work into a team-based project. The project involves investigation of current literature as well as computer implementation of either a part of a large program or the whole of a small system.

# Accelerated B.S. in Bioinformatics for Honors Premed Students

(107)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| R120 101 | General Biology | 4 |
| CHEM 125 | General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| CS 113 | Introduction to Computer Science | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R120 102 | General Biology | 4 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| Physical Education | | 1 |
| | **Term Credits** | **17** |
| **Summer** | | |
| Social Science (lower-level):GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **6** |
| **Second Year** | | |
| **1st Semester** | | |
| BNFO 135 | Programming for Bioinformatics | 3 |
| R120 201 | Foundations Of Biology | 3 |
| R120 352 | Genetics | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| BNFO 236 | Programming For Bioinfo II | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| Social Science (lower-level):GUR Elective | | 3 |
| ECON 201 | Economics | 3 |

| | | |
|---|---|---|
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| BNFO 330 | Princ of Bioinformatics II | 3 |
| BNFO 482 | Databases and Data Mining in Bioinformatics | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| ENG 352<br>or ENG 340 | Technical Writing<br>or Oral Presentations | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| BNFO 491 | Computer Science Project | 3 |
| HSS 491 | Honors Sem In Humanities | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **104** |

# B.A. in Computer Science

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I [1] | 3 |
| PHYS 111A | Physics I Laboratory [1] | 1 |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| MATH 112 | Calculus II | 4 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Science Elective with Lab | | 4 |
| Social Science (lower-level) Elective | | 3 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 114 | Introduction to Computer Science II | 3 |
| CS 252 | Computer Organization and Architecture | 3 |
| Select one of the following: | | 3 |
| MATH 333 | Probability and Statistics | |
| MATH 244 | Introduction to Probability Theory | |
| Science w/ Lab Elective | | 4 |
| Select one of the following: | | 3 |

| | | |
|---|---|---|
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CS 280 | Programming Language Concepts | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 241 | Foundations of Computer Science I | 3 |
| Select one of the following: | | 3 |
| ENG 352 | Technical Writing | |
| ENG 340 | Oral Presentations | |
| General Elective [3] | | 3 |
| Physical Education | | 1 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| IS 350 | Computers, Society and Ethics | 3 |
| Math Elective [4] | | 3 |
| Social Science (lower level) Elective | | 3 |
| CS 288 | Intensive Programming in Linux | 3 |
| Interdisciplinary Elective [5] | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 435 | Advanced Data Structures and Algorithm Design | 3 |
| CS 356 | Introduction to Computer Networks | 3 |
| CS 407 | Professional Development in Computing | 1 |
| CS 431 | Database System Design and Management | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| Select one of the following: | | 3 |
| IE 492 | Engineering Management | |
| MGMT 390 | Principles of Management | |
| HRM 301 | Organizational Behavior | |
| ENTR 410 | New Venture Management | |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CS 490 | Guided Design in Software Engineering | 3 |
| CS Elective [6] | | 3 |
| CS Elective [6] | | 3 |
| Interdisciplinary Elective [5] | | 3 |
| Lower General Elective [3] | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 491 | Senior Project | 3 |
| Upper General Elective [3] | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| Interdisciplinary Elective [5] | | 3 |

| | | |
|---|---|---|
| Upper General Elective [3] | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

[3] General Lower and Upper Electives: A minimum of 4 courses (12 credits minimum). Two of the four electives may be lower level (100-200) and two must be upper level (300-400) courses. Please consult your advisor for appropriate general electives.

[4] Math Elective :
If you took MATH 244 Introduction to Probability Theory you must take MATH 341 Statistical Methods II.
If you took MATH 333 Probability and Statistics you may take any of the followiing:
CS 337 Performance Modeling in Computing,
MATH 211 Calculus III A
MATH 213 Calculus III B,
MATH 222 Differential Equations
or any Math 300/400 level except MATH 305 Statistics for Technology.

[5] Interdisciplinary Elective: A sequence of three courses from mathematics, science, engineering or business. At least 1 300/400 level course. All others must be 200/300/400. ACCT 115/117 is allowed for business. Please consult your advisor for appropriate interdisciplinary electives.

[6] CS/IS/IT Elective: Two 3 credit CS/IS/IT electives (200 level or above). At least one must be in CS (excluding CS 310/410).

## Electives

Prerequisite grade requirement for Computer Science majors:

Students are expected to earn a grade of C or better in all CS courses that serve as prerequisites in a sequence of courses.

## Co-op

A GPA of 2.7 is required to enroll in co-op. In the Computer Science program, 3 credits of co-op may be used as one of the four general electives (not a Computer Science elective) with the approval of the academic advisor. Additional co-op courses are additive credit.

# B.S. in Bioinformatics

(129 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| R120 101 | General Biology | 4 |
| CHEM 125 | General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| R120 102 | General Biology | 4 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| BNFO 236 | Programming For Bioinfo II | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |
| R120 352 | Genetics | 3 |
| CS 241 | Foundations of Computer Science I | 3 |
| MATH 333 | Probability and Statistics | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **16** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| BNFO 330 | Princ of Bioinformatics II | 3 |
| R120 356 | Molecular Biology | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| Social Sciences (lower-level) GUR | | 3 |
| ECON 201 | Economics | 3 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| BNFO 340 | Data Analysis for Bioinformatics II | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| CS 431 | Database System Design and Management | 3 |
| General Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 337 | Linear Algebra | 3 |
| MGMT 390 | Principles of Management | 3 |
| Specialty Elective | | 3 |
| CS 435 | Advanced Data Structures and Algorithm Design | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| BNFO 482 | Databases and Data Mining in Bioinformatics | 3 |
| Select one of the following: | | 3 |
| ENG 340 | Oral Presentations | |
| ENG 352 | Technical Writing | |
| Specialty Elective | | 3 |
| Specialty Elective | | 3 |
| General Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| BNFO 491 | Computer Science Project | 3 |
| Humanities and Social Sciences Electives (upper-level) Capstone Seminar | | 3 |
| Humanities and Social Sciences Electives (upper-level) GUR | | 3 |
| Specialty Elective | | 3 |
| General Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| | **Total Credits** | **129** |

## Electives

**Specialty Electives**

| | |
|---|---|
| A sequence of four 200/300/400-level courses from mathematics, science, engineering, computer science, information systems, information technology or business. ACCT 115/ ACCT 117 are permitted as business specialty elective. [4] | 12 |
| **General** | |
| Select one elective in mathematics, science, computer science, or engineering | 6 |
| Select two electives in any level. | 6 |

[4] Please consult your advisor for appropriate Specialty and General Electives.

Refer to the **General University Requirements** for further information on electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Computer Science

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| MATH 112 | Calculus II | 4 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| Social Science (lower-level) Elective | | 3 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 114 | Introduction to Computer Science II | 3 |
| CS 252 | Computer Organization and Architecture | 3 |
| MATH 333 | Probability and Statistics | 3 |
| Science + Lab Elective | | 4 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CS 280 | Programming Language Concepts | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 241 | Foundations of Computer Science I | 3 |
| Select one of the following: | | 3 |
| ENG 340 | Oral Presentations | |
| ENG 352 | Technical Writing | |
| General Elective:Lower | | 3 |
| Physical Education | | 1 |

| | | |
|---|---|---|
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| CS 341 | Foundations of Computer Science II | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| Interdisciplinary Elective | | 3 |
| Social Science (lower-level) Elective | | 3 |
| CS 288 | Intensive Programming in Linux | 3 |
| CS 431 | Database System Design and Management | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 356 | Introduction to Computer Networks | 3 |
| CS 407 | Professional Development in Computing | 1 |
| CS/IS/IT Elective [4] | | 3 |
| Math Elective [2] | | 3 |
| Interdisciplinary Elective [3] | | 3 |
| Lower General Elective | | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CS 490 | Guided Design in Software Engineering | 3 |
| CS 435 | Advanced Data Structures and Algorithm Design | 3 |
| Humanities and Social Sciences (Upper Level) Elective | | 3 |
| Math Elective | | 3 |
| Select one of the following: | | 3 |
| IE 492 | Engineering Management | |
| MGMT 390 | Principles of Management | |
| HRM 301 | Organizational Behavior | |
| ENTR 410 | New Venture Management | |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 491<br>or IT 491 | Senior Project<br>or IT Capstone Project | 3 |
| CS Elective [4] | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| Interdisciplinary Elective [3] | | 3 |
| Upper General Elective [5] | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **130** |

[2] Math Elective:
If you took MATH 244 Introduction to Probability Theory, you must take MATH 341 Statistical Methods II.
If you took MATH 333 Probability and Statistics, you may take any of the following:
MATH 211 Calculus III A
MATH 213 Calculus III B
MATH 222 Differential Equations
or any Math 300/400 level except MATH 305 Statistics for Technology.

[3] Interdisciplinary Elective: A sequence of three courses from mathematics, science, engineering or business. At least 1 300/400 level course. All others must be 200/300/400. Acct 115/117 is allowed for business.Please consult your advisor for appropriate interdisciplinary electives.

[4] CS/IS/IT Elective: Two 300-/400-level CS/IS/IT electives as offered by the College of Computing Sciences. At least one must be in CS, excluding CS 310/410. Please consult your advisor regarding these COOP courses and their place in your curriculum.

5 General Upper and Lower Electives: A minimum of 3 courses (9 credits). Two of the three elective courses may be lower level (100-200) and one of these electives must be upper level (300-400) courses.

## Electives

Prerequisite grade requirement for Computer Science majors:

Students are expected to earn a grade of B or better in CS 100. Students are expected to earn a grade of C or better in all CS courses that serve as prerequisites in a sequence of courses

## Co-op

A GPA of 2.7 is required to enroll in co-op. Students may use up to 6 credits of co-op toward their general elective requirements.

Refer to the **General University Requirements** for further information on electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Computer Science and B.S. in Applied Physics

(135 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| CHEM 125 | General Chemistry I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| CHEM 126 | General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 114 | Introduction to Computer Science II | 3 |
| MATH 211 | Calculus III A | 3 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| Social Science (lower-level):GUR | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education Elective | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CS 280 | Programming Language Concepts | 3 |
| MATH 222 | Differential Equations | 4 |
| MATH 335<br>or MATH 328 | Vector Analysis<br>or Mathematical Methods for Scientists and Engineers | 3 |

| | | |
|---|---|---|
| PHYS 335 | Introductory Thermodynamics | 3 |
| Social Science (lower-level):GUR | | 3 |
| English Composition and Cultural History (lower-level):GUR | | 3 |
| | **Term Credits** | **19** |
| **Third Year** | | |
| **1st Semester** | | |
| CS 252 | Computer Organization and Architecture | 3 |
| CS 288 | Intensive Programming in Linux | 3 |
| CS 241 | Foundations of Computer Science I | 3 |
| MATH 333 | Probability and Statistics | 3 |
| PHYS 430 | Classical Mechanics I | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 435 | Advanced Data Structures and Algorithm Design | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| Physics/OPSE 300/400 Elective | | 3 |
| OPSE 310 | Virtual Instrumentation | 3 |
| Management:GUR Elective | | 3 |
| Physical Education Elective | | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CS 341 | Foundations of Computer Science II | 3 |
| CS 490 | Guided Design in Software Engineering | 3 |
| CS 431 | Database System Design and Management | 3 |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| PHYS 485 | Computer Modeling of Applied Physics Problems | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 491<br>or PHYS 490 | Senior Project<br>or Independent Study | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Physics 300/400 Elective | | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **135** |

# Electives

## Phys/OPSE

Consult the physics department for information about qualifying courses.

## Math/Phys/CS

Consult the physics department for information about qualifying courses.

## Math/Phys/EE/CS

Consult the physics department for information about qualifying courses.

## Technical

Consult the physics department for information about qualifying courses.

Refer to the **General University Requirements** for further information on GUR electives.

## Co-op Courses

Co-op courses bearing degree credit replace a technical elective or another course approved by the faculty advisor in the students major department. In applied physics, both PHYS 311 Co-op Work Experience I and PHYS 411 Co-op Work Experience II are taken for degree Credit with permission.

# B.S. in Computer Science and B.S. in Mathematical Sciences, Applied Mathematics

(135 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 227 | Mathematical Modeling | 4 |
| CS 114 | Introduction to Computer Science II | 3 |
| MATH 211 | Calculus III A | 3 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| CS 280 | Programming Language Concepts | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| MATH 222 | Differential Equations | 4 |
| CS 252 | Computer Organization and Architecture | 3 |
| English Composition and Cultural History (lower-level) GUR Elective | | 3 |
| Social Science (lower-level) Elective | | 3 |
| | **Term Credits** | **19** |
| **Third Year** | | |
| **1st Semester** | | |
| CS 241 | Foundations of Computer Science I | 3 |
| CS 288 | Intensive Programming in Linux | 3 |
| MATH 333 | Probability and Statistics | 3 |
| MATH 337 | Linear Algebra | 3 |
| MATH 340 | Applied Numerical Methods | 3 |

| | | |
|---|---|---|
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 435 | Advanced Data Structures and Algorithm Design | 3 |
| CS 341 | Foundations of Computer Science II | 3 |
| Open:GUR Elective | | 3 |
| Math 300+ Elective | | 3 |
| MATH 331 | Introduction to Partial Differential Equations | 3 |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CS 431 | Database System Design and Management | 3 |
| CS 490 | Guided Design in Software Engineering | 3 |
| Management:GUR Elective | | 3 |
| CS Elective | | 3 |
| MATH 450 | Methods Of Applied Math | 3 |
| MATH 480 | Introductory Mathematical Analysis | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 491 | Senior Project | 3 |
| CS 356 | Introduction to Computer Networks | 3 |
| MATH 451 | Methods Appl Math II | 3 |
| Math 300+ Elective | | 3 |
| Capstone Seminar: GUR Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **135** |

## General University Requirements and Electives

All students are required to satisfy the General University Requirements (GUR). All GUR courses and additional mathematics, technical, and free electives are to be selected in consultation with a faculty advisor in the Department of Mathematical Sciences. Refer to the **General University Requirements** section of this catalog for further information on electives.

## Co-op Courses

In Mathematical Sciences, the co-op courses, MATH 310 Co-op Work Experience I and MATH 410 Co-op Work Experience II, bear degree credit and count as technical or free electives, subject to approval by a faculty advisor in the Department of Mathematical Sciences.

## Electives

All electives should be selected after consultation with a Mathematical Sciences faculty advisor. Any mathematics course numbered 331 or above may be used as a mathematics, technical, or free elective. Any NJIT course at or above the 100 level may be used as a technical or free elective; except a technical elective is a course that has a significant mathematical and/or scientific content. All elective courses are to be chosen in consultation with a faculty advisor in the Department of Mathematical Sciences.

# B.S. in Computing and Business

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| Natural Science elective with Lab | | 4 |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |

| | | |
|---|---|---|
| CS 113 | Introduction to Computer Science | 3 |
| ECON 201 | Economics | 3 |
| MATH 112 | Calculus II | 4 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Natural Science elective with Lab | | 4 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 114 | Introduction to Computer Science II | 3 |
| ACCT 117 | Survey of Accounting | 3 |
| MATH 333 | Probability and Statistics | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education | | 1 |
| IS 350 | Computers, Society and Ethics | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ENG 340 or ENG 352 | Oral Presentations or Technical Writing | 3 |
| CS 280 | Programming Language Concepts | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| MGMT 216 | Business Statistics | 3 |
| CS 241 | Foundations of Computer Science I | 3 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| CS 288 | Intensive Programming in Linux | 3 |
| HRM 301 | Organizational Behavior | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| OM 375 | Management Science | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| IS 344 | Computing Applications in Business | 3 |
| CS 356 | Introduction to Computer Networks | 3 |
| IT 310 | E-commerce Technology | 3 |
| Free Elective | | 3 |
| CS 431 | Database System Design and Management | 3 |
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MGMT 491 | International Business | 3 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| CS 357 | Fundamentals of Network Security | 3 |
| Free Elective | | 3 |
| CS 490 | Guided Design in Software Engineering | 3 |
| | **Term Credits** | **15** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| CS 435 | Advanced Data Structures and Algorithm Design | 3 |
| CS 491 | Senior Project | 3 |
| Humanities and Social Sciences (upper-level) Capstone Seminar Elective | | 3 |
| Business Elective-Select one 200 level or higher from the following subjects: | | 3 |
| ACCT, ENTR, FIN, HRM, MRKT, MGMT (excluding MGMT 390) | | |
| Free Elective | | 3 |
| | 1 | |
| | **Term Credits** | **16** |
| | **Total Credits** | **129** |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Computer Science Minor (for Computer Engineering majors)

| | | |
|---|---|---|
| CS 280 | Programming Language Concepts | 3 |
| CS 431 | Database System Design and Management | 3 |
| CS 357 | Fundamentals of Network Security | 3 |
| or CS 458 | Technologies-Network Security | |
| Two courses approved by the minor coordinator | | 6 |
| **Total Credits** | | **15** |

# Computer Science Minor (not for Computer Engineering majors)

| | | |
|---|---|---|
| CS 114 | Introduction to Computer Science II | 3 |
| CS 252 | Computer Organization and Architecture | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 431 | Database System Design and Management | 3 |
| Two courses approved by the minor coordinator | | 6 |
| **Total Credits** | | **18** |

# Information Systems

Accredited by the Computing Accreditation Commission of ABET, http://abet.org

The first fully accredited program of its kind in New Jersey, the Department of Information Systems continues to be a cutting-edge example of NJIT's long history of innovation and digital communication. Its state-of-the-art curriculum, hands-on application designed focus, solid career preparation for project management and business application leadership provide students with the opportunity to research alongside distinguished professors and scholars who are experts in their fields and eager to create, disseminate and apply fundamental knowledge at the intersection of people, information and computing technology.

Business and information systems and Web and information systems degrees are offered at the undergraduate and graduate levels, and there are two rigorous research tracks at the Ph.D. level—data-intensive research and human-centered computing—all taught by a talented award-winning faculty, which have received highly competitive grants, won best paper awards, written books and published extensively in very selective journals.

## NJIT Faculty

### B

Bieber, Michael P., Professor

### D

Deek, Fadi P., Distinguished Professor

Duan, Lian, Assistant Professor

### E

Egan, Richard W., Senior University Lecturer

### H

Hiltz, S. Roxanne, Distinguished Professor Emeritus

### J

Jones, Quentin, Associate Professor

### L

Lin, Lin, Senior University Lecturer

### R

Recce, Michael, L., Associate Professor

### S

Scher, Julian M., Associate Professor Emeritus

### T

Tremaine, Marilyn M., Professor Emeritus

Turoff, Murray, Distinguished Professor Emeritus

### W

Williams, Keith A., University Lecturer

Wu, Yi-Fang, Brook, Associate Professor

### X

Xu, Songhua, Assistant Professor

## Programs

- Business & Information Systems - B.S. (p. 221)
- Human-Computer Interaction - B.S. (p. 224)
- Information Systems - B.A. (p. 217)
- Web & Information Systems - B.S. (p. 230)

## **Double Majors** (p. 92)

- Science, Technology and Society/Business and Information Systems - B.S. (p. 227)
- Data Analytics (http://catalog.njit.edu/undergraduate/computing-sciences/information-systems/data-analytics-minor)
- Design of the User Experience Minor (p. 232)
- Business and Information Systems Minor (p. 232) (not for Computing Sciences majors)
- Business and Information Systems Minor (http://catalog.njit.edu/undergraduate/computing-sciences/information-systems/minor-computing-science-majors) (for Computing Science majors)
- Mobile and Web Minor (p. 233)

# Information Systems Courses

**IS 117. Introduction to Website Development. 3 credits, 3 contact hours (3;0;0).**
This course discusses the concepts and skills required to plan, design and build websites. It will be taught in a lab to ensure hands-on experience with each of these tasks. The course begins with an overview of web technologies. Students learn to plan websites, which includes determining the business and end-user requirements for the site. Design includes learning to develop "mockups" of how the site will look and how people will use it. The major tools for building websites will be industry standard HTML and XHTML to describe webpage content, and Cascading Style Sheets (CSS) for flexibly formatting the content. Using entire site, as well as "future-proofs" a website, allowing it to be viewed on every major web browser (such as Firefox or Chrome) and easily adapt to changes in future browser technology. The course features substantial hands-on projects comprising websites of several interlinked pages and images, enabling students to thoroughly learn the course's important concepts and skills.

**IS 218. Building Web Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (IS 117 or IT 202) and (CS 100, CS 113, or CS 115). This course provides a critical, hands-on introduction to the design of Web-based Information Systems. We will explore and discuss emerging trends, capabilities, and limitations of web technologies used to capture, store, access, and disseminate information for both businesses and online communities. Students, working in groups, will design and develop different types of web applications, which will then be analyzed and critiqued by the students as to their usability in actual public and private settings. An open-source web content management system will be utilized throughout the course.

**IS 219. Adv Website Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (IS 117 or IT 202) and (CS 100, CS 113, or CS 115). This course discusses the concepts and skills required to plan, design and build advanced websites, with a focus on sophisticated user interaction enabled by programming the web browser (such as Internet Explorer or Chrome). Such programming is known as client-side scripting. These interactive websites utilize forms to gather user inputs, and vary both the content and display of the webpages based on the current user tasks and preferences. This includes designing and dynamically changing tabs and menus, as well as expanding and contracting sections of pages. Students will develop a thorough understanding of website usability (designing effective sites that people like, security and user privacy, browser capability (ensuring websites work on every major web browser), and the tools and skills that web developers use to add interactive features to websites. These skills include Javascript (for programming interactive features), the Document Object Model or DOM (specifying the internal structure of web pages), JQuery (to access information utilizing this internal structure, create animations and generally streamline Javascript), browser variables (providing information about the browser characteristics), HTML input forms, form validation (ensuring correctness of user input), securing user input (to ensure user privacy), cookies (tracking user information), basic communication with the web server (which processes the information users input into forms), and AJAX ( which integrates many of these technologies). The course will be taught in a lab to ensure hands-on experience and will include substantial design and development projects.

**IS 245. Information Technology Systems: Hardware/Software. 3 credits, 3 contact hours (3;0;0).**
This course reviews hardware/software technologies in order to enable system developers to understand tradeoffs in the design of computer architectures for effective computer systems. Also covered are operating systems and systems architecture for networked computing systems. Topics include Hardware (CPU architecture, memory, registers, addressing modes, busses, instruction sets, multi processors versus single processors, and peripheral devices), Operating systems (processes, process management, memory and file system management), and Telecommunications (basic network components, switches, multiplexers and media, installation and configuration of multi-user operating systems).

**IS 247. Designing the User Experience. 3 credits, 3 contact hours (3;0;0).**
This course covers the design and evaluation of the human-computer interface in interactive computer systems. Among the topics covered are approaches to interface design such as menus, commands, direct manipulation; screen layout strategies; metaphor models; models of human information processes; evaluation approaches such as protocol for analysis, interactive monitoring, use of surveys; and requirements for documentation and help. Students are expected to design interface mockups and evaluate them.

**IS 265. Introduction to Information Systems. 3 credits, 3 contact hours (3;0;0).**
Information systems is the study of how organizations use information technology. This course is an overview of the information systems discipline, the role of information systems in organizations, and the changing nature of information technology. Computer tools for analysis and presentation are used.

**IS 270. Designing the Multimedia Experience. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. Multimedia combines text, graphics, sound, video, and animation in a single application. Preparation for creating multimedia information systems, and understanding the crucial issues involving technology, design and effectiveness of multimedia applications. Programming techniques for integrating video, sound, animation, and graphics, and design strategies for multimedia information systems.

**IS 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**IS 322. Mobile Applications: Design, Interface, Implementation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 218, IS 219, or IT 202. This course is a practical introduction to building applications for mobile devices. The course combines hands on design and development experience, with a conceptual overview and discussion of design and practical development issues. Taken into account will be constraints and requirements of devices with small screen sizes, limited battery power, limited computational power, etc. Tools used for building an application in the context of a specific device such as iPhone or an Android based device will be discussed. Students build a mobile application to demonstrate their understanding of mobile web constraints and tools.

**IS 331. Database Design Management and Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IS 218 or IT 202. Businesses use databases extensively for analysis and decision-making because they provide efficient, large-scale information storage and rapid retrieval. Databases support the "back end functionality" of most large web systems. This course gives students extensive, pragmatic experience in designing, building, querying, updating, maintaining and managing relational databases, using the Structured Query Language (SQL). Proper database design principles are emphasized throughout the course, beginning with high level descriptions of relational databases using data modeling tools(such as entity-relationship or ER diagrams)and progressing to relational database design principles based on higher order normalizations. We will examine some poorly designed and show how theses can be transformed into well designed databases. SQL will be extensively covered, and students will design implement sophisticated SQL queries invoking self-joins, outer joins, correlated subqueries and related concepts. Students will explore and utilize design methodologies for input data validation and maintaining database integrity, and study issues of database privacy and security. Advanced topics to be discussed include the role of the Database Administrator (DBA), database life cycle activities, database denormalization, read-only database and data warehouses. Hands-on experience will be gained by with actual database using industry-standard database management systems such as Oracle.

**IS 333. Social Network Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Completion of computing GUR (CS 100, CS 101, CS 103, CS 104, CS 111, CS 113, CS 115 or BNFO 135) AND statistical GUR (MATH 105, MATH 120, MATH 225, MATH 244, MATH 279, MATH 305, MATH 333, IE 331, ECE 321 or MNET 315). In this intensive hands-on course, students will learn how to design computer programs to “grab” information from social networking systems such as Facebook, and analyze this to reveal useful but hidden information about the users and their interconnections. Since math is the only language that computers understand, the goal of this class is to build connections between the human language one finds in social network postings and profiles, and mathematical formulas. The skills and techniques utilized in the course will prepare students for advanced courses in data mining and business analytics. This course requires basic statistical knowledge and Java programming skills.

**IS 344. Computing Applications in Business. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MIS 245 or IS 265 or Acct 115 or Acct 117 or MGMT 390 A comprehensive overview of the various types of computing applications used by businesses in order to run effectively and efficiently. All the major functional departments within organizations are examined and evaluated to see how applications are integrated to implement "business processes" that flow across department boundaries, and from suppliers to customers. The modeling of business situations and the design of applicable software solutions. A full-semester hands-on student project will provide experience in designing solutions to changes in the business environment.

**IS 350. Computers, Society and Ethics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: GUR (CS 100, CS 101, CS 103, CS 104, CS 111, CS 113, CS 115, or BNFO 135), AND one basic social science course (STS 201, ECON 201, ECON 265, ECON 266, EPS 202, STS 257 or STS 258), AND HUM 101. Examines the historical evolution of computer and information systems and explores their implications in the home, business, government, medicine and education. Topics include automation and job impact, privacy, and legal and ethical issues. Co-listed as STS 350.

**IS 373. Content Management Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 117 or IT 202. This course provides a hands-on introduction to the design and implementation of enterprise-scale web systems built upon web based content management systems (CMS). CMS manage the creation, storage, retrieval, dissemination, and collection of information in order to meet the needs of businesses, organizations and individuals. Students learn to how to create blogs, discussion boards, wiki, intranets, and dynamic websites using popular CMS packages such as Wordpress and Drupal. Throughout the course students learn how to overcome common challenges that impact the design of these systems such as security for multi-user systems, content strategy, marketing and performance.

**IS 375. Discovering User Needs to Enhance User eXperience. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: none What new digital products or services needs to be developed? How do you anticipate someone’s needs before they do? How do you understand how people interact with products? These are key questions that both interaction designers and start-up entrepreneurs need to answer. It’s all about the understanding the user. We need to work with users to investigate or "research" their needs and how they interact with the product or service. In this course, we take a deep dive into qualitative user experience (UX) research. UX research is the process of understanding why and how people use products and services. This course will teach you a set of research tools to discover user needs, investigate the user experience, and enhance the user experience by deriving design recommendations. We will cover techniques like ethnography, focus groups, interviewing, and analyzing qualitative data. We will be talking with user experience researchers at major companies and getting involved with actual user research. This practical, hands-on course will give you an insight into the psychology of user behavior and lay the foundation for students who are pursuing careers designing, evaluating, or marketing products for people.

**IS 385. Special Topics in IS. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of information systems and the computing sciences not regularly covered in any other IS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**IS 390. Requirements Analysis and Systems Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CS 103, CS 113, CS 115, IS 218 or IT 202 A study of the information systems development life-cycle, from the initial stages of information requirements analysis and determination to the ultimate activities involving systems design. Theory, methodologies and strategies for information requirements analysis, including the assessment of transactions and decisions, fact-finding methodologies, structured analysis development tools, strategies of prototype development, and an overview of computer-aided software engineering (CASE) tools. Theory, methodologies and strategies for systems design, including design of user-interfaces, particularly menu-driven and keyword dialogue strategies, and issues in the proper design of computer output.

**IS 392. Web Mining and Information Retrieval. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 218, IT 114, or CS 114. This course introduces the design, implementation and evaluation of search engines and web mining applications. Topics include: automatic indexing, natural language processing, retrieval algorithms, web page classification and clustering, information extraction, summarization, search engine optimization, and web analytics. Students will gain hands-on experience applying theories in case studies.

**IS 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: IS 310 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**IS 421. Advanced Web Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: IS 219 and (IS 331 or CS 431). This course focuses on the design, development, and management of cloud-based web information systems, within the context of startup companies and established organizations. Within the course, we examine business, organizational and technical challenges faced by developers, project managers, and the business development professionals that create web-based software products. The course consists of readings, discussions, and a final team project that demonstrates modular design, planned scalability, maintainability, and the creation of a set of organizational processes that supports the continued support and development of the application. Some of the topics covered in the course are: continuous deployment, continuous integration, automated unit testing, modular design, software team management, agile development, Kanban, customer focused development, and the technologies used to scale cloud applications.

**IS 448. Usability & Measuring UX. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: Statistics GUR (MATH 105, MATH 120, MATH 225, MATH 244, MATH 279, MATH 305, MATH 333, IE 331, ECE 321 or MNET 315). User experience research is the process of understanding why and how people use products and services. Usability refers to the ease of use and learnability of such a product or service. The primary function of usability is to be able to measure and assess the optimal use of a product from the perspective of the user. This course will teach students a set of quantitative tools to understand user needs, derive design recommendations, and evaluate the user experience. Students will receive an overview of the different quantitative methods being used in industry and academia, such as eye-tracking, big social media data analysis, and physiological tests. They will then get an in-depth knowledge of how to design, execute, and analyze data from experiments and surveys using both descriptive and inferential statistics. The course will incorporate a hands-on approach and be comprised completely of individual and group project assignments.

**IS 455. IS Mgmt & Business Processes. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IS 344 and (IS 265 or MIS 245). Grade of C or better. This course will emphasize how information systems enable core and supportive business processes, as well as those that interface with suppliers, partners and customers. It will discuss basic administrative, management and policy issues associated with the impact of information systems on the user and organization. The second part of the course looks at business processes in organizations: what the business process view is and why it is important, how information systems can improve processes, and how Enterprise Resource Planning systems help with that improvement. Hands-on use of a major ERP system (SAP) is included.

**IS 461. Systems Simulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: completion of a 100-level GUR course in computing; MATH 333. This course introduces computer simulation as an algorithmic problem solving technique. Includes discrete simulation models, elementary theory, stochastic processes, use of simulation languages, random number generators, simulation of probabilistic processes, design of simulation experiments, validation of models, queueing systems, and applications to the design and analysis of operational systems. The GPSS language is covered in detail.

**IS 465. Advanced Information Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: statistical GUR (MATH 105, MATH 120, MATH 225, MATH 244, MATH 279, MATH 305, MATH 333, IE 331, ECE 321 or MNET 315), and (IS 265 or MIS 245) and IS 344, and (IS 331 or CS 431). Design and programming concepts are presented for automation of management information systems. Includes the organization of files and techniques for processing information based upon organizational requirements and available hardware and software. Some case studies are presented.

**IS 485. Special Topics in Information Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: junior standing and/or department approval. The study of new and/or advanced topics in an area of IS not regularly covered in any other IS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. A student may register for no more than two semesters of Special Topics.

**IS 486. Topics in Information Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Same as for IS 485. A continuation of IS 485.

**IS 488. Independent Study in Information Systems. 3 credits, 0 contact hours (0;0;0).**
Prerequisites: Open only to students in the Albert Dorman Honors College or to any student who intends to apply to the IS Undergraduate Thesis program. Students need approval from the IS department and the IS faculty member who will guide the independent study. Independent studies, investigations, research, and reports on advanced topics in IS. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of Independent Study.

**IS 489. IS Undergrad Thesis Research. 3 credits, 3 contact hours (3;0;0).**
Students continue their research in preparation for completing a Research Thesis.

**IS 491. Senior Project. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: IS 331, IS 431, or CS 431, and senior standing. Integration of knowledge and skills gained in previous information systems courses into an individual research project. The project entails investigation of current literature and the design, implementation and evaluation of an information system.

# B.A. in Information Systems

(129 credit)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 138 | General Calculus I [1] | 3 |
| Science elective | | 3 |
| CS 107 | Computing as a Career | 1 |
| IS 117 | Introduction to Website Development | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 265 | Introduction to Information Systems | 3 |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| ECON 201 | Economics | |
| Science Elective with lab | | 4 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| IS 247 | Designing the User Experience | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| MATH 105 | Elementary Probability and Statistics [1] | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| General Elective 1 | | 3 |
| Physical Education II | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 207 | Computing and Effective Communication | 1 |
| IS 344 | Computing Applications in Business | 3 |
| Social Science | | 3 |
| IS Career Track Elective 1 [4] | | 3 |
| General Elective 2 | | 3 |
| New Media or Business Specialization Elective 1 [3] | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| IS 331 | Database Design Management and Applications | 3 |
| General Elective 3 | | 3 |
| General Elective 4 | | 3 |

| | | |
|---|---|---|
| IS 390 | Requirements Analysis and Systems Design | 3 |
| Select one of the following: | | 3 |
| ENG 352 | Technical Writing | |
| ENG 340 | Oral Presentations | |
| New Media or Business Specialization Elective 2 [3] | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| Select one of the following: | | 3 |
| IT 120 | Introduction to Network Technology | |
| CS 356 | Introduction to Computer Networks | |
| New Media or Business Specialization Elective 3 [3] | | 3 |
| IS Career Track Elective 2 [4] | | 3 |
| General Elective 5 | | 3 |
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| IS 455 | IS Mgmt & Business Processes | 3 |
| IE 492<br>or ENTR 410 | Engineering Management<br>or New Venture Management | 3 |
| New Media or Business Specialization Elective 4 [3] | | 3 |
| IS Career Track Elective 3 [4] | | 3 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Select one of the following: | | 3 |
| IT 491 | IT Capstone Project | |
| CS 491 | Senior Project | |
| IS 491 | Senior Project | |
| IS 465 | Advanced Information Systems | 3 |
| Humanities and Social Sciences (upper-level) Capstone Seminar Elective | | 3 |
| New Media or Business Elective 5 [3] | | 3 |
| General Elective 6 | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

1 **Math:** MATH 111 Calculus I and MATH 333 Probability and Statistics are highly recommended to replace MATH 138 General Calculus I and MATH 105 Elementary Probability and Statistics, particularly for students contemplating advanced or graduate work in computing. These students also are encouraged to take MATH 112 Calculus II and one or more advanced statistics courses as free electives, such as MATH 341 Statistical Methods II or MATH 344 Regression Analysis both of which require MATH 333 Probability and Statistics as a prerequisite.

3 **Business and New Media Specialization Electives:** Students must complete an entire set of either 5 approved business electives or 5 approved new media electives.

4 **Career Track Electives.** Students are strongly encouraged (but not required) to take 3-4 courses from one of the following Career Tracks, which focus on a particular specialty within the field of Information Systems. Note: Qualified students should consider the BA/MS or BA/PhD program, which allows undergraduates to start on a graduate degree as part of their undergraduate requirements. See the Office of Graduate Studies for more information. Consult your Academic Advisor for further details.

## Recommended Business Specialization Electives

BA IS students who take the following 5 courses qualify for a formal minor in Business. A more extensive list of other approved business electives is available at http://is.njit.edu

| | | |
|---|---|---|
| ACCT 117 | Survey of Accounting | 3 |
| MGMT 190 | Introduction to Business | 3 |

| | | |
|---|---|---|
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| Select one of the following: | | 3 |
| MRKT 360 | Internet Marketing | |
| HRM 301 | Organizational Behavior | |
| MGMT 492 | Business Policy | |
| **Total Credits** | | **15** |

## Recommended New Media Specialization Electives

Choose 5 courses from the following to fulfill the requirements for the Specialization. Students taking the New Media specialization have taken most of the courses for a minor in Professional Communications. Check with the Humanities Department to determine current options for electives to complete this minor, if you are interested.

| | | |
|---|---|---|
| ENG 200 | Communicating in Organizations | 3 |
| ENG 333 | Cybertext | 3 |
| ENG 351 | Online Journalism | 3 |
| ENG 353 | Composing Documents for Print | 3 |
| ENG 354 | Composing Documents for the Web | 3 |
| COM 303 | Video Narrative | 3 |
| COM 352 | Photojournalism | 3 |
| COM 390 | Electronic Writing Workshop | 3 |
| **Total Credits** | | **24** |

## Recommended Career Track Electives

Students are strongly encouraged (but not required) to take 3-4 courses from one of the following Career Tracks, which focus on a particular specialty within the field of Information Systems. Note: Qualified students should consider the BA/MS or BA/PhD program, which allows undergraduates to start on a graduate degree as part of their undergraduate requirements. See the Office of Graduate Studies for more information. Consult your Academic Advisor for further details.

### Database

| | | |
|---|---|---|
| IS 392 | Web Mining and Information Retrieval | 3 |
| IT 310 | E-commerce Technology | 3 |
| IS 631 | Enterprise Database Management | 3 |
| IS 634 | Information Retrieval | 3 |
| IS 687 | Transaction Mining and Fraud Detection | 3 |
| CS 434 | Advanced Database Systems | 3 |
| CS 441 | Database Programming | 3 |

### Networks

| | | |
|---|---|---|
| IS 448 | Usability & Measuring UX | 3 |
| CS 357 | Fundamentals of Network Security | 3 |
| CS 408 | Cryptography and Internet Security | 3 |
| CS 458 | Technologies-Network Security | 3 |
| IT 202 | Internet and Applications | 3 |
| IT 220 | Wireless Networks | 3 |
| IT 230 | Computer and Network Security | 3 |
| IT 420 | Computer Systems and Networks | 3 |

### Management of Information Systems

| | | |
|---|---|---|
| IS 392 | Web Mining and Information Retrieval | 3 |
| IT 310 | E-commerce Technology | 3 |
| IS 461 | Systems Simulation | 3 |
| IS 677 | Information System Principles | 3 |
| IS 678 | IT Service Management | 3 |

| | | |
|---|---|---|
| IS 680 | Information Systems Auditing | 3 |
| IS 681 | Computer Security Auditing | 3 |
| IS 687 | Transaction Mining and Fraud Detection | 3 |
| IT 332 | Digital Crime | 3 |
| IT 430 | Ethical Hacking for System Administrators | 3 |

## Medical Informatics (Healthcare Information Systems)

| | | |
|---|---|---|
| For an IS Career Track in Medical Informatics, the student must complete both: | | |
| CPT 325 | Medical Informatics Technology | 3 |
| CPT 425 | Medical Informatics Technology II | 3 |
| Select two of the following: | | 6 |
| IS 392 | Web Mining and Information Retrieval | |
| IS 448 | Usability & Measuring UX | |
| IS 661 | User Experience Design | |
| IT 220 | Wireless Networks | |
| CS 370 | Introduction to Artificial Intelligence | |

## Systems Analysis & Design

| | | |
|---|---|---|
| IS 373 | Content Management Systems | 3 |
| IS 461 | Systems Simulation | 3 |
| IS 663 | System Analysis and Design | 3 |
| IS 685 | Enterprise Architecture and Integration | 3 |
| CS 280 | Programming Language Concepts | 3 |
| CS 288 | Intensive Programming in Linux | 3 |
| CS 433 | Introduction to Linux Kernel Programming | 3 |
| CS 490 | Guided Design in Software Engineering | 3 |
| IT 335 | Introduction to .NET Framework | 3 |
| IT 340 | Introduction to System Administration | 3 |
| IT 490 | Systems Integration | 3 |

## Intelligence & Decision Support

| | | |
|---|---|---|
| IS 392 | Web Mining and Information Retrieval | 3 |
| IT 310 | E-commerce Technology | 3 |
| IS 461 | Systems Simulation | 3 |
| CS 370 | Introduction to Artificial Intelligence | 3 |
| CS 434 | Advanced Database Systems | 3 |
| IT 380 | Educational Software Design | 3 |

## Web Systems

| | | |
|---|---|---|
| IS 117 | Introduction to Website Development | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 322 | Mobile Applications: Design, Interface, Implementation | 3 |
| IS 373 | Content Management Systems | 3 |
| IS 392 | Web Mining and Information Retrieval | 3 |
| IS 421 | Advanced Web Applications | 3 |
| IT 310 | E-commerce Technology | 3 |
| IS 448 | Usability & Measuring UX | 3 |
| IS 683 | Web Systems Development | 3 |
| IS 688 | Web Mining | 3 |
| IS 690 | Web Services and Middleware | 3 |
| IT 202 | Internet and Applications | 3 |
| IT 302 | Advanced Internet Applications | 3 |

## Information Systems Security, Auditing and Crisis Response

| | | |
|---|---|---|
| IS 681 | Computer Security Auditing | 3 |
| IS 687 | Transaction Mining and Fraud Detection | 3 |
| CS 357 | Fundamentals of Network Security | 3 |
| CS 408 | Cryptography and Internet Security | 3 |
| CS 458 | Technologies-Network Security | 3 |
| IT 230 | Computer and Network Security | 3 |
| IT 330 | Computer Forensic | 3 |
| IT 331 | Privacy and Information Technology | 3 |
| IT 332 | Digital Crime | 3 |
| IT 430 | Ethical Hacking for System Administrators | 3 |

## Human-Computer Interaction

| | | |
|---|---|---|
| IS 448 | Usability & Measuring UX | 3 |
| IS 661 | User Experience Design | 3 |
| IS 764 | Research Methods for Human-Centered Computing and Design | 3 |
| IT 265 | Game Architecture and Design | 3 |
| IT 201 | Information Design Techniques | 3 |
| IT 266 | Game Modification Development | 3 |
| or CS 266 | Game Modification Development | |

## Build Your Own Career Track

Students may construct a career track of 3-4 electives in consultation with their advisor.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Business and Information Systems

(129 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| Science Elective | | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 138 | General Calculus I [1] | 3 |
| CS 107 | Computing as a Career | 1 |
| IS 117 | Introduction to Website Development | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ECON 201 | Economics | 3 |
| IS 265 | Introduction to Information Systems | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| ACCT 117<br>or ACCT 115 | Survey of Accounting<br>or Fundamentals of Financial Accounting | 3 |
| Science with lab | | 4 |
| Physical Education | | 1 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 105 | Elementary Probability and Statistics [1] | 3 |
| Select one of the following: | | 3 |

| | | |
|---|---|---|
| IS 350 | Computers, Society and Ethics | |
| HUM 251 | Ethical Issues in Business | |
| IT 310 | E-commerce Technology | 3 |
| IS 247 | Designing the User Experience | 3 |
| General Elective 1 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 207 | Computing and Effective Communication | 1 |
| General Elective 2 | | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 344 | Computing Applications in Business | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Social Science (lower-level) GUR | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MGMT 216 | Business Statistics | 3 |
| FIN 218 | Financial Markets and Institutions | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| General Elective 3 | | 3 |
| Select one of the following: | | 3 |
| ENG 340 | Oral Presentations | |
| ENG 352 | Technical Writing | |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| HRM 301 | Organizational Behavior | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| IT 120<br>or CS 356 | Introduction to Network Technology<br>or Introduction to Computer Networks | 3 |
| General Elective 4 | | 3 |
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MRKT 330 | Principles of Marketing | 3 |
| MGMT 491 | International Business | 3 |
| IE 492<br>or ENTR 410 | Engineering Management<br>or New Venture Management | 3 |
| IS 455 | IS Mgmt & Business Processes | 3 |
| LIT/HIST/PHIL/STS:GUR | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| IS 465 | Advanced Information Systems | 3 |
| Select one of the following: | | 3 |
| CS 491 | Senior Project | |
| IT 491 | IT Capstone Project | |

| | | |
|---|---|---|
| IS 491 | Senior Project | |
| Humanties and Social Sciences (upper-level) Capstone Seminar | | 3 |
| General Elective 5 | | 3 |
| General Elective 6 | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

[1] MATH 111 Calculus I and MATH 333 Probability and Statistics are highly recommended to replace MATH 138 General Calculus I and MATH 105 Elementary Probability and Statistics, particularly for students contemplating advanced or graduate work in computing. These students also are encouraged to take MATH 112 Calculus II and one or more advanced statistics courses as free electives, such as MATH 341 Statistical Methods II or MATH 344 Regression Analysis, both of which require MATH 333 Probability and Statistics as a prerequisite.

## Curriculum Overview

Following is an overview of the curriculum.

| | | |
|---|---|---|
| **Core Information Systems Courses** | | |
| IS 265 | Introduction to Information Systems | 3 |
| IT 310 | E-commerce Technology | 3 |
| IS 247 | Designing the User Experience | 3 |
| IS 350 | Computers, Society and Ethics [1] | 3 |
| IS 344 | Computing Applications in Business | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| IS 455 | IS Mgmt & Business Processes | 3 |
| IS 465 | Advanced Information Systems | 3 |
| IE 492 | Engineering Management | 3 |
| or ENTR 410 | New Venture Management | |
| IS 491 | Senior Project | 3 |
| **Core Business Courses** | | |
| ACCT 117 | Survey of Accounting | 3 |
| ECON 201 | Economics | 3 |
| HUM 251 | Ethical Issues in Business [1] | 3 |
| MGMT 216 | Business Statistics | 3 |
| FIN 218 | Financial Markets and Institutions | 3 |
| HRM 301 | Organizational Behavior | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| MGMT 491 | International Business | 3 |
| **Technical Foundation Courses** | | |
| CS 100 | Roadmap to Computing | 3 |
| IS 117 | Introduction to Website Development | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| CS 356 | Introduction to Computer Networks | 3 |
| or IT 120 | Introduction to Network Technology | |
| **Career Building Courses** | | |
| CS 107 | Computing as a Career | 1 |
| CS 207 | Computing and Effective Communication | 1 |
| CS 407 | Professional Development in Computing | 1 |

[1] Students may take HUM 251 Ethical Issues in Business or IS 350 Computers, Society and Ethics

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Human-Computer Interaction

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Science elective with Lab [1] | | 4 |
| MATH 101<br>or MATH 138 | Foundations of Mathematics for the Liberal Arts<br>or General Calculus I | 3 |
| IS 117 | Introduction to Website Development | 3 |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| IS 218 | Building Web Applications | 3 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Physical Education | | 1 |
| Science elective with Lab [1] | | 4 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| General Elective 1 | | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| IS 247 | Designing the User Experience | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| Physical Education | | 1 |
| R830 102 | Prin Of Psychology | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Select one of the following: | | 3 |
| AD 150 | Color and Composition | |
| R085 102 | Design Fundamentals | |
| R085 103 | 3-D Design Fund | |
| R080 121 | Intro To Drawing | |
| HCI Specialization Elective 1 | | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| R830 301 | Stat Meth Cog & Beh | 4 |
| R830 304 | Cognitive Processes | 3 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| IS 331 | Database Design Management and Applications | 3 |
| IS 448 | Usability & Measuring UX | 3 |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| IE 355 | Human Factors | |
| AD 201 | Human Factors/Ergonomics | |
| R830 372 | Perception | 3 |
| General Elective 2 | | 3 |
| IS 390 | Requirements Analysis and Systems Design (General Elective 2) | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 407 | Professional Development in Computing | 1 |
| General Elective 3 | | 3 |
| General Elective 4 | | 3 |
| HCI Specialization Elective 2 | | 3 |
| R830 302 | Exp Meth Cog & Beh | 4 |
| ENG 340<br>or ENG 352 | Oral Presentations<br>or Technical Writing | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| General Elective 5 | | 3 |
| General Elective 6 | | 3 |
| HCI Specialization Elective 3 | | 3 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| IE 492<br>or ENTR 410 | Engineering Management<br>or New Venture Management | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| HSS Capstone | | 3 |
| CS 491<br>or IT 491 | Senior Project<br>or IT Capstone Project | 3 |
| General Elective 7 | | 3 |
| General Elective 8 [2] | | |
| HCI Specialization Elective 4 | | 3 |
| | **Term Credits** | **12** |
| | **Total Credits** | **129** |

1 Science: A two-course related sequence (8 credit minimum) of laboratory science in physics, chemistry, biology, or as approved by advisor. These courses fulfill the Natural Sciences GUR.

2 If all other credits add up to at least 129 credits, this elective may be waived.

## HCI Specializations:

Students choose, with Advisor approval a coherent sequence of 4 courses, chose from one of the HCI specializations given below.

### Cognitive Design

| | | |
|---|---|---|
| Select four of the following: | | 12 |
| STS 351 | Minds and Machines | |
| STS 359 | Cyberpsychology | |
| R830 103 | Cognitive Science | |
| R830 104 | Cognitive Science II | |
| R830 324 | Psych Of Adolescent | |
| R830 335 | Social Psychology | |
| R830 346 | Psychology Of Language | |
| R830 354 | Adult & Aging | |
| R830 371 | Psychology & Personality | |

| | | |
|---|---|---|
| R830 405 | Psych Of Emotion | |
| R830 410 | Perceptual Dev | |
| R830 411 | Intro To Cog Neurosc | |
| R830 424 | Health Psychology | |
| R830 431 | Media Psych | |

## Game Design and Production

| | | |
|---|---|---|
| Select two of the following: | | 12 |
| IT 201 | Information Design Techniques | 3 |
| IT 265 | Game Architecture and Design | 3 |
| Choose two remaining electives from among the following. You may take both courses from one grouping or individual courses from two different groupings. | | |
| For students who want to focus on designing games in existing engines/development environments, consider these courses: | | |
| IT 286 | Foundations of Game Production | |
| IT 287 | Advanced Game Production | |
| For students who are more artistic, design or asses creation focused, consider these courses: | | |
| IT 386 | 3D Modeling and Animation | |
| For students who want to be challenged with C/C++ programming to develop their own 2D and 3D games, consider these courses: | | |
| IT 266 | Game Modification Development | |
| IT 276 | Game Development | |
| Students may also want to consider these interesting Digital Design courses: | | |
| DD 275 | History of Games | |
| DD 301 | Acting Fundamentals for Animators | |

## Graphical Arts Design

| | | |
|---|---|---|
| Select four of the following, which were not taken to fulfill other requirements: | | 12 |
| AD 112 | Communication in Art and Design - Digital Media [1] | |
| AD 150 | Color and Composition | |
| DD 284 | Video and Animation | |
| DD 321 | Interactive and Reactive Environments | |
| ID 203 | Past, Present and Future of Design | |
| R080 121 | Intro To Drawing [1] | |
| R085 102 | Design Fundamentals | |
| R085 103 | 3-D Design Fund | |
| R085 231 | Graphic Design | |
| R085 232 | Graphic Design II | |
| R080 245 | Intro. To Computer Art | |
| R085 331 | Graphic Design | |
| R085 332 | Graphic Design IV | |
| R080 345 | Inter Computer Art | |
| R080 354 | Exp In Computer Art | |
| R085 370 | Computers in Graphic Design | |
| R080 445 | Adv Exp Comp Art | |

[1] Note that AD 112 Communication in Art and Design - Digital Media or the Rutgers course R080 121 Intro To Drawing, if used to fulfill the required Art/Design/Drawing requirement, may not then also be used to fulfill a course requirement in the Graphical Arts Design HCI Specialization.

## Web & Multimedia Design

| | | |
|---|---|---|
| Select four of the following: | | 12 |
| COM 303 | Video Narrative | |
| ENG 333 | Cybertext | |
| ENG 354 | Composing Documents for the Web | |

| | |
|---|---|
| IS 219 | Adv Website Development |
| IS 333 | Social Network Analysis |
| IS 373 | Content Management Systems |
| IS 421 | Advanced Web Applications |
| IS 322 | Mobile Applications: Design, Interface, Implementation |
| CPT 373 | Web App Development for Mobile |
| CS 388 | Android Application Developmnt |
| STS 347 | Introduction to Music |
| STS 349 | Advanced Music Technology |

### Build Your Own HCI Specialization

Students may propose a coherent set of courses that have a common thread related to an HCI-related area that you are interested in.  The IS advisor approves the proposed specialization.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register.  A full-time credit load is 12 credits.  First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## B.S. in Science, Technology & Society and B.S. in Business and Information Systems

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| MATH 138 | General Calculus I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Science with Lab | | 4 |
| STS 201 | Understanding Technological Society | 3 |
| Physical Education GUR | | 1 |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| IS 117 | Introduction to Website Development | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| ECON 201 | Economics | 3 |
| Science with Lab | | 3 |
| Physical Education GUR | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MGMT 216 | Business Statistics | 3 |
| ACCT 117<br>or ACCT 115 | Survey of Accounting<br>or Fundamentals of Financial Accounting | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| IS 265<br>or MIS 245 | Introduction to Information Systems<br>or Introduction to Management Information Systems | 3 |
| STS 308 | Technology and Global Development: Introduction to STS | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| IS 218 | Building Web Applications | 3 |

| | | |
|---|---|---|
| FIN 218 | Financial Markets and Institutions | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| STS 310 | Technology and Human Values | 3 |
| 300 Level STS Specialization | | 3 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| STS 304 | Writing about Science, Technology and Society | 3 |
| 300 Level STS Specialization | | 3 |
| IT 120<br>or CS 356 | Introduction to Network Technology<br>or Introduction to Computer Networks | 3 |
| IS 247 | Designing the User Experience | 3 |
| 300 Level STS Elective | | 3 |
| IS 344 | Computing Applications in Business | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| STS 307 | Fundamentals of Research in STS | 3 |
| 300 Level STS Specialization | | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| HRM 301 | Organizational Behavior | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| STS 490 | Project and Seminar I | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| IS 455 | IS Mgmt & Business Processes | 3 |
| MGMT 491 | International Business | 3 |
| 300 Level STS Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Humanities and Social Sciences (upper-level) Capstone Seminar | | 3 |
| CS 491<br>or IT 491 | Senior Project<br>or IT Capstone Project | 3 |
| IS 465 | Advanced Information Systems | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| STS 491 | Project and Seminar II | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

## GUR Requirements

| | | |
|---|---|---|
| **Social Science (lower-level) GUR** [1] | | |
| Select one of the following Economics courses: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |

| | | |
|---|---|---|
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Physical Education GUR** | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

1 Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| | |
|---|---|
| **Major Option** | |
| Select appropriate electives in consultation with an advisor [1] | 18 |
| **Free Electives** | |
| Students select appropriate electives in consultation with an advisor. | |

1 Usually the Director of the STS Program. Courses may be selected from different disciplines but must comprise a coherent program of study within an option.

Refer to the **General University Requirements** for further information on electives.

## Specializations

- Mind, Behavior, and Society

- Environmental and Sustainability Studies
- Race and Gender in Science in Technology
- Politics, History, and Ethics in Science and Technology
- Music, Literature, and Culture in a Technological Society

## Co-op

Co-op courses replace electives with the approval of an advisor. In science, technology and society, STS 311 Co-op Work Experience I and STS 411 Co-op Work Experience II are taken for degree credit.

# B.S. in Web & Information Systems

(129 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| CS 107 | Computing as a Career | 1 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| IS 117 | Introduction to Website Development | 3 |
| MATH 138<br>or MATH 111 | General Calculus I<br>or Calculus I | 3 |
| Science Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| IS 265 | Introduction to Information Systems | 3 |
| Science elective with Lab | | 4 |
| Social Science I | | 3 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| General Elective 1 | | 3 |
| IT 114<br>or CS 114 | Advanced Programming for Information Technology<br>or Introduction to Computer Science II | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| MATH 105 | Elementary Probability and Statistics [1] | 3 |
| Physical Education I | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 207 | Computing and Effective Communication | 1 |
| Social Science II | | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| IS 219 | Adv Website Development | 3 |
| IS 247 | Designing the User Experience | 3 |
| IS 344 | Computing Applications in Business | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |

| | | |
|---|---|---|
| ENG 340<br>or ENG 352 | Oral Presentations<br>or Technical Writing | 3 |
| General Elective 2 | | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| IS 373 | Content Management Systems | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| IS 448 | Usability & Measuring UX | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 407 | Professional Development in Computing | 1 |
| General Elective 3 | | 3 |
| IS 322 | Mobile Applications: Design, Interface, Implementation | 3 |
| IS 333 | Social Network Analysis | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| IS 392 | Web Mining and Information Retrieval | 3 |
| Physical Education II | | 1 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| General Elective 4 | | 3 |
| IE 492<br>or ENTR 410 | Engineering Management<br>or New Venture Management | 3 |
| IS 421 | Advanced Web Applications | 3 |
| IT 310 | E-commerce Technology | 3 |
| Upper-LIT/HIST/PHIL/STS Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| General Elective 5 | | 3 |
| General Elective 6 | | 3 |
| HSS Capstone | | 3 |
| IS 491 | Senior Project | 3 |
| IS 465 | Advanced Information Systems | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

[1] **Math:** MATH 111 Calculus I and MATH 333 Probability and Statistics are highly recommended to replace MATH 138 General Calculus I and MATH 105 Elementary Probability and Statistics, particularly for students contemplating advanced or graduate work in computing. These students also are encouraged to take MATH 112 Calculus II and one or more advanced statistics courses as free electives, such as MATH 341 Statistical Methods II or MATH 344 Regression Analysis, both of which require MATH 333 Probability and Statistics as a prerequisite.

## Curriculum Overview

| | | |
|---|---|---|
| **Core Web Courses** | | |
| IS 117 | Introduction to Website Development | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 219 | Adv Website Development | 3 |
| IS 373 | Content Management Systems | 3 |
| IS 322 | Mobile Applications: Design, Interface, Implementation | 3 |
| IS 392 | Web Mining and Information Retrieval | 3 |
| IS 421 | Advanced Web Applications | 3 |
| IS 333 | Social Network Analysis | 3 |
| **Core Information Systems Courses** | | |
| IS 265 | Introduction to Information Systems | 3 |
| IT 310 | E-commerce Technology | 3 |

| | | |
|---|---|---|
| IS 247 | Designing the User Experience | 3 |
| IS 344 | Computing Applications in Business | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| IS 448 | Usability & Measuring UX | 3 |
| IS 465 | Advanced Information Systems | 3 |
| IE 492 | Engineering Management | 3 |
| or ENTR 410 | New Venture Management | |
| IS 491 | Senior Project | 3 |
| **Technical Foundation Courses** | | |
| CS 100 | Roadmap to Computing | 3 |
| CS 113 | Introduction to Computer Science | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| IT 114 | Advanced Programming for Information Technology | 3 |
| or CS 114 | Introduction to Computer Science II | |
| **Career Building Courses** | | |
| CS 107 | Computing as a Career | 1 |
| CS 207 | Computing and Effective Communication | 1 |
| CS 407 | Professional Development in Computing | 1 |

## Electives

BS WIS majors are encouraged to take technical electives within the College of Computing Sciences, as well as web-related graphics and communications electives offered by Humanities (COM and ENG) and the School of Architecture. Students can also use 5-6 electives to pursue a minor within or outside the College of Computing Sciences.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Design of the User Experience Minor

| | | |
|---|---|---|
| IS 247 | Designing the User Experience | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| IS 448 | Usability & Measuring UX | 3 |
| R830 304 | Cognitive Processes | 3 |
| R830 372 | Perception | 3 |
| **Total Credits** | | **15** |

*Prerequisite: Computing GUR*

Students must take R830 101 Principles Of Psychology I or STS 210 General Psychology as their Social Science GUR; Current BA IS, BS BIS and BS WIS majors should substitute two BS HCI specialization courses listed in the catalog for IS 247 Designing the User Experience and IS 375 Discovering User Needs to Enhance User eXperience.

Students outside CCS may substitute one course for a IS, CS or IT course approved by the IS Undergraduate Advisor.

# Business and Information Systems Minor (not for Computing Sciences majors)

| | | |
|---|---|---|
| Prerequisite | Computing GUR | |
| IS 265 | Introduction to Information Systems | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| IS 344 | Computing Applications in Business | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |

| | | |
|---|---|---|
| IS 455 | IS Mgmt & Business Processes | 3 |
| **Total Credits** | | **15** |

# Business and Information Systems Minor (for Computing Sciences Majors)

| | | |
|---|---|---|
| IS 265 | Introduction to Information Systems | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| IS 344 | Computing Applications in Business | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| IS 455 | IS Mgmt & Business Processes | 3 |
| **Total Credits** | | **15** |

# Mobile and Web Minor

| | | |
|---|---|---|
| IS 117 | Introduction to Website Development [1] | 3 |
| IS 219 | Adv Website Development [2] | 3 |
| IS 322 | Mobile Applications: Design, Interface, Implementation | 3 |
| Select two - four of the following: | | 6 |
| IS 218 | Building Web Applications [1] | |
| IS 373 | Content Management Systems | |
| IS 392 | Web Mining and Information Retrieval | |
| IS 421 | Advanced Web Applications | |
| **Total Credits** | | **15** |

1 Not for BA IS, BS BIS and BS HCI majors.

2 Not for BA IS majors.

# Information Technology

Information Technology (IT) is the "practitioner focused" discipline within the field of computing. The BSIT degree program, the applied computing degree at NJIT, provides a balanced approach to software and hardware applications and their conceptual underpinnings. Moreover, the program offers an array of specializations that prepare students to enter various areas of the information economy. IT courses are taught by faculty and industry professionals having years of IT experience. Students benefit from a hands-on approach that provides them with a real grasp of the actual technology, development tools, and paradigms in demand in the IT industry.

The four years of the program have been carefully structured to meet the following goals:

| | |
|---|---|
| Year 1 | Breadth and depth of information technology |
| Year 2 | Tools and applications of information technology |
| Year 3 | Software and hardware infrastructure of information technology |
| Year 4 | Management and synthesis of information technology |

All Information Technology majors are required to prepare a Program of Study Form, an approved copy of which must be on file with the Academic Advisor. The form should be prepared as early as possible in the student's career, and changes can be made in consultation with the advisor.

*The curriculum is for freshmen entering NJIT in fall 2009. Students entering before that date may have a different program and should consult their Academic Advisor to learn which curriculum applies.*

## Information Technology Specializations

Students can choose from a partial or full array of specializations, each consisting of 9 courses. The specialization provides coherent set of courses, focusing on an application area of Information Technology relevant to the student's interest.

### Criminal Justice and Law Specialization

The IT specialization in Criminal Justice and Law offers students the opportunity to study different aspects of criminal justice. Students take core courses in conjunction with Rutgers-Newark School of Criminal Justice and study the origins of both digital and traditional crime. Students will learn how new technologies can be implemented to investigate and prevent crimes. Skills learned in this specialization can lead to careers in law enforcement, forensics, or future study in law school.

### Management Information Systems Specialization

Choose 9 (27 credits) from the following:The IT specialization in Management focuses on the design of information systems that improve business effectiveness. Students will be exposed to current technologies and their impact on organizations, and examine issues that will need to be addressed in the current and future technologically-oriented economy, both nationally and internationally.

### Game Development Specialization

The Game Development specialization is designed to give students a command of programming in C and C++ as well as other scripting languages (such as Unreal Script, XML, Lua and Python are commonly used in game development) associated with game development. The students will learn how the system architecture for games is designed with various considerations in mind such as the target platform and 2D or 3D graphics. Students will learn how to design and create their own game engines as well as how to program the game logic that uses those engines. Upon graduation, a student from the Game Development specialization will have completed both game modification projects and a number of games they have programmed from scratch and implemented on multiple platforms.

### Multimedia Specialization

The IT specialization in Multimedia offers students significant opportunities to build on fundamental principles of computer-aided graphic design, audio and video production as they are used in streaming media, web-based commerce, entertainment, education and public information services.

### Network and Information Security Specialization

Network Security is a high priority for computing professionals in business organizations, government agencies, the military, and any proprietary setting. Students choosing this specialization will come to understand the evolution of computer security; applied computer operations and security protocols; data transmission and storage protection methods via cryptography; ways of identifying, understanding and recovering from attacks against computer systems; methods of security breach prevention; network systems availability; applications security, recovery and business continuation procedures; and counter systems penetrations techniques.

### Web Applications Specialization

The IT specialization in Web Applications focuses on different aspects of the Information Systems lifecycle. Students will take courses in different areas of web and information systems including web design techniques and web application development. Students will learn how these technologies can be best utilized within organizations.

## NJIT Faculty

### D

Deek, Maura A., Senior University Lecturer

### H

Halper, Michael H., Professor

### K

Kettering, Joan M., Senior University Lecturer

### S

Senesy, Stanley J., Senior University Lecturer

Sequeira, Marc T., University Lecturer

Statica, Robert, Senior University Lecturer

### W

Watrous-deVersterre, Lori L., Senior University Lecturer

## Programs

- Information Technology - B.S. (p. 238)

## Accelerated Programs (p. 92)

- Information Technology - Accelerated B.S. and J.D. (p. 238) (with Seton Hall School of Law)

- Information Technology Minor (p. 244) (not for Computing Sciences majors)
- Information Technology Minor (p. 244) (for Computing Sciences majors)

## Information Technology Courses

**IT 101. Introduction to Information Technology. 3 credits, 3 contact hours (3;0;0).**
The foundations of information technology (IT), including basic computer architecture, various kinds of computer hardware, and networking technology, are introduced. Various data representation schemes, such as the binary number systems, are covered. Different levels of software are examined, including aspects of the operating systems from the perspective of the IT professional. The software development process is discussed. Database management software and SQL are dealt with, as are applications and languages developed around the internet and Web infrastructure. Overall, fundamental knowledge required of today's IT professional is obtained along with an appreciation of IT's impact on business and society. Hands-on experience with some important elements of the IT field is gained through various laboratory assignments.

**IT 114. Advanced Programming for Information Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites CS 113 or CS 115. Problem solving techniques and program design knowledge are expanded with an eye toward IT-related applications. Various kinds of data structures are introduced, including classic containers such as lists, stacks, queues, and trees. Sorting and searching techniques are examined. The fundamentals of client/server programming and the use of sockets are covered. Recursion and its various applications are studied. The built-in class library features of an object-oriented programming language are exploited throughout.

**IT 120. Introduction to Network Technology. 3 credits, 3 contact hours (3;0;0).**
An introduction to the basics of networking in a modern operating system environment. Emphasis is placed on the application and management of networking technology. Topics to be covered include: the OSI model, network hardware and technologies, network protocols, wired and wireless networks, TCP/IP. Whenever possible, concepts will be explained through the use of hands-on exercises that reinforce the lecture material.

**IT 201. Information Design Techniques. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 101. This course presents an introduction to the theory and practice of information design. Topics covered include the theoretical foundations of information design, graphic design, content design, interaction design, usability, multimedia design, sound and video, animation, and an introduction to 3D modeling.

**IT 202. Internet and Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 100 or CS 113 or CS 115 or a course in a high-level programming language as approved by department. This course presents the concepts and software technologies that underline web-oriented, three-tier software architectures and applications. The enabling software mechanism include the markup languages (HTML5 and CSS3) used by browsers, client-side scripting languages and libraries (Javascript and AJAX), web servers and server-side-scripting languages (Apache, PHP, HTTP protocol), and background databases (SQL, MySQL). The course uses a hands-on, guided development approach with substantial assignments to illustrate the fundamental computing concepts systems, and technologies considered and to provide direct experience in their use.

**IT 220. Wireless Networks. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 120. This course introduces the students to the applied topic of Wireless Networks, focusing on applied methods, tools and technologies, as well as practical experience in designing & implementing wireless networks. Topics include hardware, software, data, applications, communication, design & installation of wireless networks, together with the implementation, performance, security and limitations of such systems.

**IT 230. Computer and Network Security. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 120. This course introduces the applied topic of Computer Security, presenting the evolution of computer security, the main threats, attacks & mechanisms, applied computer operations & security protocols, main data transmission & storage protection methods via cryptography, ways of identifying, understanding & recovery from attacks against computer systems, various methods of security breach prevention, network systems availability, applications security, recovery & business continuation procedures and counter systems penetrations techniques and the role of the US Government in security of national computer infrastructure.

**IT 240. Scripting for System Administration. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 113 or CS 111 or CS 115. This course will introduce task automation using shell scripting in a multi-OS environment using the Shell and the Perl programming languages. Topics covered will include scripting commands, control structures, functions, scalar data and lists, regular expressions, hashing, automating administration functions and debugging. Lessons will be enhanced through the use of hands-on exercises to strengthen comprehension.

**IT 265. Game Architecture and Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201 or equivalent. Course introduces students to the core concepts and design methodologies integral to designing and developing games and other Entertainment Software.

**IT 266. Game Modification Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 102 or IT 114 or CS 116 or CS 114. This course introduces students to the basic concepts of game programming and development. Students will learn how to reprogram a professional game engine, or Modification (Mod) development as it is referred to in the industry. Students will work with C intensively. Students will work on their own game projects utilizing the professional game engine.

**IT 276. Game Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 265 and IT 266, or, CS 265 and CS 266. This course introduces students to the core concepts and skills necessary for the development of games utilizing 2D graphics. Students will learn how to set up and program their own 2D graphics based game engine. The engine will integrate 2D graphics, audio, input handling and network socket programming. Students will learn how to utilize their own custom 2D graphics and sounds into their projects. Once complete, students will have created two fully functional games.

**IT 286. Foundations of Game Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 202 and IT 265. This class introduces students to many of the tools and design methodologies needed for electronic game production. This class will focus heavily on scripting, level design and content control as applied to game development. Students will learn a few scripting languages that are used in the games industry such as Unreal Script and Python. Students will work on projects to develop the levels, controls and scripts in order to create a new game experience with a professional game.

**IT 287. Advanced Game Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 286 or COM 266. This course will build on tools and techniques presented in Foundations of Game Production and guide students through the development cycle of game levels. This will be a hands-on class that will teach students the development styles and revision techniques used in the professional game industry. Upon completion of the course, students will have first hand experience producing professional quality content for electronic games and a portfolio of work.

**IT 302. Advanced Internet Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 202 or IS 217. This course covers Internet-related software technologies in a more comprehensive, in-depth manner than IT 202. Topics considered include: client-side technologies like HTML5 and jQuery, JQuery UI (user interface) library, jQuery Mobile, CSS3 (transitions, animations), feature detection and polyfills using jQuery UI and Modernizr, advanced Javascript DOM and JSON (Javascript Object Notation), basic web services applications, JSONP. Advanced PHP topics considered include: sessions, cookies, HTTP exchanges, encryption, graphics library (CAPTCHA?s), and as time permits regular expressions and remote file access. An introduction to the Model-View-Controller (MVC) paradigm is presented using Ruby-on-Rails environment. Programming assignments are required which provide experience with the concepts covered.

**IT 303. Model View Controller Software Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 202 or instructor approval. The Model View Controller(MVC) software architecture or pattern separates the concerns of application or domain logic, interface design, and the view of the system presented to the user, with the objective of more effective design, development and testing. This course covers environments and frameworks for modeling, developing and programming Internet Applications with emphasis on the Model View Controller paradigm. Design and development, applicability of principles, integrated test-driven development applicability of major external libraries like JQuery and Prototype, deployment, scaling and security issues will be examined. Case studies will be used to illustrate the concepts and frameworks considered. A substantial development project will be required.

**IT 310. E-commerce Technology. 3 credits, 3 contact hours (3;0;0).**
An overview of the technologies relevant to electronic commerce. Communications and networking, web authoring tools, system security, databases and archiving, EDI, transaction processing, and factory/warehouse data networks. Provides competency to appraise tools such as HTTP servers, secure transaction software and firewalls, low and high-end database systems, heterogeneous networks, NNTP Servers, client software, procurement systems, and intelligent agents. Covers e-commerce models including agent-based and Java-based, electronic contracts and the electronic exchange of technical data, electronic cash systems and user security.

**IT 311. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Completion of the sophomore year, approval of the program coordinator, and permission of the Office of Cooperative Education and Internship. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**IT 320. Virtual Instrumentation. 3 credits, 3 contact hours (3;0;0).**
Cross-listed with OPSE 310. Prerequisite: CS 113 or CS 115. Covers the basics of virtual instrumentation including use of IEEE GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform such as National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisition and instrument control, instrument status, and acquisition speed.

**IT 330. Computer Forensic. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 230. This course introduces students to the applied topic of Computer Forensic, the study of obtaining and analyzing digital information from computers that have been used to commit illegal actions (computer crime), for use as evidence in civil, criminal, or administrative cases.

**IT 331. Privacy and Information Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Computing GUR. This course will introduce the legal, social and technical issues involving information privacy. Topics covered will include the historical development of information privacy law; law enforcement, technology and surveillance; government databases and records; privacy and business records and financial information; privacy and the media; health and genetic privacy and international privacy law.

**IT 332. Digital Crime. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Computing GUR. Comprehensive, multidisciplinary overview of the methods and means by which technology is used by the criminal in today's society. An examination of the historical, legal, technological and sociological aspects of cybercrime. The course covers the challenges of a new era of technology has brought to combating crime of all types, including terrorism. Topics covered will include: the sociology of the white collar criminal, the criminal justice system and law enforcement, computer security and deterrence/prevention.

**IT 335. Introduction to .NET Framework. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 202 or equivalent. This course introduces students to .NET Framework, a new computational environment that supports more than 25 programming languages and is platform and device independent. Problem solving and system development topics are integrated into the course by using C# languages as a vehicle to illustrate the concepts.

**IT 340. Introduction to System Administration. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 120. This course will introduce the tasks and techniques required to perform as a system administrator of Linux systems. Topics to be covered include: booting, process control, the file system, managing users and resources, backups, configuration management, networking, the network file system, email servers, security, hardware devices, interoperability and daemons. Whenever possible, lectures will be augmented with hands-on exercises.

**IT 360. Programming for Computer Graphics. 3 credits, 3 contact hours (3;0;0).**
Introduction to programming graphics and animation through the use of an appropriate application interface such as openGL. Topics include 2D and 3D graphics with mappings from the real world coordinates to graphics display. Perspective display will be provided by an interface. Basic vector and matrix operations which underlie the concepts of perspective will be covered.

**IT 380. Educational Software Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201. Educational Media Design employs the instructional principles of constructivist pedagogy as the process used to develop a solution to develope courseware for K-12 audience. The course builds on the participatory design model of software engineering in order to develop integrated learning environments that support visual and verbal literacy; enables student to be able to plan, organize, and systematically develop instructional materials. This course implements instructional design theory and pedagogy in order to create an actual application for a computer-based environment. Same as STS 318.

**IT 386. 3D Modeling and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201. This class introduces students to the concepts of 3D modeling and animation, and putting those concepts into action by working with software. This class will be a hands-on, project focused course, using 3D modeling packages, taking students from design to final render.

**IT 400. Information Technology and the Law. 3 credits, 3 contact hours (3;0;0).**
This course will provide an introduction to legal concepts, principles and terminology as applied to modern information technology. The historical background and foundations of the various principles of U.S. Statutory and Common Law will be considered and will be used to explore how such principles may be applied to encompass and govern modern legal interactions in the U.S. and internationally. Through assignments and class discussion, which will often involve the Socratic Method, students will be expected to spot potential legal issues and make logical arguments for and against various legal propositions.

**IT 411. Co-op Work Experience. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Completion of the sophomore year, approval of the program coordinator, and permission of the Office of Cooperative Education and Internship. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**IT 420. Computer Systems and Networks. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IT 120 and either CS 113 or CS 115. This course provides students with an understanding of methods, tools and technologies required to work with computer systems and networks. It includes a detailed discussion of Internet/intranet issues, including standards, connectivity, performance, protocols, network configurations, network design, wireless technology, management and simulation through practical cases, covering both hardware and software systems.

**IT 430. Ethical Hacking for System Administrators. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 340 or equivalent. This course will explore the various means that an intruder has available to gain access to computer resources. Traditional security analysis often falls short due to the rapidly evolving threats that exist. The course was developed to teach how system and network vulnerabilities are found and exploited and what steps can be taken to mitigate the risk.

**IT 485. Special Topics in Information Technology I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: junior standing and/or advisor approval. The study of new and/or advanced topics in an area of information technology and its application not regularly covered in any other IT course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. A student may register for no more than two semesters of special topics courses.

**IT 486. Special Topics in Information Technology II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: same as for IT 485. A continuation of IT 485.

**IT 488. Independent Study in Information Technology. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: open only to Information Technology majors who have the prior approval of the program director and the IT faculty who will guide the independent study taking the form of investigations, research, and reports on advanced topics in information technology. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the program director and the faculty mentor. A student may register for no more than one semester of independent study.

**IT 490. Systems Integration. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 420. The course will introduce the major design, implementation & distributed deployment issues regarding system integration, Network Operating Systems (NOS), cross platform database integration, e-commerce and e-business applications implementation, cross-servers & multiple locations e-sessions migration and the related communications security.

**IT 491. IT Capstone Project. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: senior standing. An opportunity for students to integrate the knowledge and skills gained in previous information technology work into a team research project. The project involves investigation of current literature as well as implementation of either a part of a large application or the whole of a small system.

# Accelerated B.S. in Information Technology and J.D.

| | | |
|---|---|---|
| **Core Courses** | | |
| IT 230 | Computer and Network Security | 3 |
| IT 310 | E-commerce Technology | 3 |
| IT 330 | Computer Forensic | 3 |
| IT 400 | Information Technology and the Law | 3 |
| LAW 6014 | Criminal Law | 3 |
| LAW 6005 | Contracts | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |
| **Track 2 Law - Year 1 Seton Hall University Law School** | | |
| LAW 6009 | Civil Procedures | 5 |
| LAW 6015 | Constitutional Law | 5 |
| LAW 6016 | Property | 5 |
| LAW 6005 | Contracts | 2 |
| LAW 6008 | Torts | 1 |
| **Area Electives** [1] | | |
| LAW 6003 | Legal Research & Writing | 1 |
| LAW 6004 | Legal Research & Writing II | 2 |
| LAW 6008 | Torts | 3 |
| **Total Credits** | | **45** |

[1] **Seton Hall University Law:** 6 cr. from 30 first year credits will count as 2 of the 3 required area electives.

# B.S. in Information Technology

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| IT 101 | Introduction to Information Technology | 3 |
| CS 100 | Roadmap to Computing | 3 |
| MATH 138 | General Calculus I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Select one of the following Science courses: | | 3 |
| Phys1/202 | | |
| Chem1 | | |
| Bio 1 | | |
| Geol 1 | | |
| CS 107 | Computing as a Career | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| IT 120 | Introduction to Network Technology | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Select one of the following Science courses: | | 3 |
| Phys2/203 | | |
| Chem 2 | | |
| Bio 2 | | |
| Geol 2 | | |
| Science Lab course | | 1 |

| | | |
|---|---|---|
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| IT 114 | Advanced Programming for Information Technology | 3 |
| IT 201 | Information Design Techniques | 3 |
| Social Science (lower-level):GUR Elective | | 3 |
| General Elective 1 | | 3 |
| English Compsotion and Cultural History (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| IT 202 | Internet and Applications | 3 |
| Specialization Course 1 | | 3 |
| Specialization Course 2 | | 3 |
| General Elective 2 | | 3 |
| Social Science (lower-level):GUR Elective | | 3 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| IS 331 | Database Design Management and Applications | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| MGMT 390<br>or IE 492 | Principles of Management<br>or Engineering Management | 3 |
| Specialization Course 3 | | 3 |
| Specialization Course 4 | | 3 |
| IT 340 | Introduction to System Administration | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| IT 420 | Computer Systems and Networks | 3 |
| ENG 352<br>or ENG 340 | Technical Writing<br>or Oral Presentations | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| Specialization Course 5 | | 3 |
| Specialization Course 6 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| IT 490 | Systems Integration | 3 |
| Humanities and Social Sciences (upper-level) Capstone Seminar GUR Elective | | 3 |
| General Elective 3 | | 3 |
| Specialization Course 7 | | 3 |
| General Elective 4 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| IT 491 | IT Capstone Project | 3 |
| Specialization Course 8 | | 3 |
| General Elective 5 | | 3 |
| General Elective 6 | | 3 |
| General Elective 7 | | 3 |

| | | |
|---|---|---|
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| | **Total Credits** | **129** |

## Electives

| | | |
|---|---|---|
| **Social Sciences (lower level) Electives GUR** | | |
| Select two of the following: | | 6 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Aproved introductory courses in basic social sciences at Rutgers-Newark | | |
| ENG 352 | Technical Writing [1] | 3 |
| or ENG 340 | Oral Presentations | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| HIST 2XX | Approved 200-level history course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level)** | | |
| Select one of the following 300-level courses: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following. Students in honors college enroll in HONORS section. | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Management GUR** | | |
| IE 492 | Engineering Management | 3 |
| or MGMT 390 | Principles of Management | |
| AS 333 | Leadership and Management I (acceptable only for students taking the aerospace option) | 3 |
| **Mathematics** [2] | | |
| Select one calculus course | | 3 |
| Select one course chosen in consultation with the IT Academic Advisor | | 3 |
| Select at least one probability and statistics course (included in the math GUR, as approved by advisor) | | 3 |
| **Natural Sciences** | | |
| Select two Natural Science courses [3] | | 7 |

1. IT students should select ENG 352 Technical Writing or ENG 340 Oral Presentations to fulfill the Open GUR requirement.
2. Depending on the specialization, a specific math sequence may be required.

[3] One of the courses must be a laboratory science, approved by advisor. Depending on the specialization, a specific natural science sequence may be required.

## Information Technology Electives

| | |
|---|---|
| **Information Technology Core** | |
| Select information technology/computer and information science courses that provide fundamental knowledge and practice in information technology functions, system development, and software. | 30 |
| **IT Capstone Project** | |
| Complete a culminating project [1] | |
| **Specialization Courses** | |
| Select nine courses, focusing on an application area relevant to Information Technology [2] | |
| **General Electives** | |
| Select a minimum of six courses to be chosen in consultation with the advisor | 18 |
| **CSS Electives** | |
| Select a coherent set of courses in conjunction with the declared specialization. [3] | |

[1] A culminating project experience that integrates the student's IT and specialization expertise. The IT Program strongly supports and encourages the student to implement this project in collaboration with NJIT industrial partners and/or NJIT's Enterprise Development Centers. In accordance with the need for the IT professional to have highly developed communication skills, the student will present the results of their projects at the completion of the project.

[2] Students may select specializations from all four NJIT colleges and schools. A list of possible specialization areas can be obtained from the Academic Advisor.

[3] They must be courses within the College of Computing Sciences and 300/400 level.

## Co-op

In IT, IT 311 Co-op Work Experience I and IT 411 Co-op Work Experience can be taken for degree credit.

## Criminal Justice and Law Specialization

(27 credits)

| | | |
|---|---|---|
| IT 220 | Wireless Networks | 3 |
| IT 230 | Computer and Network Security | 3 |
| IT 310 | E-commerce Technology | 3 |
| IT 330 | Computer Forensic | 3 |
| IT 400 | Information Technology and the Law | 3 |
| IT 430 | Ethical Hacking for System Administrators | 3 |
| Select three of the following: | | 9 |
| R202 203 | Police And Community | |
| R202 301 | Cj Reserach Methods | |
| R202 102 | Criminology | |
| R202 310 | Case Proc Law Courts | |
| R202 331 | Delinquency Juv Justice | |
| R202 202 | Gender Crime & Justice | |
| **Total Credits** | | **27** |

## Management Information Systems Specialization

(24 credits)

| | | |
|---|---|---|
| Select 8 of the following: | | 24 |
| ACCT 117 | Survey of Accounting | 3 |
| HRM 301 | Organizational Behavior | 3 |
| IS 265 | Introduction to Information Systems | 3 |
| or MIS 245 | Introduction to Management Information Systems | |
| IT 220 | Wireless Networks | 3 |

| | | |
|---|---|---|
| IT 302 | Advanced Internet Applications | 3 |
| IT 310 | E-commerce Technology | 3 |
| IS 344 | Computing Applications in Business | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| IS 455 | IS Mgmt & Business Processes | 3 |
| IS 465 | Advanced Information Systems | 3 |
| MIS 363 | Project Management for Managers | 3 |
| or MGMT 480 | Managing Technology and Innovation | |
| MRKT 330 | Principles of Marketing | 3 |
| OM 375 | Management Science | 3 |

## Game Development Specialization

(27 credits)

| | | |
|---|---|---|
| Select 9 of the following: | | 27 |
| IT 265 | Game Architecture and Design | |
| CS 266 | Game Modification Development | |
| or IT 266 | Game Modification Development | |
| CS 276 | 2D Game Development | |
| or IT 276 | Game Development | |
| AD 150 | Color and Composition | |
| STS 318 | Educational Media Design | |
| CS 280 | Programming Language Concepts | |
| IT 386 | 3D Modeling and Animation | |
| or COM 335 | 3-D Modeling and Animation | |
| MATH 337 | Linear Algebra | |
| COM 345 | Character Modeling and Animation | |
| IT 286 | Foundations of Game Production | |
| or COM 266 | Foundations of Game Production | |
| IT 4XX | Game Development Workshop | |
| CS 366 | 3D Game Development | |
| IT 287 | Advanced Game Production | |
| ARCH 434 | | |
| **Total Credits** | | **27** |

## Multimedia Specialization

(27 credits)

| | | |
|---|---|---|
| IS 270 | Designing the Multimedia Experience | 3 |
| COM 335 | 3-D Modeling and Animation | 3 |
| or IT 386 | 3D Modeling and Animation | |
| COM 350 | Digital Video Production | 3 |
| STS 347 | Introduction to Music | 3 |
| Select five of the following: | | 15 |
| STS 349 | Advanced Music Technology | |
| COM 266 | Foundations of Game Production | |
| or IT 286 | Foundations of Game Production | |
| COM 303 | Video Narrative | |
| COM 345 | Character Modeling and Animation | |
| COM 351 | Documentary Studies | |
| COM 352 | Photojournalism | |
| COM 369 | Digital Poetry | |
| COM 376 | Game Design Studio | |

| | | |
|---|---|---|
| IT 265 | Game Architecture and Design | |
| IT 266 | Game Modification Development | |
| or CS 266 | Game Modification Development | |
| IT 276 | Game Development | |
| or CS 276 | 2D Game Development | |
| ARCH 434 | | |
| CS 366 | 3D Game Development | |
| AD 150 | Color and Composition | |
| ENG 353 | Composing Documents for Print | |
| ENG 354 | Composing Documents for the Web | |
| ENG 355 | Television News Writing and Production | |
| IS 373 | Content Management Systems | |
| STS 318 | Educational Media Design | |

## Network and Information Security Specialization

(27 credits)

| | | |
|---|---|---|
| Select 9 of the following: | | 27 |
| IT 220 | Wireless Networks | |
| IT 230 | Computer and Network Security | |
| IT 310 | E-commerce Technology | |
| IT 330 | Computer Forensic | |
| IT 331 | Privacy and Information Technology | |
| IT 332 | Digital Crime | |
| IT 400 | Information Technology and the Law | |
| IT 430 | Ethical Hacking for System Administrators | |
| CS 332 | Principles of Operating Systems | |
| CS 357 | Fundamentals of Network Security | |
| CS 458 | Technologies-Network Security | |
| **Total Credits** | | **27** |

## Web Applications Specialization

(24 credits)

| | | |
|---|---|---|
| Select 8 of the following: | | 27 |
| IS 117 | Introduction to Website Development | 3 |
| IS 218 | Building Web Applications | 3 |
| IS 219 | Adv Website Development | 3 |
| IS 247 | Designing the User Experience | 3 |
| IS 322 | Mobile Applications: Design, Interface, Implementation | 3 |
| IS 373 | Content Management Systems | 3 |
| IS 375 | Discovering User Needs to Enhance User eXperience | 3 |
| IS 392 | Web Mining and Information Retrieval | 3 |
| or IS 421 | Advanced Web Applications | |
| IT 302 | Advanced Internet Applications | 3 |
| IT 310 | E-commerce Technology | 3 |
| MGMT 480 | Managing Technology and Innovation | 3 |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Information Technology Minor

(15 credits)

| | | |
|---|---|---|
| IT 114 | Advanced Programming for Information Technology | 3 |
| IT 120 | Introduction to Network Technology | 3 |
| IT 201 | Information Design Techniques | 3 |
| IT 310 | E-commerce Technology | 3 |
| Upper division course approved by the minor coordinator | | 3 |
| **Total Credits** | | **15** |

# Information Technology Minor (for Computing Sciences majors)

| | | |
|---|---|---|
| IT 120 | Introduction to Network Technology | 3 |
| IT 202 | Internet and Applications | 3 |
| IT 420 | Computer Systems and Networks | 3 |
| IT 490 | Systems Integration | 3 |
| Upper division IT course approved by the minor coordinator | | 3 |
| **Total Credits** | | **15** |

# College of Science and Liberal Arts

The mission of the College of Science and Liberal Arts (CSLA) is to address the complexities of modern life at the intersection of science, technology and human values, and to provide the intellectual foundations necessary to understand and analyze them. CSLA is dedicated to instruction that develops fundamental principles, informed and enriched by research that encourages innovation, enabling students to formulate significant questions, think analytically, offer creative solutions, and communicate them effectively.

CSLA faculty and students are at the forefront of many national research activities, from solar astronomy to mathematical modeling. CSLA provides students with skill sets for professional success that include literacy in the mathematical, physical and biological sciences as well as traditional liberal arts disciplines. CSLA partners with departments throughout the university to explore emerging frontiers and expand interdisciplinary initiatives in such areas as genomics, robotics, mathematical biology, nanotechnology and environmental science.

## Programs

- Applied Physics - B.S. (p. 422)
- BioChemistry - B.S. (p. 306)
- Biology - B.A. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba)
- Biology - B.S. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/bs)
- Biophysics - B.S. (p. 425)
- Chemistry - B.S. (p. 311)
- Communication and Media - B.A. (p. 367)
- Communication and Media - B.S. (p. 375)
- Environmental Science - B.S. (p. 312)
- History - B.A. (p. 327)
- Law, Technology and Culture - B.A. (p. 329)
- Mathematical Sciences - B.S.
  - with Applied Mathematics Concentration (p. 401)
  - with Applied Statistics Concentration (p. 403)
  - with Computational Mathematics Concentration (p. 408)
  - with Mathematical Biology Concentration (p. 410)
  - with Mathematics of Finance and Actuarial Science Concentration (p. 412)
- Science, Technology, & Society - B.S. (p. 384)
- Theatre Arts and Technology - B.A. (p. 372)

## **Accelerated Programs** (p. 92)

- Applied Physics - B.S./M.D. (p. 420)

- Biology - B.A. / M.D., D.M.D., D.D.S., O.D. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba-md-dmd-dds-od)
- Biology - B.A. / Physical Therapy Ph.D. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba-physical-therapy-phd)
- Biology - B.A. / Physician Assistant (p. 292)
- Chemistry - B.S. for Pre-Professional Students (p. 304)
- Communication and Media - B.S./ Medicine, Dentistry, Physical Therapy, and Optometry (p. 361)
- Communication and Media - B.A./J.D. (p. 370) (with Seton Hall School of Law)
- Communication and Media - B.S./J.D. (p. 358) (with Seton Hall School of Law)
- History - B.A. /D.P.T. (p. 323) (with RBHS)
- History - B.A./J.D. (p. 325) (with Seton Hall School of Law)
- History - B.A./M.D., D.M.D., D.D.S., O.D. (p. 325)
- Mathematical Sciences - B.S./M.D., D.M.D., D.D.S., O.D. (p. 399)
- Mathematics - B.S./M.D. (p. 398)
- Pre-Law - B.A./J.D. (p. 327) (with Seton Hall School of Law)
- Science, Technology & Society - B.S./J.D. (p. 381) (with Seton Hall School of Law)
- Science, Technology & Society - B.S./M.D., D.D.S., D.O. (p. 364)

## **Double Majors** (p. 92)

- Applied Mathematics and Applied Physics - B.S. (p. 405)
- Biology and Chemistry - B.S. (p. 295)
- Biology and Mathematical Sciences - B.S. (p. 406)
- Computer Science and Applied Mathematics - B.S. (p. 209)
- Computer Science and Applied Physics - B.S. (p. 207)
- Science, Technology & Society and Business and Information Systems - B.S. (p. 379)

- Applied Mathematics Minor (p. 402)
- Applied Physics Minor (http://physics.njit.edu/Minor.php)
- Applied Statistics Minor (p. 404)
- Biological Sciences Minor (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/biological-sciences-minor)
- Chemistry Minor (p. 315) (not for Chemical Engineering majors)
- Chemistry Minor (p. 476) (for Chemical Engineering majors)
- Communication Minor (p. 387)
- Computational Mathematics Minor (p. 409)
- Electronic Creative Writing Minor (p. 387)
- Environmental Science Policy Minor (p. 315)
- Environmental Studies Sustainability Minor (p. 427)
- Global Studies Minor (http://catalog.njit.edu/undergraduate/science-liberal-arts/humanities/global-studies-minor)
- History Minor (p. 342)
- Journalism Minor (p. 388)
- Leadership and Aerospace Studies Minor (p. 286)
- Legal Studies Minor (p. 342)
- Literature Minor (p. 388)
- Mathematical Biology Minor (p. 411)
- Mathematics of Finance and Actuarial Science Minor (p. 414)
- Philosophy and Applied Ethics Minor (p. 388)
- Science, Technology & Society Minor (http://humanities.njit.edu/academics/undergraduate)
- Technology, Gender and Diversity Minor (p. 388)
- Theatre Arts and Technology Minor (p. 388)

## Programs

- Applied Mathematics - M.S. (p. 784)
- Applied Physics - M.S. (p. 800)
- Applied Statistics - M.S. (p. 786)
- Biology - M.S. (p. 737)

## Programs



## College of Science and Liberal Arts Courses

**AS 111. Foundation of the US Air Force. 1 credit, 2 contact hours (2;0;0).**
Explores the mission and organizational structure of the United States Air Force. Introduces the student to Reserve Officer Training Corps by examining air power, customs and courtesies, officership, and core values. Examines Air Force opportunities, benefits, career choices, and installations which provides information needed to determine whether or not to pursue a career as an Air Force officer. An introduction to effective communication is included. One hour of class, and, two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 112. The Air Force Today II. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: AS 111 or approval of the professor of aerospace studies. Continues with the mission and organizational structure of the Air Force. A macro view of U.S. military history is introduced with emphasis on U.S. air power. Air Force communications is developed with emphasis on interpersonal communications, oral communications, and written communications. Leadership abilities are developed through group leadership problems and Leadership Laboratory. One hour of class and two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 221. Evolution of USAF Air and Space Power. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: AS 112 or approval of the professor of aerospace studies. Examines the development of air power from its earliest beginnings to the present, including in-depth examination of World War I, World War II, Korean Conflict, Vietnam War, Cold War, and Desert Storm. Traces the evolution of air power concepts and doctrine and continues to develop leadership abilities through Leadership Laboratory. One hour of class and two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 222. Air Power Key To Deterence. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: AS 221 or approval of the professor of aerospace studies. Emphasizes the concepts and skills required by the Air Force officer including oral communications, Air Force quality, leadership, followership, ethics, and values. Continues to develop leadership abilities through group leadership problems and Leadership Laboratory. One hour of class and two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 301. Aerospace Independent Study. 3 credits, 3 contact hours (0;0;3).**

**AS 333. Leadership and Management I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AS 222 or approval of the professor of aerospace studies. Emphasizes the concepts and skills required by the successful management and leader. Curriculum includes individual motivational and behavioral processes, leadership, communication, and group dynamics, providing the foundation for developing the junior officer's professional skills. Course material stresses decision making, and the use of analytic aids in planning, organizing, and controlling in a changing environment. Develops communication skills through writing and speaking exercises. Three hours of class and two hours of Leadership Laboratory per week. Note: AS 333 may be taken to satisfy the Management GUR.

**AS 334. Leadership and Management II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AS 333 or approval of the professor of aerospace studies. A continuation of AS 333. Organizational and personal ethics, management of change, organizational power, politics, and managerial strategy are discussed within the context of the military. Actual Air Force case studies are used throughout the course. Three hours of class and two hours of Leadership Laboratory per week.

**AS 335. Leadership Lab. 0 credits, 0 contact hours (0;0;0).**

**AS 336. POC Leadership Lab. 0 credits, 0 contact hours (0;0;0).**

**AS 401. Aeropsace Independent Study. 3 credits, 0 contact hours (0;0;0).**

**AS 443. National Security Affairs/Prep Act. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AS 334 or approval of the professor of aerospace studies. Focusing on the U.S. Armed Forces as an integral element of American society, this course examines a wide variety of topics concerning American civil and military relations and the environment in which U.S. defense policy is formulated. Specific topics include the role of the professional officer in a democratic society, socialization processes within the American military forces, and the requisites for maintaining adequate national security forces. A special emphasis is placed on further refining the student's communications skills in the context of the course material. Three hours of class and one and one-half hours of Leadership Laboratory per week.

**AS 444. Preparation for Active Duty. 3 credits, 0 contact hours (0;0;0).**
Prerequisite: AS 443 or approval of the professor of aerospace studies. Focuses on the role of the Air Force officer while on active duty. Includes responsibilities as an officer, a commander, a leader, and a manager. Topics include a review of military law, nonjudicial punishment, role of the staff judge advocate, laws of armed conflict, military ethics, officer professional development, an officer's social responsibilities, fraternization, personal finances, staff work, and Air Force base services and activities. Concludes with a review of the Air Force Core Values. Three hours of class and two hours of Leadership Laboratory per week.

**BIOL 200. Concepts in Biology. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 107, MATH 108 or equivalent. This course will introduce student to the study of biology at the beginning of their course of study. Central ideas in the biological sciences will be highlighted, with an emphasis on the process of scientific discovery and investigation. The course will provide the basis for more advanced coursework and learning experiences in the biological sciences as students delve into the curriculum of study.

**BIOL 205. Foundations of Biology: Ecology and Evolution Lecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BIOL 200 with a C or better, co-requisite BIOL 206. This introductory course considers the population level of biological organizations. Topics include Mendelian and population genetics, evolution, and ecology of populations and communities.

**BIOL 206. Foundations of Biology: Ecology and Evolution Lab. 1 credit, 3 contact hours (0;3;0).**
Prerequisite: BIOL 200 with a C or better, Co-requisite BIOL 205. The laboratory reinforces the topics covered in Foundations of Ecology and Evolution Lecture (Biol 205) lecture with hands-on activities and exposes students to current methods of research and analysis in these areas.

**BIOL 222. Evolution. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 101 and R120 102 and BIOL 205 and BIOL 206 with grade of C or better. This course will provide a comprehensive introduction to the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic basis of variation and heredity, natural selection, evolution and development, and speciation.

**BIOL 225. Insects and Human Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 101 and R120 102 (General Biology sequence). This course, through lecture and discussion, will cover the breadth of influence insects have on society, from the provision of ecosystem services to the economic and social costs associated with their role as vectors of disease. Student will learn how insects are used in science, agriculture and indicators of global climate change and water quality. Students will also learn some insect biology and have the opportunity to observe insects (living and dead) to gain a better understanding of the diversity and complexity of these creatures.

**BIOL 250. Biology of Neotropical Habitats: Ecuador and Galapagos Islands. 3 credits, 4 contact hours (2;2;0).**
This course is an introduction to tropical biology and evolution held in Ecuador's Highlands, Rain Forest, and in the Galapagos islands. The course uses a hands-on approach to study the flora and fauna of these unique habitats. The course also addresses the history, politics, and culture of Ecuador, with emphasis on how these issues influence the management and sustainability of Ecuadorian natural resources.

**BIOL 285. Comparative Vertebrate Anatomy. 4 credits, 4 contact hours (3;1;0).**
Prerequistes: R120:201 and 202 (Foundations of Biology: Cell and Molecular Biology); and BIOL 205 and BIOL 206 (Foundations of Biology: Ecology and Evolution), all with grades of C or better. This course introduces students to the groups of vertebrates and explores the anatomical evolution of vertebrates within the context of the functional interrelationships of organs and the changing environments to which vertebrates have adapted. An ideal entry point into the ways living creatures interact with their immediate physical world, we examine how the forms and activities of animals reflect the materials available to nature and consider rules for structural design under environmental forces.

**BIOL 310. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Departmental approval and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**BIOL 315. Principles of Neurobiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 and BIOL 205 and BIOL 206 with a grade of C or better. This course will review neuroscience concepts at a basic level. It will cover basics of cellular physiology, molecular biology and developmental biology of nerve cells, network physiology, behavior, cognition and memory and learning. This course will prepare students who are interested in a neuroscience sequence for their major.

**BIOL 320. Discovering Biological Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102, BIOL 201, BIOL 202, BIOL 205, BIOL 206 all with a grade of C or better. Success in the constantly evolving field of biology necessitates staying current in scientific literature. This requires competency in skills such as analysis of primary sources, synthesis of information from multiple sources, and oral and written communication skills. This course focuses on these competencies. Students will develop skills need to read and analyze scientific literature, and to communicate science. Each semester the content theme of the course will change depending on the expertise of the faculty member teaching the course.

**BIOL 321. Comparative Vertebrate. 4 credits, 4 contact hours (3;1;0).**
Prerequisites: R120 201, R120 202, BIOL 205 and BIOL 206, all with grades of C or better. This course introduces students to the groups of vertebrates and explores the anatomical evolution of vertebrates within the context of the functional interrelationships of organs and the changing environments to which vertebrates have adapted. An ideal entry point into the ways living creatures interact with their immediate physical world, we examine how the forms and activities of animals reflect the materials available to nature and consider rules for structural design under environmental forces.

**BIOL 337. Collective Intel in Biol Syst. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 202, BIOL 205 and BIOL 206 with a grade of C or better. This course will provide an overview of the fundamental principles underlying the organization of animal and human societies. It will include detailed consideration of behavioral, social, and physical processes that are responsible for the coordination of activities in large animal and human groups and social.

**BIOL 338. Ecology of the Dining Hall. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:R120 201 and R120 202 and BIOL 205 and BIOL 206 with a C or better. This course will use the examination of an on-campus ecosystem, the dining hall, as a framework for learning about a number of applied ecological concepts. We will investigate topics such as food webs, nutrient cycling, microbial ecology, and agroecology as they apply to the organisms and biological processes, present in our dining hall. Course work will involve extensive reading and discussion of scientific and popular literature, supplemented by regular class trips to the dining hall and related on-campus facilities.

**BIOL 340. Mammalian Physiology. 4 credits, 6 contact hours (3;3;0).**
Prerequisites: R120 201 and R120 202 and BIOL 205 and BIOL 206 with a grade of C or better. This course will review general principles of the function of the human body as a mammal, with emphasis on the function and regulation of neuromuscular, cardiovascular, respiratory, endocrine, digestive, and excretory systems. The goal is to provide students with the basic knowledge to understand how their own bodies operate.

**BIOL 341. Introduction to Neurophysiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 with a grade of C or better. This course will examine the physiology of neurons such as excitability, impulse conduction, synaptic communication and neural and synaptic plasticity. The objective is to provide students with a basic understanding of neural signaling and communication.

**BIOL 342. Developmental Biology (Embryology). 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 and BIOL 205 and BIOL 206. Descriptive and experimental approaches to molecular, cellular and organismal changes during embryonic development; mechanisms of cell differentiation, organogenesis, morphogenesis, and pattern formation.

**BIOL 344. Physiological Mechanisms. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 340 or R120 340 with a grade of C or better. This course will utilize clinical (pathological) case studies to reinforce physiologic knowledge and provide students a strong basis for future studies in biomedical and health related fields.

**BIOL 345. Comparative Physiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 340 or R120 340 or (R120 141 and R120 142) with grades of C or better. We will use a comparative approach to examine the physiology of animals including major physiological systems, with an emphasis on vertebrates. Topics to be covered include metabolic, temperature, osmotic and ionic regulation; respiration and circulatory transport, digestive, muscle, nervous, and locomotor systems; endocrine regulation and biological rhythms. We will further examine how physiological systems are integrated and thus allow animals to respond, physiologically, in different environment.

**BIOL 346. Neurobiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 and BIOL 205 and BIOL 206. This course will examine the basic principles that govern neuronal function, emphasizing cellular, developmental, and physiological aspects. The course begins with cellular properties of neurons and synaptic communication and will review the organization, function, development, and disorders of neural systems.

**BIOL 347. Lab Approaches in Neuroscience. 3 credits, 4 contact hours (1;3;0).**

**BIOL 350. Immunology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 201, R120 202, BIOL 205 and BIOL 206 all with a grade of C or better. The objective of this course is to facilitate an understanding of preliminary knowledge of the immune system in humans and other mammals. Students will be able to translate a basic understanding of the immune system and how that knowledge translates to further understanding medicine, research topics in cell biology, and broad topics in public health policy.

**BIOL 352. Genetics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Biol 200, or R120 201 or Biol 205/206 or R120, 102 or R120 201/202.

**BIOL 368. The Ecology and Evolution of Disease. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120:201, R120:202, BIOL 205, and BIOL 206, and (MATH 111 or MATH 238) with grade of C or better. This course addresses those aspects of ecology and evolutionary biology most relevant to understanding the origin, dynamics and treatment of disease (both infectious and hereditary/genetic). The class will be a mixture of lecture and discussion of case studies. Material covered will include biology, mathematical models, and some aspects of human behavior.

**BIOL 375. Conservation Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 201 and R120 202 and BIOL 205 and BIOL 206 with a grade of C or better. This course will provide a comprehensive introduction to the field of conservation biology, as well as philosophical and economic concerns.

**BIOL 383. Neural Basis of Behavior. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 02 and BIOL 205 and BIOL 206 with a grade of C or better. This lecture course explores the neural mechanisms underlying animal behavior. This course is intended for upper-level undergraduate students who have some background in biology, hence the prerequisite for Foundation of Biology. This courses would also be of interest to graduate students interested in neuroscience, such as, students in the Quantitative Neuroscience (QNS) program, students in the Integrative Neuroscience (INS) program, and students at the Center for Molecular and Behavioral Neuroscience (CMB). It is unnecessary for the students to have taken animal behavior or neurobiology; however, these courses would be helpful.

**BIOL 385. Evolution of Animal Behavior Laboratory. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: BIOL 205, BIOL 206, R120 201 and R120 202 with a grade of C or better. A lab course focusing on research in Animal Behavior. This course will cover foraging, predator avoidance, territoriality, and mate choice. Labs will be inquiry based with students designing experiments to test hypotheses concerning aspects of animal behavior.

**BIOL 398. Visualizing Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Junior standing. This course aims to explore points of intersection between art and Biology. We will first explore important concepts of Biology in a lecture format with readings, based on popular science. Teams of students will develop a product based on their bilogical driven interests and artistic toolkits. Regular individualized meetings will be held between the intructor and each team. A written essay on the creative process and scientific significance of the selected topic will accompany the creative work. A final showcase of the products will be held at the end of the semester.

**BIOL 400. Biology in Science Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: (R120 340 or BIOL 340 or R120 345) and (R120 355 or R120 356 or R120 352) with a grade of C or better. Popular science fiction media will be utilized to initiate thinking critically and creatively about the biological sciences; from the molecular level to whole organism physiology. Students will explore the potential biology of fictitious organisms, and determine real-life analogues. These topics will be used as a vehicle to improve scientific writing and to apply biological knowledge in a new and unique way.

**BIOL 410. Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: BIOL 310. Restriction: departmental approval and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic progam. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**BIOL 440. Cell Biology of Disease: Cells gone Bad!. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (BIOL 340 or R120 340) and (R120 355 or R120 356) with a grade of C or better. This course will briefly review the normal physiology of mammals and humans and will then extensively explore the basis of many human diseases at the cellular level. The goal is to understand how alterations in normal functions of cells affect the function of the whole system by reviewing current research in the field of cell biology abnormalities.

**BIOL 445. Endocrinology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:(BIOL 340 or R120 340)and (R120 355 or R120 356) with a grade of C or better. This course will discuss endocrinology from both an enatomical and physicologic view. We will discuss synthesis, distribution and regulation of the entire human endocrine system. The goal is to provide students with a basic knowledge of the complex endocrine system.

**BIOL 447. Systems Neurobiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 315 with a grade of C or better. This course will examine, from a systems perspective, phenomena that relate to neuronal network activity and behavior. Neuronal systems will be studied in detail. The overall goal of the course is to provide students with the basic knowledge of the neurobiological basis of behavior.

**BIOL 448. Neuropathophysiology: Nervous System Gone Bad!. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 315 or BIOL 340 or R120 340 or BIOL 341 or R120 444 or BIOL 447 with a grade of C or better. This course will briefly examine the normal physiology of the nervous system and then would extensively explore the basis of many neuronal diseases. The goal is to understand how any alteration in normal functions of the nervous system affects the function of the whole system by reviewing current research in the field of nervous system abnormalities.

**BIOL 451. Cell Physiology and Imaging. 4 credits, 4 contact hours (1;3;0).**
Prerequisites: PHYS 111, PHYS 121 and R120 455. This course will examine celluar phenomena, such as subcellular structure, secretion, intracellular calcium regulation, etc., from a physiological perspective and using imaging techniques as a tool to understand them. Cell biology, and optics and the user of microscopes, will be discussed in detail.

**BIOL 462. Comparative Biomechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 201, R120 202, BIOL 205 and BIOL 206 all with a C or better. This course takes a comprehensive look at the mechanical aspects of life. We will examine how the forms and activities of animals and plants reflect the materials available to nature, consider rules for fluid flow and structural design, and explore how organisms contend with environmental forces. Drawing on physics, we look at how animals swim and fly, modes of terrestrial locomotion, organism responses to winds and water currents, circulatory and suspension-feeding systems, the relationship between size and mechanical design, and the links between the properties of biological materials (eg spider silk, jellyfish jelly, and muscle) and their structural and functional roles.

**BIOL 475. Ecological Field Methods and Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 280 or R120 370 with a C or better and permission of instructor. This field-orientated class will study animal and plant communities using a combination of field, laboratory and theory work. The goal of this course is to understand ecological principles and to introduce students to modern methodology for field work, the techniques and instruments used, as well as the theoretical basis for their application. Students will collect data, analyze them and report the results in written and oral format.

**BIOL 491. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Departmental approval required. Research in Biology. Each student works under the supervision of a Biology or associated faculty member. A research paper and poster are required.

**BIOL 492. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Departmental approval required. Research in Biology. Each student works under the supervision of a Biology or associated faculty member.

**BIOL 495. Honors Seminar in Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BIOL 320 with a grade of C or better. The honors seminar allows students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. This course satisfies NJIT's Honors Capstone requirement.

**CHEM 105. Applied Chemical Principles. 4 credits, 5 contact hours (3;2;0).**
Prerequisite: high school algebra or equivalent. The fundamentals and relation of chemistry to living in today's society. Suitable laboratory experiments illustrate the course material. Not open to engineering or science students, or students who have completed a college level chemistry course.

**CHEM 108. College Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: a one-year college prep high school chemistry course, high school math including algebra and trigonometry. Delivered as a telecourse, the course provides the first of a two-semester sequence of college chemistry for high school students and other distance learners seeking college credit and/or preparation for the AP Examination. Matriculated undergraduates may not receive credit for this course.

**CHEM 109. College Chemistry II. 3 credits, 4 contact hours (3;1;0).**
Prerequisite: CHEM 108. A continuation of CHEM 108.

**CHEM 121. Fundamentals of Chemical Principles I. 3 credits, 3 contact hours (3;0;0).**
Introduces the basic concepts of chemistry, including chemical reactions, and bonding, electronic and molecular structure, gases and thermochemistry.

**CHEM 122. Fundamentals of Chemical Principles II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Chem 121 with a grade C or better. Continuation of the Chem 121 sequence. Introduces the basic concepts of chemistry, including equilibrium, chemical kinetics, thermodynamics, electrochemistry, and nuclear chemistry.

**CHEM 124. General Chemistry Laboratory. 1 credit, 3 contact hours (0;3;0).**
Corequisite: CHEM 122 or CHEM 123 or CHEM 126 with a grade of C or better. Chemical principles studied in the CHEM 125 and CHEM 126 or CHEM 121, CHEM 122 and CHEM 123 sequence are illustrated and reinforced by performance of laboratory experiments.

**CHEM 125. General Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Co-requisite Math 110, or Math 111, or Math 112 with a C or better. The first semester of a two-semester sequence in chemistry. Introduces the basic concepts of chemistry, including chemical reactions and bonding, electronic and molecular structure, gases and thermochemistry. Students majoring in chemistry or biochemistry should also register for lab Chem 125A.

**CHEM 125A. General Chemistry Lab I. 1 credit, 3 contact hours (0;3;0).**
General Chemistry Lab I is a laboratory course; it is designed to be taken currently with CHEM 125 or CHEM 121. Instructions are in the lab manual and concepts are from the text and lecture of the CHEM 125/121 courses. The experiments are designed to provide undergraduate students with practical experience and train students with laboratory techniques/equipment common to chemistry laboratories.

**CHEM 126. General Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Math 110 or higher and Chem 125 with a C or better The second semester of a two-semester sequence in chemistry. Introduces the basic concepts of chemistry, including equilibrium, chemical kinetics, thermodynamics, and electrochemistry. Students majoring in chemistry or biochemistry should also register for lab Chem126A; all others for lab Chem 124.

**CHEM 126A. Gen Chemistry Lab II. 1 credit, 3 contact hours (0;3;0).**

**CHEM 221. Analytical Chemical Methods. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 222 with grade of C or better. Laboratory introducing quantitative chemical analyses by gravimetry, titration, spectroscopy, chromatography, and potentiometry.

**CHEM 222. Analytical Chemistry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 123 or CHEM 126, CHEM 124 with grade of C or better. Lecture course introducing concepts of chemical analyses by gravimetry, titration, spectroscopy, chromatography, and potentiometry.

**CHEM 231. Physical Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 122 or CHEM 126, PHYS 111 with a grade of C or better. Corequisite: MATH 211. The topics covered include the properties of ideal and non-ideal gases and liquids, solutions, thermochemistry, thermodynamics, the phase rule, and phase equilibria.

**CHEM 235. Physical Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 231 with a grade of C or better. A continuation of CHEM 231. The topics include homogeneous and heterogeneous chemical equilibria, ionic equilibria, electrochemistry, kinetic theory of gases, transport phenomena, kinetics, and irreversible processes.

**CHEM 235A. Physical Chemistry II Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 221, CHEM 235 with a grade of C or better. Corequisite: MATH 225 (special section for chemical engineering and chemistry majors). Laboratory experiments apply and extend the basic knowledge of physical chemistry acquired in the lecture. Reports and presentations are an essential part of the course.

**CHEM 236. Physical Chemistry for Chemical Engineers. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: (CHEM 122 or CHEM 126)and CHEM 124 and (CHE 230 or CHE 232) with a grade C or better. This course will introduce the chemical engineering students to the concepts of order, disorder, chemical equilibrium and phase equilibrium. Credit for this course will not be given if credit for CHEM 235 has been given.

**CHEM 238. Analytical/Organic Chem Lab for Chemical Engineers. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 124 and CHEM 245 with a grade of C or better. This course will offer the CHE students experience in organic and analytical laboratory experiments. These experiments will reinforce concepts learned in the organic chemistry lecture classes. This laboratory course will also provide exposure to analytical and other techniques useful in the chemistry and chemical engineering laboratories.

**CHEM 243. Organic Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 123 or CHEM 126 with a grade of C or better. The preparation and properties of the various classes of organic compounds are discussed, with attention given to industrial sources such as coal and petroleum. Also covers the commercial utilization of these materials in the synthesis of useful products used in areas such as foods, cosmetics, textiles, plastics, and pharmaceuticals.

**CHEM 244. Organic Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 243 with a grade of C or better.

**CHEM 244A. Organic Chemistry II Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 124 with a grade C or better. Corequisite: CHEM 244. Synthesis and characterization of organic compounds are performed in a unique multi-scale manner: micro, macro and a kilo scale.

**CHEM 245. Organic Chemistry for Chemical Engineers. 4 credits, 5 contact hours (5;0;0).**
Prerequisite: CHEM 126 or CHEM 122 with a grade of C or better. This course is a one-semester course(opposed to classic two-semester sequence) to provide chemical engineering students with a basic understanding of organic compounds and their reactions.

**CHEM 246A. Organic Chemistry Laboratory. 4 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 244A with a grade of C or better. This course will cover some common reaction types that are not included in CHEM 244A. The experiments will be carried out in microscale. Students will learn new concepts in organic synthesis, including multi-step synthesis, organometallic reagents, and green chemistry for chemical synthesis, catalytic reactions, protecting groups, and peptide couplings. NMR and IR will be used for compound characterization.

**CHEM 301. Chemical Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: high school algebra and trigonometry or equivalent with a grade of C or better. Designed for engineering technology majors. Not open to students who have completed a college level chemistry course. Covers principles of chemistry, with a focus on chemical energetics and chemistry of materials. Suitable laboratory experiments illus-trate the course material.

**CHEM 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Cannot be used for degree credit.Note: Normal grading applies to this COOP Experience.

**CHEM 311. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CHE 310 with a grade C or better.

**CHEM 336. Physical Chemistry III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 235 with a grade of C or better. An introduction to quantum mechanics, statistical mechanics, spectroscopy, and solid state.

**CHEM 339. Analytical/Physical Chem Lab for Chemical Engineers. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: CHEM 245, or CHEM 236 with a grade of C or better. Co-requisite: MATH 225. This course will offer students an introduction to physical and analytical chemistry laboratory techniques. The application of principles learned in lecture will be reinforced by the experiments done in this lab. They will also provide exposure to analytical and other techniques used in chemistry and chemical engineering.

**CHEM 340. Chemistry and Engineering of Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: CHEM 235, CHEM 244 with a grade of C or better. Emphasizes processing/property relationships for a variety of engineering materials, including polymers, metals, ceramics, composites, semiconductors, optical fibers, and biomaterials. Introduces concepts of chemical structure, bonding and crystallinity. Covers important chemical, physical, electrical, and mechanical properties and corrosion and materials degradation. Also includes materials selection in the chemical process industries.

**CHEM 360. Environmental Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126 or CHEM 122 and CHEM 124 or CHEM 125A and CHEM 126A with a grade of C or better. Chemistry of the environment with emphasis on the atmosphere. Included are an introduction to the composition and chemistry of the natural and polluted atmosphere, thermodynamics and kinetics of atmospheric reactions, indoor and outdoor air pollution, air quality and its impact on human health, air quality regulations, and climate change. Examples of specific environmental issues covered in this course are the stratospheric ozone depletion, classical and photochemical smog, acid rain, and climate change.

**CHEM 361. Environmental Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 360 with a grade of C or better. Chemistry of the environment, including the hydrosphere and geosphere. Principles of physical, inorganic, and organic chemistry are applied to understand the origins of environmental pollutants, their transport, distribution, and decomposition pathways in water and soil environments.

**CHEM 391. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Junior standing in Chemistry. Provides an opportunity to work on a reserch project under the individual guidance of a member of the department.

**CHEM 412. Inorganic Chemistry. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: Prerequisite: CHEM 231 with a grade of C or better. A lecture-recitation-laboratory course in practical inorganic chemistry. Covers the chemistry of most of the elements and their compounds. Preparation in the laboratory is followed by purification and characterization.

**CHEM 437. Applications of Computational Chemistry and Molecular Modeling. 3 credits, 3 contact hours (3;0;0).**
This class introduces students to applications and fundamental aspects of computational chemistry and molecular modeling for application and understanding in organic, bio- or physical chemistry. It is an introductory course involving hands-on applications of computational chemistry and molecular modeling. The course provides training application and computer programs for students to use in determining fundamental thermochemical parameters, elementary reaction paths, and design of molecular structures to try and optimize and/or improve biochemical / pharmaceutical products or industrial chemical processes. Students will use chemical software packages to perform calculations in order to identify optimum interaction structures for pharmaceutical or industrial chemical systems. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium rations in chemical environments. The course is relevant to organic, inorganic, physical bio- and pharmaceutical chemistry. It is also relevant to optimization of chemical engineering processes.

**CHEM 473. Biochemistry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 244 or CHEM 245 with a grade of C or better. Covers the fundamentals of biochemistry including buffers, blood, proteins, enzymes, carbohydrates, fats, and nucleic acids. Emphasis on the relationship of biochemistry to biotechnology and medicine.

**CHEM 474. Biochemistry II. 3 credits, 3 contact hours (3;0;0).**
Biochemistry II will focus on transducing and storing energy, synthesizing the molecules of life, and responding to environmental changes. Topics include basic concepts of metabolism, glycolysis and gluconeogenesis, citric acid cycle, oxidative phosphorylation, photosynthesis, fatty acid metabolism, protein turnover and amino acid catabolism, biosynthesis of amino acids, DNA replication and recombination, RNA synthesis and processing, protein synthesis, control of gene expression, the immune system, and drug development.

**CHEM 475. Biochemistry Lab I. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: CHEM 244 or CHEM 473 with a grade of C or better. This course will offer the chemistry and related (chemical engineering, biology, bioinformatics, bioengineering)students fundamental laboratory approaches for biochemistry and biotechnology. These experiments will reinforce concepts learned in biochemistry lecture classes.

**CHEM 480. Instrumental Analysis. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 221, CHEM 222 or equivalent with a grade of C or better. Laboratory exploring the principles of operation of modern instruments for chemical analysis. Ultra-violet and infrared spectroscopy, mass spectrometry, gas chromatography, high performance liquid chromatography, voltametry, and potentiometry are among the instruments utilized. Apply calibration methods, statistical data treatment, and sample preparation techniques are applied.

**CHEM 490. Special Topics in Chemistry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: depends upon the nature of the course given. Course is offered in specific areas as interest develops.

**CHEM 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: senior standing in chemistry or chemical engineering. Provides an opportunity to work on a research project under the individual guidance of a member of the department.

**CHEM 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: CHEM 491 with a grade of C or better. A continuation of CHEM 491.

**COM 266. Foundations of Game Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Hum 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. IT 201 and IT 265, all with a grade of C or better. This class introduces students to many of the tools and production methodologies needed for electron games. This class will focus heavily on content control and story handling through the use of scripting and game development tools. Students will learn a few scripting languages that are used in the games industry, such as Unreal Script and LUA and use them to create a new game experience.

**COM 303. Video Narrative. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Introduces various multimedia resources and environments in order to develop new strategies for both reading and writing within a visually-based, screen-oriented culture. Students will study different historical and theoretical lineages in videography, and learn hands-on techniques and technologies to produce independent media works of their own.

**COM 310. Interpersonal Communication. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and one of the following: HUM 211, HUM 212, HUM 213 all with a grade of C or better. This course surveys theory and research related to interpersonal communication. The course focuses on effectively managing personal and professional relationships. The course's format consists of lectures, group discussions, experiential activities, and written assignments that require students' active involvement.

**COM 321. Technology & Tactics of Sound. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, one of the following: HUM 211, 212, HIST 213, 214 This course provides an introduction to sound and its manifold uses and functions in the digital era. The course offers students an effective primer in the science of how sound has been measured and understood historically as a media format.

**COM 325. Special Topics in Communication. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Varies according to topic. The study of new and/or advanced topics in an area of Communication, not regularly covered in any other Humanities course at the 300-level. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**COM 335. 3-D Modeling and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. IT 201 with a grade of C or better or permission of program advisor. This class introduces students to the concepts of 3D modeling and animation, and putting those concepts into action by working with software. This class will be a hands-on, project focused course, using 3D modeling packages, taking students from design to final render.

**COM 345. Character Modeling and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. COM 335 with a grade of C or better. This class builds on the concepts of 3D modeling and animation, applying those techniques to character creation and animation. This class focuses on the considerations and techniques involved in the creation and animation of character in 3D.

**COM 350. Digital Video Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Instruction in the creation and editing of non-linear digital video; emphasis on tream production of a short film; individual editing skills with Final Cut Pro editing software; development and editing of a variety of graphic formats and digital images; formulation of a script treatment; and development of a storyboard. Topics covered include: digital multi-media production; web-casting; interactive television; data-casting;CD and DVD production.

**COM 351. Documentary Studies. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This course will allow students to study the methods by which documentary work is conducted and to complete a documentary project of their own. The course will connect the qualitative methods of the social sciences and the humanistic concerns of the arts by allowing students to study documentary subjects as captured by non-fiction, photography, film, tape recorder, and the World Wide Web. Special emphasis will be placed on narrative and metaphor.

**COM 352. Photojournalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Through hands-on writing and photography supervised by the instructor, students develop competencies in discovering and creating an interdisciplinary viewpoint using a variety of writing methods and photographic viewpoints. Special focus on interpreting architecture and architectural detail, nature's conflict and place in urban and suburban environs, and the human interface with nature and man-made spaces. Particular emphasis is placed on the creative process and critical revision.

**COM 369. Digital Poetry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An investigation of activities taken up by poets who integrate computer technology in their works. Students discuss and evaluate virtues of the dynamics presented in an array of titles that include algorithmic programming, graphical artistry, videography, holography, hypermedia, and sonic design in order to build an understanding of the combined values of these disparate forms of expression.

**COM 376. Game Design Studio. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. COM 266, COM 335 and COM 345, all with a grade of C or better. This class challenges students to apply what they have learned in previous courses about game design. Students work in groups to design and create games for various platforms. Groups will work closely with the instructor to get constant feedback and criticism on their work. Students will complete case studies of various game genres. Students will work on one large project and complete it in stages, as a project would in the industry.

**COM 390. Electronic Writing Workshop. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A practice-oriented workshop for creative expression in a variety of electronic formats with the specific goal of facilitating individual writing projects for screen and performance. Topics in literary theory will be combined with current criticism in electronic writing, media and screen studies to produce new cultural works in a variety of digital sub-genres, including soundscapes, hypertext poetry, animation, code poems, interactive games, digital video and wiki poems.

**ENG 095. General Skills in English as a Second Language. 5 credits, 5 contact hours (5;0;0).**
Intended for students in need of extensive practice in speaking, listening, reading, and writing in English prior to enrolling in HSS 099S.

**ENG 101. College Composition I. 3 credits, 3 contact hours (3;0;0).**

**ENG 200. Communicating in Organizations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to understand the need for writing in an information-based corporate culture. Students write intensively in a variety of forms for a variety of audiences. Attention is given to editing, graphic design, communications ethics, and desktop publishing. At the conclusion of the course, students prepare a portfolio of their work.

**ENG 302. Communication Theory. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This course will introduce students to communication theory and practice. The course begins with a review of contemporary communication theory. After covering five selected theories--semiotic, visual, cultural, social, and reception--students will be required to apply a selected theory to a computer-mediated case study. Students will also be required to perform a collaborative field study. Through the course, students will be expected to read critically, to research peer-reviewed sources thoroughly, to present effective oral briefings, and to write analytic reports.

**ENG 333. Cybertext. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Through theoretical readings and electronic research, students explore and compare information structuring in print and digital media, particularly how digital technology influences the dynamics of text. Interactivity, visual communication and developments in the realm of cybernetics are addressed in the course. Materials presented in creative, technical and commercial areas were studied.

**ENG 336. Advanced Composition. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Involves composing in-depth, persuasive research essays designed to address the aims of discourse (expressive, referential, literary, and persuasive), using current media tools (text, graphics, audio, animaation and video) and venues (print and electronic), in several iterations.

**ENG 339. Practical Journalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A descriptive and analytic survey of news systems. Assignments include practice in writing straight news items, sports writing, feature writing, science writing, interviewing, and editing?with emphasis on understanding methods. The survey of printed and broadcast news systems includes the influence of technological, economic, legal, ethical, and historical factors.

**ENG 340. Oral Presentations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Instruction and practice in effective oral presentations. Students deliver a wide range of presentations adapted to the needs of a variety of audiences. Topics include voice and diction, presentation skills, the effective use of visual aids, reporting technical mate-rial and audience analysis.

**ENG 346. Journalism in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores how the media - defined as print as well as electronic media (television, radio and online modes of communication)have influenced different events and social movements at various points in time. Topics will include the role of William Randolph Hearst's newspapers in creating support for the Spanish-American War; press coverage of the women's suffrage movement; the role of television in ending the Vietnam war.

**ENG 347. Technical, Professional and Scientific Writing for Publication. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. The purpose of this course is to acquaint students with samples from significant technical, professional and scientific writing, sharpen skills in identifying theses and the major supporting elements in these works, while making judgments on their contributions. In addition, students will be required to demonstrate their ability to do the necessary research to integrate related sources other than the assigned texts.

**ENG 348. Literary Journalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Students will read and analyze the works of literary journalists from the 18th century to the present day. Close reading and analytical writing as well as some journalistic writing.

**ENG 349. Advanced Journalism Skills. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Through hands-on writing and reporting supervised by the instructor, students learn competencies needed in various journalistic specialties. Special focus on how to cover science and technology, social issues, culture and the arts, sports, business and consumer news. Particular emphasis on copy-editing.

**ENG 350. The Newsroom. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This is an advanced journalism course. Students will work closely with the instructor in order to write news and feature stories, commentaries and critiques, and will be encouraged to publish their work in The Vector and other publications.

**ENG 351. Online Journalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A study of how news is covered on the World Wide Web, and the impact of online news on society and politics. History of news online. Differences between print, broadcast and online-what are the strengths and weaknesses inherent to each medium? Analysis of the websites of different news organizations-from the New York Times to CNN to special interest e-zines to blogs.

**ENG 352. Technical Writing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An advanced writing course. Combines current theory with actual practice to prepare students as technical writers. Analyze complex communication situations and design appropriate responses through tasks that involve problem solving, rhetorical theory, document design, oral presentations, writing teams, audience awareness, ethical considerations, and gender equity issues.

**ENG 353. Composing Documents for Print. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores information structuring via print and digital media; how computer technology has influenced the ways in which information is presented in modern culture. Focuses on the optimal ways to prepare and present information for technical and commercial use. Important concepts such as visual literacy and effective design are discussed and addressed.

**ENG 354. Composing Documents for the Web. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Seminar and laboratory-based course designed for BA/BS majors; open to others with appropriate backgrounds and interests and permission of instructor. Follow up of ENG 353, explores information structuring via digital media, and how computer technology has influenced the ways in which information is presented in contemporary culture. Through guided interactive research, presents information for technical, commercial, and artistic use. Projects involve use of HTML editors, NJIT networks, and graphical and animation software.

**ENG 355. Television News Writing and Production. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This course consists of lectures and hands-on practice with the basics of television news writing and production and a field trip to a television station. After learning the fundamentals, the class will then begin its own news production by refining the video taped "packages" and integrating them into a studio newscast they will write and produce while guided by the instructor and with technical support from the staff of Instructional Technology and Media Services. The semester culminates in a final program that can be delivered to the campus community through ITMS's cable network.

**ENG 364. Theory of Rhetoric. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines theories of rhetoric from ancient to contemporary times. Special attention is paid to Aristotle, Peter Ramus, James Kinneavy, Walter Ong, and -Jurgen Habermas. Focuses on the ways in which theories inform the practice of communication. In the course project, students design and conduct field research based on rhetorical theory.

**ENG 369. Creative Writing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Focuses on the complexities of creating literary texts. Analyzes student writing in genres such as fiction, creative non-fiction, poetry, and drama. Considers these genres from theoretical perspectives. Topics include character development, plot, dia-logue; meter, rhyme, figurative language; audience analysis, ethos, and narrative theory. Students write, edit and critique their own work with the aim of publication.

**ENG 490. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**ENG 491. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**ENG 496. Senior Project-Communication and Media. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Intended for Communication and Media majors only. For professional and technical communication majors only. Provides students with a capstone experience. Offers PTC students the opportunity to enhance their understanding of communication through their integration of skills and knowledge gained in prior courses. The resultant research thesis or field project, of substantial length and originality, represents the culmination of the undergraduate disciplinary experience. Utilizing both a seminar and workshop approach, entails intense and sustained collaboration between student and instructor, and cooperation among students.

**EPS 202. Society, Technology, and the Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101. Uses case studies to examine the relationships between the creation and use of technologies, the human and natural environment, and the development of social and cultural institutions. Its central theme is the manner in which human society structures the environment in which it lives: nature and culture, city and country, civilization and development. This course satisfies 3 credits of the Basic Social Sciences GUR. Honors Note: See HSS 101.

**EPS 312. Technology and Policy in Contemporary America. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, HIST 213 or their equivalents. A study of technology and politics in recent America. Focuses on the role of the federal government in shaping technology, especially through funding technological innovations and applications. Topics will include the origins of technology policy in World War II, the influence of the Cold War, the science and technology policy advisory system, and political and cultural influences on technology policy. Honors Note: See HSS 101.

**EPS 313. Environmental History and Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, HIST 213 or their equivalents. Covers the rise of the modern environmental debate, and examines its current priorities and values, politics and economics, and impacts on industry and society. Students review the role of regulatory agencies, private industry, public interest groups, and the media. Current major issues in New Jersey are considered, as well as environmental debate on a national and global level. Honors Note: See HSS 101.

**EPS 360. Ethics and the Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, HIST 213 or their equivalents. An examination of contemporary environmental problems from the perspective of ethics or moral philosophy. An analysis of the ethical presuppositions and value principles underlying environmental policy. The study of ethical theories and their application to the environmental crisis. Honors Note: See HSS 101.

**EPS 362. Environmental Economics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101, HSS 202, SS 201 or their equivalents. Presents a detailed overview of the relationship between political economy and the environment. Draws on diverse case studies including global warming, harvesting of minerals on the ocean's floor, destruction of old growth forests, and contamination of the -nation's water, air, and soils. Explores the economic remedies to the fast-changing relationship between society and nature. Honors Note: See HSS 101.

**EPS 380. Policy Issues in the Coastal Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, HIST 213 or their equivalents. An examination of coastal environments from the standpoint of the scientist, the engineer, and the resource manager. Topics include beach and shoreline characteristics, technological innovations to address coastal erosion problems, and current debates in coastal policy and resource management. Case studies are used to illustrate coastal management practices and the scientific, technical, and social constraint to policy formulation.

**EPS 381. Field Techniques and Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, Hist 213 or their equivalents.; STS 307. An introduction to research methods. The objectives of the course are to provide opportunity to pursue specialized, in-depth research in a subfield of science, technology and society of the student's choice; to develop skills in problem identification, research design and problem solving; to increase familiarity with methods of data analysis; to strengthen library research skills; to provide an opportunity to gather original field data in a team-oriented environment; and to improve oral and written communication skills.

**ESTS 298. Teaching in Urban Schools. 3 credits, 3 contact hours (3;0;0).**
Restriction: Intended for students in Teaching Certificate program or by permission of the STS Director. This course introduces students to critical issues of teaching in urban schools. Readings and seminar discussions will focus on: the urban setting, children's lives in the inner city, urban schools, teachers' experiences in urban schools, the classroom, the curriculum, culturally responsive pedagogy, special education in the urban context, bilingual education, immigrant children in American schools, and Newark as an example of some of the topics studied in the course.

**ESTS 337. Obstacle to Understanding Science and Technology. 3 credits, 3 contact hours (3;0;0).**
Restriction: Intended for students in Teaching Certificate program or by permission of the STS Director. This course examines the scientific disciplines typically taught to primary and secondary school children as part of standards-based education in America. It seeks to identify those factual inaccuracies, misconceptions, and other incorrect notions held by students-up-to and through college. Methods for identifying and overcoming incorrect notions will be presented.

**ESTS 338. Paradigm Shifts in Science, Technology and Society. 3 credits, 3 contact hours (3;0;0).**
Restriction: Intended for students in Teaching Certificate program or by permission of the STS Director. This course examines how to approach, discuss and debate controversial issues in science and technology in order to facilitate civil discourse and policy-formation in a democratic society. Various types of controversies will be addressed illustrating various aspects of debate and discourse needed to arrive at compromise, understanding, and consensus. Students will learn how to moderate group discussion dealing with current science and technology issues facing society and learn to moderate discussions for themselves and for others.

**ESTS 386. Methods of Teaching. 3 credits, 3 contact hours (3;0;0).**
Restriction: Intended for students in Teaching Certificate program or by permission of the STS Director. This course investigates the principles of scientific literacy for the general public and how it can be achieved. Particular attention is paid to identifying a personal pedagogy, method of teaching, and how this can be capitalized upon to assist others to become more scientifically literate and aware.

**ESTS 388. Curriculum and Instruction for Secondary Schools. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R300 292 and ESTS 298 or R300 298. This course introduces curriculum, its development, and how it influences classroom practice. Guidance documents (national, state & local), tensions between the overt, covert and hidden curricula, use of resources to enact and augment the curriculum, the need for interdisciplinary instruction, differentiated instruction, special education, and the integration of assessment into curriculum planning and implementation are examined general and for each subject-matter discipline.

**ESTS 390. Understanding Educational Evaluation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R300 292 and STS 331 or R300 298, with a grade of C or better. This course examines educational evaluation-methods of data gathering, interpretations of data, as well as understanding and use of findings to inform and improve classroom practice. It provides knowledge and tools of evaluation to be proactive gatherers and users of data to plan and improve instruction. Students will define and understand various types of evaluations, how they are developed, administered, and analyzed, and their appropriate uses for the classroom.

**ESTS 410. ICT in Secondary Schools. 3 credits, 3 contact hours (3;0;0).**
Restriction: Intended for students in Teaching Certificate program or by permission of the STS Director. This course examines the integration of Information and Communication Technology (ICT) into instruction to foster community, collaboration, conceptual development, and exceptional academic performance. The course pays particular attention to present and potential access and academic uses of ICT in under-resourced urban schools with racially, ethnically, and linguistically diverse students whose families tend not to be participants in the US society's culture of power.

**EVSC 125. Fundamentals of Environmental Sciences. 3 credits, 3 contact hours (3;0;0).**
An introductory course that will present freshman EVSC students with general concepts and topics on Environment, including chemistry, ecosystems, geological and soil resources, water quality, agricultural and Environment, atmosphere, noise and ionizing radiation.

**EVSC 325. Energy and Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 125 with a grade C or better and PHYS 111 with grade C or better. An advanced course to instruct EVSC students, topics on energy and environmental issues such as introduction to energy, natural energy conservation, environmental issues of energy production and consumption, regulation and legislation related to energy, public policy development in energy and environment.

**EVSC 335. Environmental Law. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 with a grade of C or better. The prerequisite is a college ability to communicate competently in the English language including the ability to research and prepare essay compositions and to articulate the major points in a presentation format. The introduction to Environmental Law will cover the regulatory system developed over time that has forged a complex system of environmental rules influencing industrial and other private and public actions that impact the environment. The course will review these rules from the vantage point of the practicing technical environmental engineer and scientist. Students will become familiar with the background and derivation of these laws as well as the major operational features such as environmental permits and enforcement. Several major environmental cases will be analyzed that give definition to the key features of these laws. Each class module will direct itself to the practical application of these laws.

**EVSC 375. Environmental Biology. 3 credits, 3 contact hours (3;0;0).**
An introductory ecological approach to understanding man's impact and dependence on the natural environment. Broad topics include ecosystems, nutrient cycles, pollution, pest management, conservation of natural resources, energy, and human population.

**EVSC 381. Geomorphology. 3 credits, 3 contact hours (3;0;0).**
This is a course in geomorphology, the study of landforms and the contemporary processes that create and modify them. The course will emphasize earth surface processes and quantitative analysis of landform change. Lectures will stress geomorphic principles and two field-based problems will enable students to apply these principles to contemporary geomorphic problems in engineering and management with a focus on the natural environment.

**EVSC 385. Environmental Microbiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 101 and R120 102 with minimum grade of C. The main goals of this course are to present an overview of the important microbes involved in environmental microbiology, to discuss the environments where they are found, to learn how they are detected and monitored, and to describe their effects on humans. Traditional lectures and exams will be supplemented with discussions of experimental design and data interpretation by reading current research articles.

**EVSC 391. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Provides an opportunity to work on a research project under the individual guidance of a member of the department.

**EVSC 416. Environmental Toxicology. 3 credits, 3 contact hours (3;0;0).**
The course is intended to explore the general principles of toxicology and apply them to the assessment of acute, subacute and chronic effects of hazardous and toxic chemicals. Qualitative and quantitative measures of toxicity and testing protocols are addressed. The role of toxicology in risk assessment and risk management is discussed.

**EVSC 484. Environmental Analysis. 3 credits, 4 contact hours (2;2;0).**
The analysis of environmental samples is studied from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis, and data treatment.

**HIST 2**. History Elective. 3 credits, 3 contact hours (3;0;0).**

**HIST 213. The Twentieth-Century World. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 and co-requisite HUM 102 with a grade C or better. Uses case studies to provide an interdisciplinary view of the 20th-century world. Selected literary, philosophical, and artistic movements are discussed in the context of the major historical developments of the century. This course satisfies three credits of the GUR in Cultural History.

**HIST 214. Tech & Cult in Amer History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101 with a grade of C or better, HUM 102 prerequisite or co-requisite with a grade of C or better. This course examines the relationship between technology and society throughout the history of the United States. We analyze the roles and impacts of major technological innovations within their cultural and historical contexts, seeking to understand how these contexts shaped and were shaped by these technologies.

**HIST 310. Co-op in Law, Technology, Culture and History I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Students gain work experience related to their major in Law, Technology and Culture. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report.

**HIST 311. Co-op in Law, Technology, Culture and History II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R 510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Students gain work experience related to their major in Law, Technology and Culture. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report.

**HIST 312. Prof Development in Law. 1 credit, 1 contact hour (1;0;0).**
Prerequisite : Sophomor standing. This course is designed to enhance professional development for students who hope to attend law school or another graduate program. It will provide students with the skills necessary to apply to, be accepted into, and succeed in law school or other graduate program. It will meet workshop-style for three hours for five weeks.

**HIST 334. Environmental History of North America. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 throughR510 299 or R512 200 through R 512 299 or their equivalents with a grade of C or better. The history of interactions between humans and their natural environment on the North American Continent. Considers perceptions of, use of, and alteration of the environment. Traces the cultural, intellectual, economic, political and technological transformations from early colonial times to the late 20th century. Addresses the diverse environmentalisms that have emerged the last several decades.

**HIST 341. The American Experience. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R 510 299 or R512 200 through R 512 299 or their equivalents with a grade of C or better. American history from the colonies to the 20th century, with concentration on several selected themes basic to an understanding of the changing cultural patterns and social values of American civilization.

**HIST 343. African-American History I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Introduction to African-American history from pre-colonial West Africa to emancipation in the mid-19th century. Topics include the African slave trade, the economics and politics of slavery, gender and culture in the slave community, and the free black experience in both the north and south.

**HIST 344. African-American History II. 3 credits, 3 contact hours (3;0;0).**
HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214, R510 200 through R510 299, R512 200 through R512 299 or their equivalents with a grade of C or better. Introduction to African-American history from the mid-19th century to the present. Covers race relations and the civil rights movement, as well as migration, black social and political thought, gender roles, and class formation.

**HIST 345. Communication through the Ages. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Modes of communication, ancient and modern, in their social and cultural context?from cave painting to computers. Topics include literacy and economic development in the West; the technological revolution in media beginning with Daguerre, Samuel Morse, and Alexander Graham Bell; the institutional development of mass media and popular culture; and contemporary trends in world communication and interaction.

**HIST 351. Ancient Greece and the Persian Empire. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R51 2 200 through R512 299 or their equivalents with a grade of C or better. The political, institutional, and cultural developments of Ancient Greece and the Persian Empire from the Mycenaean period to the King's Peace (386 B.C.).

**HIST 352. The Hellenistic States and the Roman Republic. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R5102299 or their equivalents with a grade of C or better. The political and cultural developments of the Hellenistic states and their influence on the Republic of Rome to 30 B.C.

**HIST 361. The Founding of the American Nation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. North America in the colonial and revolutionary periods, with emphasis on patterns of cultural and institutional development from early settlement through the ratification of the Constitution.

**HIST 362. Sex, Gender, and the Law in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines how the US legal system has dealt with the problems of sex and gender. Surveys laws that dictated different roles for men and women as well as seemingly gender-neutral laws that affected men and women differently. Tracks the designation of sexual acts as legal or illegal and the ways that race, class, and nationality complicated these relationships.

**HIST 363. The United States as a World Power. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. American domestic and foreign policy in the 20th century. Topics include imperialism, the Progressive Era, the Depression, the New Deal, World Wars I and II, the Cold War, America and the world today.

**HIST 364. American Law in the World. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Concerns the history of American law as a product and catalyst of world politics by considering in global context the transformation of central doctrines of regulation, property rights, and civil liberties from the Declaration of Independence through the War on Terror.

**HIST 365. Comparative Colonial History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. A comparative analysis of the relationship between expanding Western nations and selected regions of Africa, Asia, and South America, from 1500 to 1970. A case study approach illuminates key historical processes, with a special emphasis on economic development and cultural change in colonial settings. Topics include European perceptions of culturally different peoples, race relations in colonial societies, forms of rebellion and resistance to European rule, nationalist movements.

**HIST 366. Gender, Race and Identity in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Surveys the social construction of gender in America from the s17th century to the present. Examines the changing gender roles and relations that have characterized and structured the historical experiences of different racial and ethnic groups. In a multicultural framework, covers the impact that colonization, industrialization, slavery, immigration and migration, urbanization, war, and social movements have had on the ways that women and men think of themselves in terms of gender as well as their respective roles in families and larger social networks.

**HIST 367. International Law and Diplomacy in History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines the origins, evolution, and application of diplomacy and international law from the 15th century to the present. Topics include the rise of modern diplomacy in Renaissance Italy; the emergence of international law and professionalization of diplomacy in early modern Europe; the development of international law and diplomatic theory in the 18th and 19th centuries; the codification of international law; and adaptation of international law to transnationalism and globalism in the 20th century.

**HIST 369. Law and Society in History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Uses historical case studies to illustrate and evaluate various approaches to the study of law and society. Topics include criminality and the rise of incarceration as a legal penalty in the 19th century; the comparative law of slavery; and the evolution of American Indian law.

**HIST 370. Legal issues in the History of Media. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better.Investigates the development and impact of media law and policy in the United States. Examines how media law and policy affect media content, industry behavior, and consumer rights. Analyzes the values and ideas, as well as political and cultural contexts, that have guided continuities and transformations in media law and policy. Topics include indecency and obscenity, copyright and intellectual property, legal protections for children, and media ownership regulation.

**HIST 372. Contemporary Europe. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better. European society in the 20th century, Nationalism, imperialism, totalitarianism, movements toward European unity, and prominent cultural developments.

**HIST 373. The Rise of Modern Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines the development of modern science in the western world from the origins of the Scientific Revolution to 1900. Explores how science challenged the revealed universe of Christianity, changed the curriculum in schools and universities, and altered the world view of philosophers. This course covers the achievements of Copernicus, Galileo, Newton, Darwin, Einstein, and other leading scientific innovators, but it also weaves the expansion of scientific knowledge into the larger fabric of European intellectual history.

**HIST 374. Modern Russian Civilization. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Russia under the last tsars, the 1917 upheavals, rise of the Soviet state to world power under Lenin, Stalin, and others, until the collapse of the communist dictatorship.

**HIST 375. Legal Issues in Environmental History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better.Examines the role of law in the formation of human relationships with the natural world. The course will focus on the management and regulation of the human use of natural resources in a variety of historical contexts, but particularly in the United States from colonial times to the present. Through readings and class discussion, students will explore a number of recurring themes, including the transformation from customary rules governing access to local resources to state enforced laws.

**HIST 377. Cities in History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines social, cultural and economic changes in urban areas. Regions and themes vary and may include urbanization in Europe, the rise of cities in Latin America, and urban change in contemporary America.

**HIST 378. Medicine and Health Law in Modern America. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R520 299 or their equivalents with a grade of C or better. Examines the legal and ethical aspects of medical and public health practice in the United States from 1900 to the present. Topics include the rights and responsibilities of physicians and patients, the roles of government in promoting health, the rise of health law and bioethics, the tensions between civil liberties and public health, as well as evolving notions of harm, liability, uncertainty, and proof as they relate to the history of medical and public health practice.

**HIST 379. History of Medicine. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better.Focuses on the evolving institutions, values, concepts, and techniques through which doctors attempted to control the impact of disease and preserve the health of Americans, beginning with the shaman and colonial physician through post-World War II changes in the system of medical care.

**HIST 380. History of Public Health. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Attempts to protect the health of human populations from the Black Death in medieval Europe to recent threats from epidemics and chemical and biological terrorism. Shiftings patterns of disease and the emergence and growth of public health as a domain of expert knowledge and policy. Topics include: epidemiology and statistical modes of inquiry; the tension between civil liberties and public health; the economics of health and disease; and the relationship between medicine and public health.

**HIST 381. Germs Genes and Body: Sci. and Tech. in Modern Medicine. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines how science and technology came to play critical roles in the rise of modern medicine. Readings, lectures, and discussion focus on the specific innovations in ideas, practices, and technologies that helped transform Western medicine in the 19th and 20th centuries. The course also considers how medicine and the biomedical sciences both inform and reflect attitudes about the human body in Western society.

**HIST 382. War and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. The evolution of warfare and the impact of war on political, economic, cultural, and social institutions, including the two World Wars and post-1945 conflicts.

**HIST 383. The Making of Modern Thought. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. The formation of contemporary images of human nature since the mid-19th century. Emphasis on Marx, Darwin, and Freud and their legacy to 20th century thought. Theories of the family, sexuality, and the changing role of women in society are explored.

**HIST 384. Invention and Regulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: The 200 level cututral history GUR, understood as Hum 211, Hum 212, Hist 213 or Hist 214 or any Rutgers 200 level course in R510 or 512. This course examines how the law has affected technological development in the United States from its founding to today. We cover four broad technical categories: industrialization, transportation, communication, information technology.We analyze the invention of technology within issues of patent and copyright, funding and regulation of technology through legislation, and legal challenges to technology. Our goal is to understand change in law and technology in historical and cultural context.

**HIST 385. Technology and Society in European and World History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 99 or their equivalents with a grade of C or better. An introduction to the social history of European and global tech-nology from the Middle Ages to the second Industrial Revolution of the late 19th century. Emphasis on such themes as the process of tech-nological innovation, the nature of technological systems, the diffusion of technology, the interaction of Western and non-Western technology, the changing relations of science and technology, and the role of technology in broader historical movements.

**HIST 386. Technology in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Survey of the history of American technology emphasizing the social and economic environments of technological change. Topics include the transfer of technology in building canals and cities, the rise of the factory system, the emergence of the American system of manufacture, and the development of major technological systems such as the railroad, telegraph, electric light and power, and automobile production and use. Focus on the professionalization of engineering practice, the industrialization of invention, and the growing links between engineers and corporate capitalism in the 20th century.

**HIST 387. Computers, Innovators and Hist. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: Hum 101, Hum 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. This course traces the development of computer technology from its theoretical origins in the 19th century, through the transformation from analog to digital computers and the emergence of personal computing in the 20th century, up to the present. Topics include the place of computer technology in society, how computers & people shape each other, who & what was involved in innovating computers, the cultural context of such innovation, as well as how the uses and users of computers have evolved.

**HIST 388. Britain in the 20th Century. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214, R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Survey of British history from the death of Queen Victoria (1901) to that of Diana, Princess of Wales (1997); emphasis on Britain's social, cultural and political transformation. Topics include causes and impact of the World Wars, the turn from Empire to Europe, rise and critique of the welfare state, and foreign relations.

**HIST 390. Historical Problems of the 20th Century through Film. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. A study of selected problems in the 20th century using film as a window into history. Such topics as the rise of Nazi Germany, America in the thirties, World War II and American society, the development of cities, and the emergence of the Third World will be considered. In any one semester only two topics will be selected for study. The material for the course will include documentary films, newsreels, TV news films, and theatrical feature films as well as selected readings.

**HIST 391. Industrial Revolution in World. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or equivalents R510 200 through R 510 299 or R512 200 through R 512 299 or equivalents with a grade of C or better. This course covers the Industrial Revolution from its emergence in Britain in the 18th century to its expansion to America, Western Europe, and Japan. Topics include the practical need for new forms of power, links between invention, empire, the impact of technical advance on the labor force, colonialism and slavery, and 19th century socio-cultural change.

**HIST 401. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents with a grade of C or better in addition to a junior or senior standing; and before registering, permission from one of the following: NJIT history department chairperson, associate chairperson or history minor advisor. Pursuit of special interests in history not covered in a regular elective course. A history faculty member provides guidance and assigns readings and papers. Note: Normal grading applies to this COOP Experience.

**HIST 402. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents with a grade of C or better in addition to a junior or senior standing; and before registering, permission from one of the following: NJIT history department chairperson, associate chairperson or history minor advisor. Pursuit of special interests in history not covered in a regular elective course. A history faculty member provides guidance and assigns readings and papers. Note: Normal grading applies to this COOP Experience.

**HIST 489. Seminar-Readings. 3 credits, 3 contact hours (3;0;0).**
prerequisites: Completion of the GUR in English (3 credits), Cultural History (6 credits), Basic Social Sciences (6 credits) an upper level History course (3 credits) and senior standing. Intended to combine study of specific topics, which vary each year, with attention to the methods for researching and writing history, these small classes for history majors in their senior year prepare students for the following semester's research project and culminate in a brief paper describing a proposed topic and the historical documents and sources to be used.

**HIST 490. Seminar Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Completion of the GUR in English and Cultural History, R510:315 or R510:316 Perspectives in History, and HSS 404 History Senior Seminar. This one-semester-long seminar allows students to apply the skills they learn in the History major to specific topics that vary semester by semester. In these small classes, students conduct research with attention to historical methods. With close guidance from instructors, students explore local archives, design a paper topic of their individual interest in conjunction with the professor, and write a research paper.

**HSS 403. Humanities Senior Seminar - Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students are required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 404. Humanities Senior Seminar - History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Completion of either the LIT/HIST/PHIL/STS or Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students are required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 405. Humanities Senior Seminar - Philosophy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 406. Humanities Senior Seminar - English. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 407. Humanities Senior Seminar - Theater. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 408. Humanities Senior Seminar - Science, Technology, and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 409. Humanities Senior Seminar - Social Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Basic Social Sciences (6 credits) and either the Lit/Hist/Phil/STS (3 credits) or the Open Elective in Humanities and Social Science (3 credits). The remaining 300-level course may be taken as a co-requisite of the seminar. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 491. Honors Sem In Humanities. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The subjects are announced at the time of registration. Each seminar is limited to 16 students. These courses satisfy the Capstone Seminar in Humanities and Social Science Electives GUR for students enrolled in the honors college only.

**HUM 099. English Composition: Reading, Writing, Speaking I. 3 credits, 3 contact hours (3;0;0).**
Focuses on developing the reading and writing skills necessary for success in a college curriculum. Emphasizes structuring and organizing effective sentences and paragraphs; drafting and revising; preparing summaries; building vocabulary; developing grammatical fluency; formulating a thesis, and other steps toward writing expository essays. Mandatory writing workshops are held in conjunction with the course work.

**HUM 099S. English Composition: Reading, Writing, Speaking I. 6 credits, 6 contact hours (6;0;0).**
Prerequisites: None, unless placement test result requires ENG 095. The first course of the two-semester composition sequence HUM 099S-HUM 100-SL. Intended for students whom English is a second language. Emphasizes reading strategies, building vocabulary, grammar, developing a thesis, organizing an essay, editing and writing different kinds of expository essays. Frequent oral presentations. Weekly writing labs are held in conjunction with the course work.

**HUM 100. English Composition: Reading, Writing, Speaking II. 3 credits, 3 contact hours (3;0;0).**

**HUM 101. English Composition: Writing, Speaking, Thinking I. 3 credits, 3 contact hours (3;0;0).**
Entrance is determined by placement test score or completion of HUM 099 with a grade of C or better. Focuses on developing written and oral communication skills; emphasizes writing expository and research essays; preparing oral reports; drafting, revising, editing; evaluation and proper documentation of source material; using rhetorical strategies such as narration and argument.

**HUM 102. English Composition: Writing, Speaking, Thinking II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 with a grade of C or better. Focuses on enhanced written and oral communication skills; emphasizes reading and interpretation of literary forms; critical analysis; methods of research using print and on-line sources; report writing and writing about literature.

**HUM 2**. Humanities Elective. 3 credits, 3 contact hours (3;0;0).**

**HUM 211. The Pre-Modern World. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 and HUM 102 with a grade of C or better. Case studies focus on differing forms of material culture, belief systems, aesthetic norms, and artistic productions to develop an understanding of ancient and medieval world views. This course satisfies three credits of the GUR in Cultural History.

**HUM 212. The Modern World. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 and HUM 102 with a grade of C or better. Uses case studies to examine such key processes as the expansion of global trade and the formation of a global economy, European perceptions of non-Western cultures, and the roots and legacy of imperialism. This course satisfies 3 credits of the Cultural History GUR. Honors Note: See HUM 101.

**HUM 230. Introduction to Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Hum 101, Hum 102 with a C or better An introduction to literary studies, this course focuses on close reading and critical writing.. Students will investigate and reflect on standard literary genres; make claims about how the content and form of each connect; find and present evidence for such claims. Students will carefully consider their own writing at a slow pace to understand, ultimately, how a literary text operates as a work of art, as well as to learn how to communicate powerfully and persuasively in a variety of settings.

**HUM 251. Ethical Issues in Business. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 with a grade of C or better. An examination of the ethical problems and moral foundations of business from the perspective of moral philosophy. Among the questions explored are: What are the rights of employees and employers in the workplace? Do corporations and managers have an obligation to society at large? What is the relationship between personal and business morality? Is there a moral justification for the free market?.

**HUM 325. Humanities Special Topics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Varies according to topic. The study of new and/or advanced topics in an area of the humanities, not regularly covered in any other HUM, LIT, ENG OR HSS course at the 300-level. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. A student may register for no more than two semesters of special topics courses.

**HUM 401. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**HUM ELEC. Humanities Elective. 3 credits, 3 contact hours (3;0;0).**

**LIT 320. American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A survey of major works of American literature. Provides a foundation for understanding the currents of American thought and experiences. Special emphasis is paid to American literature within a global context.

**LIT 321. British Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A survey of the major works of British literature. Provides a foundation for understanding the currents of British thought and experience. Special emphasis is paid to British literature within a global context.

**LIT 330. World Literature I: North America, Latin America and the Caribbean, Australia and Oceania. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Enhances understanding of other cultures and of past and contemporary global interactions.

**LIT 331. World Literature II: Africa and the Middle East, Asia, and Europe. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Enhances the under-standing of other cultures and of past and contemporary global interactions.

**LIT 340. Contemporary Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Focuses on the study of literary works published within the last ten years. Considers how contemporary issues and problems are addressed in a variety of literary works.

**LIT 350. Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores the short story and the novel from varied countries and eras. Emphasis is given to narrative methods, representative themes, and global perspectives.

**LIT 352. 20th Century European Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines themes ranging from war and occupation, revolution, Fascism, and Communism to individual liberation and self-discovery, existen-tialism, absurdism, and feminism.

**LIT 355. Poetry. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores the problems, devices, and techniques of poetry'sound, rhythm, meter; diction and tone; connotation, metaphor, and symbol?as a means of demystifying the reading of poems. Emphasis is given to the place and purpose of poetry in a technological society.

**LIT 360. Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Follows the development of play structure from folkloric origins to contemporary theater. Emphasis is on text, history of text development, and the changing purpose of theatrical presentations.

**LIT 361. 20th Century American Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines the development of 20th century American drama with emphasis on the ways, often experimental, in which the playwrights reflect the spirit of the times.

**LIT 362. Non-Western Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores classical and contemporary theater and drama in China, Japan, India, Africa, and the Middle East.

**LIT 363. Ethnic and Minority Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Using contem-porary dramas as social, historical, and cultural artifacts, examines the experience of Latinos, Asian Americans, Native Americans, and African Americans.

**LIT 364. Modern Continental and British Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An examination of some of the dramas from the late nineteenth and twentieth centuries with the purpose of gaining some understanding of how dramatists, in both subject matter and technique, reflect the spirit of the times. Representative playwrights include Ibsen, Shaw, Wilde, Strindberg, Synge, Chekhov, O'Casey, Pirandello, Anouilh, Brecht, Ionesco, and Pinter.

**LIT 365. Non-Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines the ways that writers examine cultural issues through the use of literary non-fiction. Emphasis is placed on autobiographical, persuasive, and narrative techniques.

**LIT 370. Literature and Diversity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to explore the literature of human difference, including the literature of cross-cultural experience and sexual difference.

**LIT 372. African-American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to explore themes and styles particular to literary works by and about African-Americans.

**LIT 374. Women and Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to explore literature by and about women from around the world. Special attention is paid to autobiographical narratives.

**LIT 376. Latin American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines the ways that writers of Latin America and the Caribbean explore their respective culture through techniques such as dream, myth, and legend to achieve an authentic and unique -vision. Special emphasis is given to 20th-century authors.

**LIT 378. Literature and Nature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Literature as it reveals and interprets the natural world. Examines the ways that nature has been used in fiction, drama, poetry, and non-fiction. Students learn to describe the natural world in their writing. Co-listed as STS 378.

**LIT 380. Historical Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Sources of fiction and drama are often based on historical personalities and actual incidents. Examines a number of such works. Original historical material is compared with the literary work it inspired, thus providing insights into the nature of the creative process and the purposes of the historian and the creative writer.

**LIT 382. The Comic Tradition in English and American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Presents great comic works from the 14th century to the present. Students study verse narratives, plays, novels, and essays. Emphasis is given to the classical roots and international connections of the comic tradition in English, the relationship between form and function in comedy, and elucidation of comedy's social and philosophical ends.

**LIT 384. Musical Theater Adaptations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or betterThe content of this course is primarily literary. It examines the original texts that are used for theatrical adaptations in contemporary Broadway and Off-Broadway musicals. The origin stories are drawn from literature, graphic novels, and cultural folk stories. Students will attend selected musicals.

**LIT 386. Science Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores the distinctive characteristics of science fiction as a literary genre and its function as a social criticism. Special attention is given to the ways in which cultural gender coding surfaces in the text. Films and video are used.

**LIT 388. The Russian Novel and Short Story. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Focuses on Russian fiction of the 19th and 20th centuries. Approaches material both as evidence of artistic vision and as social documents of Russian history.

**MATH 101. Foundations of Mathematics for the Liberal Arts. 3 credits, 3 contact hours (3;0;0).**
Intended for students in degree programs offered by HSS and History. This course reviews principles of algebra and the foundations of mathematics. Degree credit awarded for degrees offered by HUM and HIST.

**MATH 102. Modern Pre-calculus. 6 credits, 6 contact hours (6;0;0).**
This course is an intensive non-traditional approach to pre-calculus employing curriculum innovations for the preparation of students for college calculus. The course infuses calculus techniques into the pre-calculus curriculum. The format includes both regular class and workshop environments with a focus on student problem solving. Course meets on Saturdays in the fall and spring terms and M, T, W, R in the summer, second session. This course is only available to high school students.

**MATH 105. Elementary Probability and Statistics. 3 credits, 3 contact hours (3;0;0).**
Consider notions of probability. Topics include the binomial and normal distributions, expected value, and variance. The notions of sampling, hypothesis testing, and confidence intervals are applied to elementary situations.

**MATH 107. University Mathematics BI. 3 credits, 3 contact hours (3;0;0).**
Linear functions, equations, inequalities, systems of linear equations, quadratic equations, elementary functions, graphing functions.

**MATH 108. University Mathematics I B. 4 credits, 5 contact hours (5;0;0).**
Intended for students whose major requires MATH 111. Linear functions, equations, inequalities, systems of linear equations, quadratic equations, polynomials, rational expressions, expressions involving radicals, partial fraction decomposition, conic sections, graphing functions.

**MATH 110. University Mathematics B II - Trigonometry. 4 credits, 5 contact hours (4;1;0).**
Intended for students whose major requires MATH 111. Prerequisite: MATH 108 or placement by performance on standardized entrance examinations. Trigonometric functions and identities, laws of sines and cosines, logarithmic equations, systems of nonlinear equations, polar coordinates.

**MATH 111. Calculus I. 4 credits, 5 contact hours (5;0;0).**
Prerequisite: MATH 110 with a grade of C or better or MATH 139 with a grade of B or better, or placement by performance on standardized entrance examinations. Topics include limits, differentiation, applications of differentiation, and integration.

**MATH 111H. Honors Mathematics I. 4 credits, 4 contact hours (4;0;0).**
Admission to this course is by invitation, based on standardized entrance exams. Topics enhance those of MATH 111 and concepts are studied in detail. Emphasizes science and engineering applications.

**MATH 112. Calculus II. 4 credits, 5 contact hours (5;0;0).**
Prerequisite: MATH 111 with a grade of C or better or MATH 132 with a grade of C or better. Topics include integration, applications of integration, series, exponential and logarithmic functions, transcendental functions, polar coordinates, and conic sections.

**MATH 113. Finite Mathematics and Calculus I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: (Intended for Architecture students.) MATH 107 with a grade of C or better, or MATH 110 with a grade of C or better, or NJIT placement. An introduction to differential and integral calculus. Applications include area, volumes, curve lengths, surface area, centroids, and moments. Focus is on application throughout the course.

**MATH 114. Finite Mathematics and Calculus II. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: (Intended for Architecture students.) MATH 113 with a grade of C or better. Topics include numerical methods, set theory and counting, series, descriptive statistics and basic probability, matrices, and optimization.

**MATH 115. Elements of Geometry. 3 credits, 3 contact hours (3;0;0).**
A modern approach to the elements of geometry grounded in real-world applications. Topics included basic axiomatic, Euclidean geometry, non-Euclidean geometry, and transformational geometry. Applications and examples in architecture, engineering and science are integrated throughout the course.

**MATH 116. Mathematics of Design. 3 credits, 3 contact hours (3;0;0).**
The course is project oriented, covering theories of proportion; tiling, symmetry, symmetry groups, and informal geometry; fractals; theory of graphs and knots; three-dimensional design and polyhedra. The mathematics is oriented towards carrying out designs rather than a systematic development of mathematical theory.

**MATH 120. Basic Concepts in Statistics. 1 credit, 1 contact hour (1;0;0).**
The course offers an introduction to the basic concepts in statistics. Topics include the role of statistics, data summary, normal distribution, elements of probability, and computation of mean and variance. This course will also include an introduction to statistical estimation and inference.

**MATH 131. Calculus A. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: MATH 139 with a grade of B or higher and permission of the major advisor or placement. The course covers limits, continuity, differentiation, and related rates, also reviewing the foundations of algebra, precalculus, and trigonometry. MATH 131, MATH 132, and MATH 133 are equivalent to MATH 111 and MATH 112.

**MATH 132. Calculus B. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: MATH 131 with a grade of C or higher or MATH 111 with a grade of C or higher. The course covers optimization, integration, calculation of arc length, area, volume, and hyperbolic functions (4-1-4) MATH 131, MATH 132, and MATH 133 are equivalent to MATH 111 and MATH 112.

**MATH 133. Calculus C. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: MATH 132 with a grade of C or higher. The course covers integration, applications of integration, numerical integration, series, and polar coordinates. MATH 131, MATH 132 and MATH 133 are equivalent to MATH 111 and MATH 112.

**MATH 135. Calculus for Business. 3 credits, 3 contact hours (3;0;0).**
Intended for students with major offered by SOM. Prerequisite: MATH 107 with a grade of C or better or MATH 110 with a grade of C or better or NJIT placement. An introduction to mathematics of business, principles of differential and integral calculus, and optimization.

**MATH 138. General Calculus I. 3 credits, 3 contact hours (3;0;0).**
Intended for students who are not in Science or in Engineering. Prerequisite: MATH 107 with a grade of C or better, or MATH 110 with a grade of C or better or NJIT placement. An introduction to differential and integral calculus of a single variable.

**MATH 139. Trigonometry and Principles of Differential Calculus. 4 credits, 5 contact hours (4;0;1).**
Prerequisites: Grade A in MATH 108 or NJIT placement. Comprehensive review of trigonometry and pre-calculus topics integrated into an introduction to differential calculus. Topics covered include: Exponential, logarithmic and trigonometric functions, analytics trigonometry, conic sections, limits, derivatives, applications of differentiation.

**MATH 211. Calculus III A. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include vectors, curvature, partial derivatives, multiple integrals, line integrals, and Green's theorem. Students who are considering a major in Mathematical Sciences or who are undecided about their major should take MATH 213.

**MATH 213. Calculus III B. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include vectors, curvature, partial derivatives, multiple integrals, line integrals, and Green's, divergence, and Stokes' theorems.

**MATH 222. Differential Equations. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Methods for solving ordinary differential equations are studied together with physical applications, Laplace transforms, numerical solutions, and series solutions.

**MATH 225. Survey of Probability and Statistics. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include descriptive statistics, elements of probability, random variables and distributions; mean and variance; introduction to estimation and inference. This course satisfies the Mathematics GUR in probability and statistics. However, degree credit will not be granted for both MATH 225 and any other upper level course in probability and/or statistics.

**MATH 225A. Survey of Probability and Statistics. 1 credit, 1 contact hour (1;0;0).**
For Chemical Engineering students only. Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include descriptive statistics, elements of probability, random variables and distributions; mean and variance; introduction to estimation and inference. This course satisfies the Mathematics GUR in probability and statistics. However, degree credit will not be granted for both MATH 225 and any other upper level course in probability and/or statistics.

**MATH 226. Discrete Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. An introduction to discrete mathematics. An introduction to discrete mathematics. Topics include elementary set theory, logic, combinatorics, relations, and selections from graphs and trees and algebraic systems.

**MATH 227. Mathematical Modeling. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better and CS 115 with a grade of C or better or CS 113 with a grade of C or better or CS 100 with a grade of C or better or CS 101 with a grade of C or better. An introduction to the theory and practice of mathematical modeling. Techniques include scaling and dimension, fitting of data, linear and exponential models, elementary dynamical systems, probability, optimization, Markov chain modeling. Models are drawn from applications including biology, physics, economics, finance, and chemistry.

**MATH 238. General Calculus II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 138 with a grade of C or better or MATH 139 with a grade of C or better or MATH 111 with a grade of C or better or placement. A continuation of MATH 138. Topics include applications of integral calculus and an introduction to ordinary differential equations.

**MATH 240. Numerical Mathematics Laboratory. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better, and CS 113 or knowledge of FORTRAN, C, or C++. Introduction to basic concepts and processes of numerical mathematics with emphasis on practical issues of implementation, use of numerical algorithms and software, and interpretation of numerical data. Weekly projects involving writing computer programs, presenting numerical results in tables and graphs, evaluation and approximation of standard numerical functions, round-off errors and loss of significance, basic iterative processes, matrix arithmetic, random number generation, and Monte Carlo methods. Students gain experience using a programming language, such as C, and mathematical software, such as MATLAB.

**MATH 244. Introduction to Probability Theory. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include basic probability theory in discrete and continuous sample space, conditional probability and independence, Bayes' theorem and event trees, random variables and their distributions, joint distribution and notion of dependence, expected values and variance, moment generating functions, useful parametric families of distributions including binomial, geometric, hypergeometric, negative binomial, exponential, gamma, normal and their applications, simple case of central limit theorem and its uses.

**MATH 245. Multivariate Probability and Stochastic Processes. 3 credits, 0 contact hours (0;0;0).**
Prerequisite: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Topics include discrete and continuous multivariate distributions and their moments, multivariate normal distributions, order statistics, discrete and continuous Markov chains, Poisson processes, and Brownian motion processes.

**MATH 246. Introduction to Financial Mathematics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 135 with a grade of C or better or MATH 138 with a grade of C or better or MATH 111 with a grade of C or better. An introduction to the basics of simple interest and discount, compound interest and discount, and simple annuities. This course is primarily intended for students whose major only requires Calculus I. It cannot be used for credit towards major or minor degrees offered by the Department of Mathematical Sciences.

**MATH 279. Statistics and Probability for Engineers. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. This course introduces methods of summarizing and analyzing engineering data and the importance of observing processes over time such as control charts. Descriptive statistics, plots and diagrams are then used to summarize the data. Elements of probability and random variables with their distributions along with mean and variance are taught. All this knowledge is then used as a platform towards covering how to do basic estimation and inference, including confidence intervals and hypothesis testing based on a single sample. Students taking this course cannot receive degree credit for MATH 225, MATH 244, or MATH 333.

**MATH 305. Statistics for Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: (Intended for students in Engineering Technology.) MATH 111 with a grade of C or better, or MATH 132 with a grade of C or better, or MATH 138 with a grade of C or better. An introduction to the modern concepts of statistics needed by engineering technologists. Topics include organization of data, descriptive statistics, discrete and continuous probability distributions, sampling distribution and designs, estimation -- one and two populations, tests of hypotheses.

**MATH 309. Mathematical Analysis for Technology. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 112 with a grade of C or better, or MATH 133 with a grade of C or better or MATH 238 with a grade of C or better. Emphasis on partial derivatives; vector calculus, and multiple integrals.

**MATH 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of the sophomore year, departmental approval, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**MATH 321. Introduction to the Finite Element Method. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 with a grade of C or better. An elementary introduction to the theory and practice of the finite element method (FEM) is given. The mathematical underpinnings covered in this course include the basics of Sobolev spaces, Galerkin's method and various other weak formulations. Mathematical modeling of different physical problems and their solution techniques are also discussed. Existing finite element programs will be introduced through a course project.

**MATH 322. Differential Equations for Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better or MATH 238 with a grade C or better. An applied science study using differential equations as the vehicle for comprehension of the unknown. Introduction to first-order differential equations and their applications to motion, cooling and electromechanical systems followed by higher order differential equations and their solutions. Study of methods of undetermined coefficients, variation of parameters, and many series and numerical methods. Includes Laplace transforms, matrix methods, and eigenvalue problems.

**MATH 326. Discrete Analysis for Computer Engineers. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. An introduction to mathematical logic, Boolean algebra, and Karnaugh maps. Other topics include functions, equivalence relations and partially ordered sets, counting, graph theory and finite state machines. The emphasis is on computation but proofs will be addressed. Students cannot receive credit for both MATH 226 and MATH 326.

**MATH 328. Mathematical Methods for Scientists and Engineers. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211 with a grade of C or better, or MATH 213 with a grade of C or better. Corequisite: MATH 222. The course exposes students to concepts of mathematics encountered throughout the physical science and engineering disciplines. Topics include matrix algebra, vector analysis, complex numbers, and boundary value problems in partial differential equations.

**MATH 331. Introduction to Partial Differential Equations. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 or MATH 213 and MATH 222 all with a grade of C or better. Partial differential equations in science and engineering. Topics include initial- and boundary-value problems for parabolic, hyperbolic, and elliptic second-order equations. Emphasis is placed on separation of variables, special functions, transform methods, and numerical techniques.

**MATH 332. Introduction to Functions of a Complex Variable. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 or MATH 213 and MATH 222 all with a grade of C or better. Functions of a complex variable: Cauchy-Riemann equations, Cauchy-Goursat theorem, integration, series, residues, poles, geometrical aspects. Emphasis on techniques.

**MATH 333. Probability and Statistics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Descriptive statistics and statistical inference. Topics include discrete and continuous distributions of random variables, statistical inference for the mean and variance of populations, and graphical analysis of data.

**MATH 334. Operations Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Considers mathematical methods found especially in contemporary fields such as operations research and reliability engineering. Topics include linear programming, graph theory, finite mathematics, differential equations, matrices, and determinants.

**MATH 335. Vector Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better. Algebra and calculus of vectors. Topics include the theorems of Gauss, Green, and Stokes, and curvilinear coordinates.

**MATH 336. Applied Abstract Algebra. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Classical algebra from a modern and constructive viewpoint. Emphasis is on the development of algorithmic and computational skills. Topics include rings, fields, and groups and their applications to science and engineering.

**MATH 337. Linear Algebra. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Matrices, determinants, systems of linear equations, vector spaces, linear transformations, eigenvalues, eigenvectors, and related topics.

**MATH 340. Applied Numerical Methods. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better, and CS 100 with a grade of C or better or CS 101 with a grade of C or better oror CS 113 with a grade of C or better or CS 115 with a grade of C or better or MATH 240 with a grade of C or better. Introduction to numerical methods with emphasis on mathematical models. Implements and investigates numerical techniques for the solution of linear and nonlinear systems of equations, eigenvalue problems, interpolation and approximation, techniques of optimization, Monte Carlo methods, and applications to ordinary differential equations and integration.

**MATH 341. Statistical Methods II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Covers applications of classical statistical inference. Topics include transformation of variables, moment generating technique for distribution of variables, introduction to sampling distributions, point and interval estimation, maximum likelihood estimators, basic statistical hypotheses and tests of parametric hypotheses about means of normal populations, chi-square tests of homogeneity, independence, goodness-of-fit.

**MATH 344. Regression Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333 with a grade of C or better or MATH 341 with a grade of C or better. An introduction to statistical data analysis using regression techniques. Topics include least squares estimation, hypothesis testing, prediction, regression diagnostics, residual analysis, variance stabilizing transformations, regression using indicator variables, variable selection, and model building.

**MATH 345. Multivariate Distributions. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Topics include discrete and continuous multivariate distributions and their moments, multivariate distributions including multivariate normal and multinominal distributions, order statistics, conditional probability and the use of conditioning, discrete time Markov chains and their examples, discrete time branching processes, homogeneous and nonhomogeneous Poisson processes.

**MATH 346. Mathematics of Finance I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. The main topics include basic problems in interest, annuities, certain amortization and sinking funds, bonds and related securities.

**MATH 347. Mathematics of Finance II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 346 and MATH 244 or MATH 333 all with a grade of C or better. This course introduces mathematical models of bond and stock prices, which lead to arbitrage pricing of options and other derivative securities, and portfolio management. These areas of mathematical finance have a great impact on the way financial markets function. Topics include risk-free, and risky assets, portfolio management, futures, and options.

**MATH 371. Physiology and Medicine. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 with a grade of C or better. Mathematical models of organs and organ systems: the heart and circulation, gas exchange in the lungs, electrical properties of excitable membranes, neuro-biological clocks, the renal countercurrent mechanism, muscle mechanics. The biology is introduced with each topic. Emphasis is on quantitative problem solving, model building, and numerical simulation.

**MATH 372. Population Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 with a grade of C or better. Introduction to the mathematics of populations: Malthus' model of geometric population growth, Euler's renewal equations, age structure in human populations, predator satiation, chaos, mathematical models of inheritance, and the theory of epidemics. The ability to weave back and forth between physical concepts and mathematical notation is emphasized as well as the relationships between random and non-random models of similar phenomena.

**MATH 373. Introduction to Mathematical Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better and MATH 337 with a grade of C or better. This course provides an introduction to the use of mathematical techniques applied to problems in biology. Discrete and continuous models of biological phenomena will be discussed. Biological topics discussed range from the subcellular molecular systems and cellular behavior to physiological problems, population biology and developmental biology. Techniques of phase plane analysis for differential equations are introduced in the course. No prior background in biology is necessary.

**MATH 388. Introduction to Chaos Theory. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better. An elementary treatment of chaos theory and its applications concentrating on discrete dynamical systems. Uses theory and applications illustrated by computer experiments to develop such topics as bifurcation, attractors, the logistic map, period-doubling routes to chaos, symbolic dynamics, Sarkovskii's theorem, fractals, and Julia and Mandelbrot sets for complex dynamics.

**MATH 391. Numerical Linear Algebra. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 337 with a grade of C or better and CS 113 with a grade of C or better or CS 115 with a grade of C or better or CS 101 with a grade of C or better or CS 100 with a grade of C or better. This course provides an introduction to computational linear algebra. Topics include direct solution of linear systems, iterative methods for linear systems, fast Fourier transforms, least squares problems, singular value decomposition and eigenvalue/eigenvector problems.

**MATH 401. Undergraduate Research Seminar. 1 credit, 1 contact hour (0;0;1).**
Research seminar intended for students who participate in year-long research projects. Methodologies and techniques needed for summer research projects are discussed. Presentations of current research topics are made by various faculty.

**MATH 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MATH 310 with a grade of C or better, departmental approval, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**MATH 426. Advanced Discrete Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 226 with a grade of C or better or MATH 326 with a grade of C or better. Topics include graphs, trees and their applications, grammars, finite state machines, Turing machines and Petri nets, applied combinatorics -- Stirling, Catalan, and Ramsey numbers, Polya-Burnside counting methods, finite Markov chains and coding theory.

**MATH 430. Analytical and Computational Neuroscience. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better, and MATH 222 with a grade of C or better, and CS 100 with a grade of C or better or CS 113 with a grade of C or better or CS 115 with a grade of C or better or MATH 340 with a grade of C or better. A mathematical and computational introduction to the biophysical mechanisms that underlie physiological functions of single neurons and synapses. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, nerve impulse propagation in axons and dendrites, single- and multi-compartmental modeling, synaptic transmission, calcium handling dynamics and calcium dependent currents and processes.

**MATH 431. Systems Computational Neuroscience. 3 credits, 0 contact hours (0;0;0).**
Prerequisites: MATH 430 with a grade of C or better or departmental approval. This course provides a mathematical and computational introduction to operations of neuronal systems and networks. Topics covered include central pattern generators, neuroethology of sensory systems, sensory-motor transformations, models of various brain regions, models of visual processes, large networks modeling, models of learning and memory, neural coding and mathematics of neural networks.

**MATH 432. Mathematics of Financial Derivatives I (Capstone I). 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222 with a grade of C or better and MATH 346 with a grade of C or better. Mathematical analysis of models encountered in the area of financial derivatives. Topics include modeling and analysis of futures markets, determination of future prices, hedging strategies, swaps, option markets, stock options and their trading strategies.

**MATH 433. Mathematics of Financial Derivatives II (Capstone II). 3 credits, 3 contact hours (3;0;0).**
Corequisite: MATH 340 with a grade of C or better. MATH 432 with a grade of C or better. Mathematical analysis of models encountered in the area of financial derivatives with emphasis on numerical methods. Topics include: Binomial Trees, Black Scholes Models, Finite Difference Methods.

**MATH 440. Advanced Applied Numerical Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 331 with a grade of C or better and MATH 340 with a grade of C or better. A survey of numerical methods for solving ordinary and partial differential equations. Includes initial-value and boundary-value problems for ordinary differential equations and for elliptic, hyperbolic, and parabolic partial differential equations.

**MATH 441. Actuarial Mathematics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 346 with a grade of C or better. Topics include the economics of insurance, individual risk models for a short term, survival distributions and life tables, life insurance per year, life annuities, and net premiums.

**MATH 442. Actuarial Mathematics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 441 with a grade of C or better. Topics include net premium reserves, insurance models including expenses, nonforfeiture benefits, and dividends.

**MATH 444. Applied Sampling Methods and Quality Control. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333 with a grade of C or better, or MATH 244 with a grade of C or better and MATH 341 with a grade of C or better. An introduction to sample survey and statistical quality control. Topics include sampling from a finite population and different sampling techniques, more detailed study of random sampling and stratification, control charts and acceptance sampling plans in statistical quality control.

**MATH 445. Introduction to Experimental Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333 with a grade of C or better, or MATH 244 with a grade of C or better and MATH 341 with a grade of C or better. Basic concepts and principles of designs are covered. Topics include randomized blocks, Latin squares, factorial designs.

**MATH 446. Topics in Applied Statistics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 341 with a grade of C or better or MATH 333 with a grade of C or better. Topics may include biostatistics, environmental statistics, statistical consulting.

**MATH 447. Applied Time Series Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 341 with a grade of C or better or MATH 333 with a grade of C or better. An introduction to applied univariate time series analysis. Topics include regression techniques for modeling trends, smoothing techniques (moving average smoothing, exponential smoothing), autocorrelation, partial auto-correlation, moving average, and autoregressive representation of series, Box-Jenkins models, forecasting, model selection, estimation, and diagnostic checking, Fourier analysis, and spectral theory for stationary processes.

**MATH 448. Stochastic Simulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 340 and either MATH 244 or MATH 333 with a grade of C or better. An introduction in the use of computer simulation to study stochastic models. Topics include the generation of samples of continuous and discrete random variables and processes with applications to stochastic models, statistical analysis of the results, and variance reduction techniques.

**MATH 450. Methods Of Applied Math. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 331 with a grade of C or better, Math 337 with a grade of C or better, and MATH 340 with a grade of C or better. Combines mathematical modeling with physical and computational experiments conducted in the Undergraduate Mathematics Computing Laboratory.

**MATH 451. Methods Appl Math II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Math 450 H with a grade of C or better. Small teams of students conduct research projects under the guidance of faculty members who perform applied research.

**MATH 453. High-Performance Numerical Computing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 391 with a grade of C or better and MATH 440 with a grade of C or better. The course covers state-of-the-art numerical algorithms for solving large-scale problems accurately and efficiently. Topics include iterative methods for linear systems and eigenvalue computations, introduction to parallel program and parallel numerical algorithms and spectral methods. An instructor-selected advanced topic will be included in the course.

**MATH 460. Differential Geometry of Curves and Surfaces. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222 with a grade of C or better. Curves in the plane and Euclidean space, moving frames, surfaces in Euclidean space, orientability of surfaces, Gaussian and mean curvatures, surfaces of revolution, ruled surfaces, minimal surfaces, special curves on surfaces, Theorema Egregium, the intrinsic geometry of surfaces.

**MATH 473. Intermediate Differential Equations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222 with a grade of C or better and MATH 337 with a grade of C or better. Topics in the qualitative behavior of solutions of ordinary differential equations with applications to engineering problems. Includes phase plane analysis, stability, dynamical systems, and chaos.

**MATH 477. Stochastic Processes. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better and MATH 337 with a grade of C or better. This course introduces the theory and applications of random processes needed in various disciplines such as mathematical biology, finance, and engineering. Topics include discrete and continuous Markov chains, Poisson processes, as well as topics selected from Brownian motion, renewal theory, and simulation.

**MATH 478. Intro Stat Methods in Data Sci. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Math 333 with a grade of C or better or Math 341 with a grade of C or better. This course introduces to students concepts in statistical methods used in data science, including data collection, data visualization and data analysis. Emphasis is on model building and statistical concepts related to data analysis methods. The course provides the basic foundational tools on which to pursue statistics, data analysis and data science in greater depth. Topics include sampling and experimental design, understanding the aims of a study, principles of data analysis, linear and logistic regression, resampling methods, and statistical learning methods. Students will use the R statistical software.

**MATH 480. Introductory Mathematical Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better. Builds on principles taught in basic calculus courses. Topics discussed include continuity, differentiation, integration, and the limit process of sequences and series.

**MATH 481. Advanced Calculus. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 480 with a grade of C or better. Systematic development of partial differentiation, multiple and improper integrals, transformations, inverse and implicit function theorems, and integrals over curves and surfaces.

**MATH 491. Independent Study in Mathematics. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Senior standing and departmental approval. Each student works under the direct supervision of a member of the Department of Mathematical Sciences. The work consists primarily of a project applying the student's mathematical skills to an engineering- or science-oriented project.

**MATH 492. Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Senior standing and departmental approval. Each student works under the direct supervision of a member of the Department of Mathematical Sciences. The work consists primarily of a project applying the student's mathematical skills to an engineering- or science-oriented project.

**MATH 495. Topics in Applied Mathematics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 331 with a grade of C or better, MATH 332 with a grade of C or better, and MATH 340 with a grade of C or better, or departmental approval. A survey of selected areas of applied mathematics. Case histories of problems in applied mathematics from an industrial background.

**MATH E. Math Stack Engineers. 3 credits, 3 contact hours (3;0;0).**

**MATH NE. Math Stack For Non-Engineers. 3 credits, 3 contact hours (3;0;0).**

**OPSE 301. Introduction to Optical Science and Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121. Laboratory and lecture introduces optics and photonics principles with their elementary applications for applied physics, engineering, computer science, or biology majors. Topics include speed at light, reflection, refraction, geometric optics, interference and interferometry, polarization, dispersion, birefringence, fiber-optics, diffraction, introduction to spectroscopy and ray tracing.

**OPSE 310. Virtual Instrumentation. 3 credits, 5 contact hours (2;3;0).**
Prerequisites: CS 113 or CS 115. Intended for all engineering, computer science, and science majors. Covers the basics of virtual instrumentation including use of IEEE GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform such as National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisition and instrument control, instrument status, and acquisition speed.

**OPSE 402. High Power Laser and Photonics Applications. 3 credits, 4 contact hours (1;3;0).**
Prerequisite: PHYS 121. Open to all engineering, computer science, and science majors with junior or senior standing. Advanced combined laboratory and lecture course emphasizing photonics and high power laser applications. Topics include Maxwell's equations, principles of lasers, electro-optics, non-linear optics, absorption and transmission of light, bio-optics, fiber-optic communications, chemiluminescence, scattering from periodic surfaces and colloids, sensors. Topics and experiments change on a semester basis depending on interests of enrolled students.

**OPSE 410. Biophotonics. 3 credits, 3 contact hours (3;0;0).**
Prerequsite: PHYS 121. An introduction to the interaction of light with biological tissues. Biophotonics for diagnostic and therapeutic applications will be discussed. Topics include propagation of light in turbid tissues, absorption, scattering, laser surgery, and optical rotation.

**PE 103. Swim Instruction. 1 credit, 1 contact hour (0;1;0).**
Students develop aquatic skills, including various swimming strokes and rescue techniques, according to skill level. Limited to 10 students.

**PE 104. Survival Swimming. 1 credit, 1 contact hour (0;1;0).**
Designed for the average, weak or non-swimmer and will emphasize survival swimming, basic rescue and water safety techniques, and swimming instruction.

**PE 105. Lifesaving/Lifeguard Training. 1 credit, 1 contact hour (0;1;0).**
An American Red Cross certification course. The purchase of textbooks is required. Laboratory hours are established at first lecture.

**PE 106. Water Safety Instructor. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: Valid Advanced Lifesaving certificate. An American Red Cross certification course. The purchase of textbooks is required. Laboratory hours are established at first lecture. Upon successful completion of this course, an individual will be able to teach swimming at all levels as well as emergency water safety.

**PE 115. Strength Training and Conditioning. 1 credit, 1 contact hour (0;1;0).**
Covers strength and conditioning techniques and programs, goal setting, and record keeping.

**PE 117. Jogging. 1 credit, 1 contact hour (0;1;0).**
The purpose of this course is to help students improve personal fitness and health through active participation in a safe and effective jogging and conditioning program. Students will learn the lifetime benefits of walking & jogging and the health related components of fitness. Correct biomechanical movements will be emphasized along with fitness and health improvements for all students. Upon completion of the course the students will understand the importance of proper safety techniques and the cardiovascular benefits of activities associated with jogging and conditioning.

**PE 118. Walking. 1 credit, 1 contact hour (0;1;0).**
An approach to cardiovascular fitness and weight reduction. Walking tours may be offered.

**PE 128. Hydrofitness. 1 credit, 1 contact hour (0;1;0).**
Water fitness designed to tone major muscle groups, and strengthen the cardiovascular system. Includes exercises for all parts of the body, recipes for staying in shape, and the aerobic way to a strong heart.

**PE 129. Individualized Fitness. 1 credit, 1 contact hour (0;1;0).**
Specific training to meet the individual student's interest. Areas include techniques of strength training, goal setting and record keeping.

**PE 131. Step Aerobics. 1 credit, 1 contact hour (0;1;0).**
A high-intensity aerobic workout designed for the moderate to advanced participant using the "Reebok Step" to increase cardiovascular strength and endurance with emphasis on target heart rates, safety, fat reduction, and achieving overall fitness and good health.

**PE 132. Aerobics. 1 credit, 1 contact hour (0;1;0).**
Designed for cardiovascular conditioning, weight loss, and muscle toning.

**PE 133. Swim for Health. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: must be able to swim. Designed for those who want to use swimming to improve their health and fitness. Swim for Health is a concentrated program which teaches the techniques and methods used in the development of individualized ?training programs.?.

**PE 135. Beginning Swimming. 1 credit, 1 contact hour (1;0;0).**
Designed for the non-swimmer. Includes survival techniques and basic rescue.

**PE 136. Beginning Karate. 1 credit, 1 contact hour (0;1;0).**
An introduction to shotokan karate. Includes basic self-defense. Gi (martial arts uniform) optional.

**PE 137. Intermediate Karate. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: PE 136 or permission of the instructor. A continuation of PE 136. Includes an introduction to katas, Japanese terms and complex self-defense. Gi (martial arts uniform) required.

**PE 139. Individual Fitness II. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: PE 129 or permission of the instructor. Designed to increase cardiovascular efficiency, muscular strength, and endurance through specific training that meets a student's continuing goals.

**PE 140. Circuit Training. 1 credit, 1 contact hour (0;1;0).**
Designed as a low-impact aerobic program utilizing weights to increase flexibility, coordination, muscle tone, and cardiovascular endurance.

**PE 141. Introduction to Dance. 1 credit, 1 contact hour (0;1;0).**
An introduction to several styles of dance, including ballet, modern, jazz, tap, folk, ethnic, and social.

**PE 145. Aerobic Instructor Certification. 1 credit, 1 contact hour (1;0;0).**
This Air Force-sponsored physical training course is open to NJIT AFROTC enrolled students only. Course activities include conditioning exercises, calisthenics, a 1.5 mile run, Air Force Sports, Warrior Runs, a Physical Fitness Diagnotic, and a Physical Fitness Assessment.

**PE 150. Beginning Yoga. 1 credit, 1 contact hour (0;1;0).**
Course introduces the ancient discipline of personal development that balances body, mind, and spirit. Students learn a series of physical postures as well as practical methods for relaxation, proper breathing, meditation, and concentration that promote health, alleviate stress, improve skelatal alignment, and increase muscular strength and flexibility.

**PE 151. Intermediate Yoga. 1 credit, 1 contact hour (0;1;0).**
In this course students will deepen their study and practice of yoga. Students will master the basic knowledge learned in the Beginning Yoga, while studying advanced poses and breathing techniques. By the end of the course, students will demonstrate and advanced kinesthetic awareness of the body, the ability to perform advanced poses, and a deeper understanding of the philosophy and science of yoga.

**PE 170. Modern Dance. 1 credit, 1 contact hour (0;1;0).**
This course provides a basis for students to understand and develop an appreciation of dance as an art form. Through active participation students explore fundamental movement principles and modern dance techniques. Incorporated into this course is the study of all the major dance genres and dance history, as well as the study of anatomy. Structured improvisation and choreography allow students to manipulate abstract ideas, and develop their creativity.

**PE 171. Latin Dance. 1 credit, 1 contact hour (0;1;0).**
This course will focus on training students to understand and perform basic ballroom and Latin steps, turns, and partnering. Students will also learn the rhythms, history, and culture of each style. Students will demonstrate mastery of these styles through choreographed and non-choreographed class performances.

**PE 180. Zumba Fitness. 1 credit, 1 contact hour (0;1;0).**
This course combines high energy and motivating music with unique moves and combinations that allow participants to exercise with no worries. Zumba combines traditional Latin dance styles including salsa, mambo, cha-cha, cumbia and merengue, as well as hip hop and belly dancing moves. The routines feature aerobic fitness interval training with a combination of fast and slow rhythms that tone and sculpt the body. By focusing on interval training, classes seek to burn calories without exhausting participants with a high impact pace. Zumba is based on the theory that a work out should be fun and easy to do. This allows participants to stick to a fitness program and achieve long-term benefits that are good for both the body and mind.

**PE 1XX. PE Exemption. 0 credits, 0 contact hours (0;0;0).**

**PE 201. Introduction to Lifetime Sports I. 1 credit, 1 contact hour (0;1;0).**
Offered only in the fall semester, introduces a variety of the individual, dual, and team sports available at NJIT.

**PE 202. Lifetime Sports II. 1 credit, 1 contact hour (0;1;0).**
A continuation of PE 101. Participate in a variety of activities or develop an area(s) of concentration.

**PE 208. Sports for Women. 1 credit, 1 contact hour (0;1;0).**
Designed specifically for women interested in learning and competing in individual, dual and team sports.

**PE 210. Skiing. 1 credit, 1 contact hour (0;1;0).**
Instruction and practical experience in recreational skiing designed for the novice and intermediate skier. Includes lectures on safety, equipment and clothing, first aid and injuries, tuning and repair; six sessions at Hidden Valley, and possibly one weekend trip to Vermont. Students are responsible for costs of lift tickets and any equipment rentals. Transportation may be provided.

**PE 211. Introduction to Bowling and Archery. 1 credit, 1 contact hour (0;1;0).**
The rules, techniques and scoring of each sport. Archery equipment is provided. For bowling, students must pay a $1 per class alley fee.

**PE 213. Volleyball. 1 credit, 1 contact hour (0;1;0).**
Learn current techniques and skills while playing triples (3 on 3) and leading up to competitive team (6 on 6) volleyball.

**PE 214. Advanced Volleyball. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: PE 113 or approval of the instructor. Advanced methods and techniques of spikes, serves, blocks, sets, team transition, strategy, tournament play, statistics, and videotape analysis.

**PE 220. Introduction to Racquet Sports. 1 credit, 1 contact hour (0;1;0).**
An introduction to the racquet sports of badminton, paddleball, tennis, and racquetball. Includes rules of play, service, strokes, and playing strategy for singles and doubles.

**PE 221. Badminton. 1 credit, 1 contact hour (0;1;0).**
Includes the rules, skills, strokes, and strategies of badminton, and provides an opportunity for competition.

**PE 223. Tennis for Beginners. 1 credit, 1 contact hour (0;1;0).**
Introduces students to the rules and basic techniques and strategies of tennis.

**PE 224. Intermediate Tennis. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: PE 223 or permission of the instructor. Emphasizes correcting problem strokes, strategies, drills, and tournament play.

**PE 225. Golf. 1 credit, 1 contact hour (0;1;0).**
Designed for the beginner. Areas covered are grip, stance, swing, strokes, and use of clubs, progressing towards actual course play. Students pay green and range fees.

**PE 226. Intermediate Golf. 1 credit, 1 contact hour (0;1;0).**
Prerequisite:PE 225 or permission of the instructor. Designed to strengthen and advance the skills and theory learned in PE 125.

**PE 234. Beginning Fencing. 1 credit, 1 contact hour (0;1;0).**
Introduces fencing as both a lifetime and intercollegiate sport. Basic equipment is provided.

**PE 242. Introduction to Racquetball. 1 credit, 1 contact hour (0;1;0).**
An introduction to rules, skill development, strategies and tournament play.

**PE 243. Introduction to Volleyball. 1 credit, 1 contact hour (0;1;0).**
An introduction to rules, skill development, strategies, and tournament play.

**PE 244. Advanced Racquetball. 1 credit, 1 contact hour (0;1;0).**
Prerequisite: PE 242 or permission of the instructor. Advanced methods and techniques of various serves; passing, and kill shots; advanced strategy; tournament play focusing on singles and doubles play.

**PE 245. Air Force Physical Training II. 1 credit, 1 contact hour (1;0;0).**
This Air Force-sponsored physical training course is open to NJIT AFROTC enrolled students only. Course activities include conditioning exercises, calisthenics, a 1.5 mile run, Air Force Sports, Warrior Runs, a Physical Fitness Diagnotic, and a Physical Fitness Assessment.

**PE 2XX. PE Exemption. 0 credits, 0 contact hours (0;0;0).**

**PHIL 300. Philosophy of Law and Social Justice. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Introduction to philosophical issues concerning law, using lectures and case studies. Topics covered will include: the interpretation of legal texts; the foundation of moral obligation to obey the law; the nature of rights; and the function of punishment.

**PHIL 331. Problems in Philosophy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An examination of problems of a social, ethical, esthetic, religious, and scientific nature, and a study of the related principles and methods of philosophy. Readings are chosen from a wide range of periods and schools from the Greeks to the present, with some application of philosophical analysis to individual and societal problems.

**PHIL 333. Moral Philosophy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A critical discussion of the history and fundamental elements of ethical thought. Examines topics such as the basic ethical theories, the nature of right and wrong, the significance of moral choice, the structure of the moral life, and the place of reason in ethics. Readings from both classical and modern philosophers.

**PHIL 334. Engineering Ethics and Technological Practice: Philosophical Perspectives on Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A philosophical examination of the nature of engineering practice and applied technology. Considers such questions as: How do the societal functions of engineers and the practical application of technologies relate to basic moral and intellectual values? What moral obligations are implied by the uses of technology? What are the ethical duties of engineers in the practice of their careers? How are technological practice and engineering related to questions about knowledge and reality?.

**PHIL 337. World Religions. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An introduction to five world religions which make strong claims to be in some sense universal: Hinduism, Judaism, Buddhism, Christianity, and Islam, with special attention to their impact on contemporary politics, gender, economics, and culture. Study of selected scriptures, major customs, representative figures, and one or two works of art from each religious tradition.

**PHIL 340. Ethical Issues in Public Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Course premise is the inevitability of ethical issues in public policy decision making. Societal forces such as government, industry, economics, public interest, and science can play various roles in shaping public policy and are related to ethical concerns. Focuses on both historic and current public policy case studies.

**PHIL 350. Representative Philosophies. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. The ideas of a few great thinkers, from a variety of historical periods. Shows at first hand how these philosophers accelerated intellectual progress and how their work may contribute to the solution of modern problems.

**PHIL 351. Biomedical Ethics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An examination of the ethical problems and moral foundations of medicine. Among the issues explored are the changing nature of the doctor/patient relationship, increased patient autonomy, advance directives, the rationing of care, doctor-assisted suicide, and "the right to die." Honors Note: See HSS 101.

**PHIL 355. The Philosophy of Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An investigation into the foundations and implications of modern science, with special emphasis on the influence of philosophy on scientific thought, and on philosophic questions.

**PHIL 380. Philosophy of Language. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines tradition, formation and change in the ways that language shapes thought. Special attention is paid to the relationships between language and religion, as well as language and science.

**PHYS 102. General Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. Intended for students in architecture, computer science (B.A. only), STS and other disciplines requiring laboratory science electives. Elementary statics and dynamics. Subjects discussed are kinematics, Newton's laws of motion, energy, momentum, conservation principles, and mechanical properties of matter. Lab must be taken concurrently.

**PHYS 102A. General Physics Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: None. This course is the laboratory component of PHYS 102 and must be taken concurrently.

**PHYS 103. General Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 102 with grade of C or better. A continuation of PHYS 102 for students in architecture, computer science (B.A. only), STS and other disciplines requiring laboratory science electives. Topics discussed are heat, thermodynamics, sound, wave motion, illumination, geometric and physical optics, and color. Lab must be taken concurrently.

**PHYS 103A. General Physics Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: PHYS 102 with grade of C or better. This course is the laboratory component of PHYS 103 and must be taken concurrently.

**PHYS 111. Physics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 131; Corequisite: MATH 111 or MATH 132. Elementary mechanics with an emphasis on the fundamental concepts and laws of mechanics, especially the conservation laws. Topics are scalar and vector quantities of mechanics; rectilinear and circular motion; equilibrium and Newton's laws of motion; work, energy, momentum; the conservation laws. Lab must be taken concurrently. See PHYS 111A.

**PHYS 111A. Physics I Laboratory. 1 credit, 2 contact hours (0;2;0).**
Corequisite: MATH 111. Laboratory component of PHYS 111. Lab must be taken concurrently with PHYS 111.

**PHYS 114. Introduction to Data Reduction with Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 131; Corequisite: MATH 111 or MATH 132. Physics majors only. An introduction to both the theory and application of error analysis and data reduction methodology. Topics include the binomial distribution and its simplification to Gaussian and Poisson probability distribution functions, estimation of moments, and propagation of uncertainty. Forward modeling, including least-squares fitting of linear and polynomial functions are discussed. The course enables students to apply the concepts of the data reduction and error analysis using data analysis software to real data sets found in the physical sciences.

**PHYS 121. Physics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 111 with a grade of C or better. MATH 111 or 132. Co-requisite: MATH 112 or MATH 133. This course deals with an introduction to electricity and magnetism. Topics include simple dc circuits, the electric field, the magnetic field, electric potential, capacitance relationships between electric and magnetic fields, inductance, and simple ac circuits. Lab must be taken concurrently. See PHYS 121A.

**PHYS 121A. Physics II Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisites: PHYS 111 and MATH 111 all with grade of C or better. Corequisite: MATH 112.

**PHYS 202. Introductory Astronomy and Cosmology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. A non-mathematical presentation of contemporary views of the origin, evolution, and structure of the solar system, stars, galaxies, and the universe. Special topics include neutron stars, black holes, gravitationally strange objects, and the ?big bang.?.

**PHYS 202A. Astronomy and Cosmology Laboratory. 1 credit, 2 contact hours (0;2;0).**
Corequisite: PHYS 202. Includes demonstration of physical principles applicable to astronomy. Use of telescope for lunar, solar and planetary observations.

**PHYS 203. The Earth in Space. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. Introduces fundamental phenomena, such as plate tectonics, erosion, volcanism, and glaciation. Studies the interaction between the Earth's four major reservoirs?atmosphere, hydrosphere, biosphere and solid earth; investigates the dependence of the Earth on the Sun; the effect of the Moon on the Earth. Extends knowledge gained from studying the Earth to other planets in this solar system.

**PHYS 203A. The Earth in Space Laboratory. 1 credit, 2 contact hours (0;2;0).**
Corequisite: PHYS 203. Optional laboratory course associated with PHYS 203.

**PHYS 204. Biophysics of Life. 3 credits, 3 contact hours (3;0;0).**
A non-mathematical view of how living entities work in terms of the basic concepts of physics. The course will discuss how these concepts underline topics ranging from birth to death, from touch to pleasure, from vision to beauty, and from a thought to a heartbeat.

**PHYS 231A. Physics III Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: PHYS 121 and MATH 112, all with grade of C or better.

**PHYS 231H. Physics III Honors. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: PHYS 121 or PHYS 121H and MATH 112 or MATH 112H, all with grade of C or better. Third semester of a three-semester program in Honors Physics. Physical optics is treated in greater detail. Modern physics includes a greater number of topics, with special emphasis on the wave-particle duality in nature. Lab must be taken concurrently. See PHYS 231A.

**PHYS 234. Physics III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112. Elements of simple harmonic motion, wave motion, geometric and physical optics are considered. The wave and particle duality of nature is emphasized and made plausible by an examination of the important experiments and theories which lead to the modern concepts of matter and radiation. The conservation laws are broadened to include the equivalence of mass and energy.

**PHYS 310. Introduction to Atomic and Nuclear Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234; MATH 222, all with grade of C or better. Selected topics in atomic physics including the Pauli Exclusion Principle and the Atomic Shell Model. In nuclear physics, the two-body problem, nuclear models, alpha, beta, and gamma radiation, acclerators, and nuclear detectors are studied. R750 403 may be substituted for this course.

**PHYS 311. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Acceptance into the co-op program. Students gain major-related experience and reinforcement of the academic program. Work assignments are facilitated and approved by the Office of Cooperative Education and Internships. Participation in seminars and a final report/project is mandatory. Note: Normal grading applies to this COOP Experience.

**PHYS 320. Astronomy and Astrophysics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121, with grade of C or better. A quantitative introduction to the astronomy of the sun, earth, and solar system, with an emphasis on the physical principles involved. Includes celestial mechanics, planetary atmospheres and the physics of comets, asteroids and meteorites.

**PHYS 321. Astronomy and Astrophysics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 320, with grade of C or better. A quantitative introduction to the astronomy of the stars, the galaxy, and cosmology, with an emphasis on the physical principles involved. Includes stellar interiors, stellar evolution, galactic dynamics, large-scale structure and early history of the universe.

**PHYS 322. Observational Astronomy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 320, with grade of C or better. Most class time is spent in an observatory performing observations of celestial objects such as the Sun, Moon, planets, stars, stellar clusters, and galaxies. Experimental projects include charting the skies, asterophotography (film and CCD), measuring masses of planets, rotational period of the Sun, topography of the Moon, H-R diagrams of stellar clusters, etc.

**PHYS 335. Introductory Thermodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 211 or MATH 213, all with grade of C or better. Corequisites: MATH 222, MATH 238 or MATH 335. Introductory thermodynamics, kinetic theory, statistical physics. Topics include equations of state, the three laws of thermodynamics, reversible and irreversible processes. R750 315 may be substituted for this course.

**PHYS 350. Biophysics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 121 with a grade of C or better. This course presents an introduction to general biophysics and a preparation for medical school and biotechnology careers. It features molecules, viruses and cells racing to form enormous electric fields, succumbing to diseases and creating life. It explains how key medical devices preserve life. It asses students? progress using questions just like those on the medical school entrance exams and seeks an understanding of a few, simple principles of life science.

**PHYS 390. Selected Topics of Current Interest in Physics. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: PHYS 234 with grade of C or better. Seminar covering topics that are currently in the forefront of physics. The lecture series offers exposure to such topics as nuclear physics, solid state physics, plasma physics, the special and general theories of relativity, and the history and philosophy of science.

**PHYS 411. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: PHYS 311, with grade of C or better, and acceptance into the co-op program. Provides for co-op work assignments which must be approved by the Office of Cooperative Education and Internships. Participation in seminars and a final -report/project are mandatory. Note: Normal grading applies to this COOP Experience.

**PHYS 418. Fundamentals of Optical Imaging. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: PHYS 234 or PHYS 231, with grade of C or better. This is a course with both lectures and experiments and the emphasis is on the hands-on experiences. Upon completion of the course, students should not only grasp the basic concepts involved in imaging science, but also be able to work on simple real world imaging systems. The main content of the lecture part of this course can be summarized as the following: Optical sources, detectors and their working mechanism; Image formation and transmission; Optical imaging system and their characteristics; Imaging processing and algorithms. This course is developed in close collaboration with Edmund Optics Inc.

**PHYS 420. Special Relativity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 and MATH 222, all with grade of C or better. An introduction to Einstein's Special Theory of Relativity at the advanced undergraduate level. Topics include invariance of the speed of light, relativity of time and space, the Lorentz transformations, space-time diagrams, the twin paradox and time travel, relativistic mechanics, rotating reference frames, laser gyroscopes, superluminal motion, phase and group velocities, and applications in high-energy physics, relativistic engineering, nuclear physics, astrophysics, and cosmology.

**PHYS 421. General Relativity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 and MATH 222, all with grade of C or better. An introduction to Einstein's General Theory of Relativity at the advanced undergraduate level. Topics include review of Newton's Theory of Gravitation, review of Einstein's Special Theory of Relativity, tensor calculus on both flat and curved manifolds, the covariant derivative, curvature, Einstein's Gravitational Field Equations, the weak-field limit, gravitational radiation, the black hole solution, Hawking radiation, the No-Hair Theorem, cosmology, and a history of the Universe.

**PHYS 430. Classical Mechanics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 and MATH 222 and MATH 328 or MATH 335, all with grade of C or better. Newtonian mechanics of particles and systems. Lagrange's and Hamilton's approaches. Continuous systems. R750 361 may be substituted for this course.

**PHYS 431. Classical Mechanics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 430, with grade of C or better. Theory of small oscillations and mechanical waves. Rigid bodies. Topics include stability, linearization methods, forced vibrators and perturbation theory, fluids and mechanics of continuous media. 21&62 750 362 may be substituted for this course.

**PHYS 432. Electromagnetism I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H and Math 328 or Math 335, all with grade of C or better. Electrostatics and magnetostatics, Maxwell's equations with applications, and electrodynamics.

**PHYS 433. Electromagnetism II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 432, with grade of C or better. Maxwell's equations with applications and electrodynamics.

**PHYS 441. Modern Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222 , all with grade of C or better. Topics include wave-particle duality, wave mechanics, two-state quantum systems, the motion of an electron in a periodic lattice, band theory of solids, electrical, thermal and magnetic properties of solids, and plasmas and super fluid systems. R750 316 may be substituted for this course.

**PHYS 442. Introduction to Quantum Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 430, with grade of C or better. Wave-particle duality, the Schrodinger and Heisenberg formulations of quantum mechanics. The hydrogen atom, perturbation theory, and concepts of degeneracy, composite states and general properties of eigenfunctions. R750 404 may be substituted for this course.

**PHYS 443. Modern Optics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with a grade of C or better. Electromagnetic theory of light, interference, diffraction, polarization, absorption, double refraction, scattering, dispersion, aberration, and an introduction to quantum optics. Other topics include holography, lasers, information retrieval, spatial filtering, and character recognition.

**PHYS 444. Fluid and Plasma Dynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222 , all with grade of C or better. Introduces the basics of plasma physics. Covers the following plasma parameters, single particle motions, plasma as fluid, waves, diffusion and resistivity, equilibrium and instability, kinetic theory, nonlinear effects. Applications in three areas: controlled fusion, astrophysics, and interaction between light and plasma.

**PHYS 446. Solid State Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222, with grade of C or better. Corequisite: PHYS 442. An introduction to modern concepts of the solid state. Topics include crystal structure and diffraction, crystal binding and elastic properties, thermal properties, dielectric phenomena, band theory of solids and Fermi surfaces, electrical conductors, semiconductors, magnetism, and super-conductivity. R750 406 may be substituted for this course.

**PHYS 450. Advanced Physics Laboratory. 3 credits, 5 contact hours (1;4;0).**
Prerequisites: PHYS 335, PHYS 430, PHYS 432, all with grade of C or better. Introduction to electrical measurements; instrumentation; theoretical and applied electronics, solid state electronic devices, digital circuitry; computer design; experiments in modern physics.

**PHYS 451. Biophysics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121 with a grade of C or better. An introduction to electrical aspects of biophysics and a preparation for medical school and biotechnology careers. Covering how medical devices work and using active learning with reports on new research.

**PHYS 452. Atomic and Nuclear Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with grade of C or better. Topics include atomic spectra, atomic structure, and nuclear physics.

**PHYS 456. Introduction to Solid State Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with grade of C or better. Treats the same topics as PHYS 446 while introducing the necessary modern physics. Designed for students choosing a minor in applied physics. Students majoring in applied physics are ineligible.

**PHYS 461. Mathematical Methods of Theoretical Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 430, PHYS 432, PHYS 433, all with grade of C or better. Topics include vector and tensor analysis, matrix methods, complex variables, Sturm-Liouville theory, special functions, Fourier series and integrals, integral equations, and numerical solutions of differential equations.

**PHYS 480. Topics in Applied Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Permission of instructor. Current topics and interests in applied physics and physics. Emphasis is on research and scientific development in microelectornics, optoelectronics, optical physics, materials science, surface science, solar physics, and modern physics.

**PHYS 481. Applied Solid State Physics: Microelectronics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 446, with grade of C or better. Topics include physics of bipolar and field effect devices, Phonon and optical spectra, unipolar devices, and thermal and high field properties of semiconductor devices.

**PHYS 482. Applied Solid State Physics: Microelectronics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 446, with grade of C or better. Topics include large-scale integrated circuits, device characteristics, charge-coupled devices, LED and semiconductor lasers, photodetectors, and electrical and optical properties of materials.

**PHYS 483. Applied Solid State Physics. 3 credits, 6 contact hours (0;6;0).**
Prerequisite: PHYS 446, with grade of C or better. Introduction to digital concepts; binary circuits and microprocessor architecture. Applications of discrete solid-state devices and integrated circuits are explored both in theory and practice. The laboratory also serves as an introduction to hardware and software components of a typical microcomputer.

**PHYS 485. Computer Modeling of Applied Physics Problems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with grade of C or better. General computer programming modeling methods and techniques. Numerical solutions to integro-differential equations. Eigenvalues problems. Application of computer-aided-design and other packages. R750 461 may be substituted for this course.

**PHYS 490. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Departmental approval. Undertake individual research or a project under the supervision of a member of the physics department. 21&62 750 485, 486 may be substituted for this course.

**PHYS 491. Independent Study II. 3 credits, 3 contact hours (0;0;3).**

**R460 101. Intro To The Earth. 3 credits, 3 contact hours (3;0;0).**

**R460 102. Africa:A Virtual Tour. 3 credits, 0 contact hours (0;0;0).**

**R460 103. Planet Earth. 3 credits, 3 contact hours (3;0;0).**

**R460 104. Planet Earth Lab. 1 credit, 1 contact hour (1;0;0).**

**R460 106. Environ. Geol. 3 credits, 3 contact hours (3;0;0).**

**R460 107. Environ Geology Lab. 1 credit, 1 contact hour (1;0;0).**

**R460 114. Earth & Life History. 3 credits, 3 contact hours (3;0;0).**

**R460 115. Earth & Life Hist Lab. 1 credit, 1 contact hour (1;0;0).**

**R460 201. Earthquakes - Volcano. 3 credits, 3 contact hours (3;0;0).**

**R460 203. Natural Disasters. 3 credits, 3 contact hours (3;0;0).**

**R460 206. Env Geology. 3 credits, 0 contact hours (0;0;0).**

**R460 207. Env Geology Lab. 1 credit, 1 contact hour (0;1;0).**

**R460 215. Environmental Disasters. 3 credits, 3 contact hours (3;0;0).**

**R460 225. Intro Oceanography. 3 credits, 3 contact hours (3;0;0).**

**R460 230. Weather And Climate. 3 credits, 3 contact hours (3;0;0).**

**R460 309. Geomorphology. 3 credits, 3 contact hours (3;0;0).**

**R460 311. Geologic Field Problems. 3 credits, 3 contact hours (3;0;0).**

**R460 314. Stratigraphy. 4 credits, 4 contact hours (4;0;0).**

**R460 320. Structural Geology. 4 credits, 0 contact hours (0;0;0).**

**R460 321. Mineralogy. 4 credits, 3 contact hours (3;0;0).**

**R460 322. Petrology. 3 credits, 3 contact hours (3;0;0).**

**R460 323. Rocks and Minerals. 4 credits, 4 contact hours (4;0;0).**

**R460 325. Intro to GIS. 3 credits, 3 contact hours (3;0;0).**

**R460 331. Oceanography. 3 credits, 3 contact hours (3;0;0).**

**R460 375. Quant Methods Geosci. 4 credits, 4 contact hours (4;0;0).**

**R460 400. Intro to Soil Science. 4 credits, 4 contact hours (4;0;0).**

**R460 401. Intro Geochemistry. 3 credits, 3 contact hours (3;0;0).**

**R460 406. Applied Geophys. 3 credits, 3 contact hours (3;0;0).**

**R460 415. Geologic Problems. 3 credits, 3 contact hours (3;0;0).**

**R460 416. Geologic Problems. 3 credits, 3 contact hours (3;0;0).**

**R460 427. Hydrogeology. 3 credits, 3 contact hours (3;0;0).**

**R950 261. Fundamentals Of Speech. 3 credits, 3 contact hours (3;0;0).**

**R950 281. Public Speaking. 3 credits, 3 contact hours (3;0;0).**

**R950 289. Princ Of Oral Interp. 3 credits, 0 contact hours (0;0;0).**

**R950 290. Oral Interpetaion. 3 credits, 0 contact hours (0;0;0).**

**R950 382. Persuasion. 3 credits, 3 contact hours (3;0;0).**

**STS 100. Social Science and CSLA Research. 3 credits, 3 contact hours (3;0;0).**
This course introduces the content and methodologies of CSLA disciplines, provides examples of research problems through the lens of the social sciences and gives students an understanding of each major and an overview of the social, historical, and ethical influences on contemporary sciences, and the changing relationships among science, technology and culture. Each week CSLA researchers lecture on applied approaches to problem solving in their domains.

**STS 101. Foundations of Science, Technology and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. This course introduces students to the multi-disciplinary study of science, technology and society. Through a combination of lectures by the STS teaching staff and external speakers, as well as classic and contemporary readings and case studies that exemplify the field's core content, students examine the social, aesthetic, environmental, economic and political constructs that contextualize the development and proliferation of mechanical and digital technologies with which we interact.

**STS 2**. Science Tech and Society Elect. 3 credits, 3 contact hours (3;0;0).**

**STS 201. Understanding Technological Society. 3 credits, 3 contact hours (3;0;0).**
A problem-centered and task-oriented course that integrates social science theory and practice into the leading public issues of a technological society. Students learn critical thinking through hands-on assignments. The course emphasizes student understanding of social institutions that directly affect technological development and professional careers.

**STS 205. Intro to Research Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102. This course is intended to give second year undergraduate students an understanding of what research is, what it is used for, how it is conducted, and how it is reported. It provides an overview of applying the scientific method to real-life research, including ethical concerns, qualitative and quantitative methods (and how and when they should be used), and how to critically evaluate published research findings.

**STS 210. General Psychology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 with a grade of C or better. Introduction to the study of human behavior. Topics include motivation, perception, learning, cognitive development, personality and emotion, individual difference, and biological basis of behavior, as well as methodology in psychological research.

**STS 221. Sociology. 3 credits, 3 contact hours (3;0;0).**
An examination of modern society and culture, analyzing the forces for stability and change. Topics covered include the individual and society (socialization, conformity, alienation, and class structure), social institutions (religion, law, education, family, state), social processes (conflicts and harmony, cohesion and dissolution, power, authority, and revolution), urbanization, industrialization, and technological change.

**STS 257. Technology, Society and Culture: An American View. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. This course will examine several key cases in the way technology fits into society. The politics, sociology, and ethics of technological development will be investigated. Topics include several significant advances of the twentieth century: nuclear warfare, fast food, the simplicity movement, and futuristic enhancement. What do all these things have to do with one another?.

**STS 258. Technology, Society and Culture: A Global View. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. This course will investigate the issues and problems inherent in the globalization of technology and culture at the beginning of this new millennium. Countries and economies are becoming more entwined in each others identities and economies, and cultural diversity is both threatened and proliferating at one and the same time. How much can the world's markets continue to grow and connect? How does the spread of information change what we know about one another? Should we be afraid of progress? Does the world understand the United States? Do we understand the world? How can "Growth" or "development" be sustained? How can we guide its change?.

**STS 300. Legal Reasoning, Writing, and Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101. Integrates the process of legal research and fundamentals of legal writing with analysis of law. Focuses upon legal reasoning through analysis of fact and upon the logic of law in judicial opinions, statutory construction, and constitutional interpretation as contemporary issues are analyzed.

**STS 301. Independent Study. 1 credit, 3 contact hours (0;0;3).**
Prerequisites: junior standing in the STS program and written approval of the program director. Consists of self-paced study on an individual or small group basis in a specific area integral to a student's STS concentration but not available on a regular course basis.

**STS 302. Independent Study. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: junior standing in the STS program and written approval of the program director. See STS 301.

**STS 303. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: junior standing in the STS program and written approval of the program director. See STS 301.

**STS 304. Writing about Science, Technology and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Develop abilities to write lucidly and speak forcefully about the interrelationship of science, technology and society. Learn to articulate a sense of purpose in order to choose the appropriate methods for reporting issues in a technological society. Effective development and transfer of technical knowledge in a complex world.

**STS 306. American Mosaic: Understanding Cultural Diversity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of multiculturalism in the United States. The course provides students with a methodological framework for understanding cultural diversity in the United States and around the world.

**STS 307. Fundamentals of Research in STS. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Focuses on research methods in the field of science, technology and society. Focuses on the following methods: problem statement and hypothesis formulation; research design in science, technology and society; data sources; and data acquisition and analysis.

**STS 308. Technology and Global Development: Introduction to STS. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Introduces the important public issues that technology brings to the modern world, such as energy development and environmental pollution. Emphasizes the close connections between science and technology, social institutions, and cultural values. Also analyzes today's "global village", the changing relations between East and West and the Third World, and worldwide development and environmental issues.

**STS 309. Advocacy and the Law. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ENG 300, SS 300 both with a grade of C or better. Offers opportunities to explore the retrieval and use of legal and law-related materials while developing skills in oral advocacy and in writing persuasive legal documents, such as motion memoranda and briefs. Includes learning to listen to participants in the legal process as well as developing effective styles and forms of speech in the classroom.

**STS 310. Technology and Human Values. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Examines the interactions between science, technology and human values. Specifically, explores psychological, moral, and philosophical consequences of, and humanistic responses to, technological change. Readings, essays, fiction, and research articles treat such topics as the philosophical foundations of modern science, scientism, technicism; the impact of technology on images of man found in modern literature; and the moral implications of various kinds of recent technology.

**STS 311. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op Office. Mandatory participation in seminars and completion of a -report. Note: Normal grading applies to this COOP Experience.

**STS 312. Technology and Policy in Contemporary America. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. A study of technology and politics in recent America. Focuses on the role of the federal government in shaping technology, especially through funding technological innovations and applications. Topics will include the origins of technology policy in World War II, the influence of the Cold War, the science and technology policy advisory system, and political and cultural influences on technology policy.

**STS 313. Environmental History and Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Covers the rise of the modern environmental debate, and examines its current priorities and values, politics and economics, and impacts on industry and society. Students review the role of regulatory agencies, private industry, public interest groups, and the media. Current major issues in New Jersey are considered, as well as environmental debate on a national and global level.

**STS 316. Mass Communications, Technology and Culture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Uses the tools of the humanities and social sciences to study the interplay between technology and mass culture. Focuses on motion pictures, electronic music, and television as both technologies and as forms of art. Devotes special attention to the portrayal of science and technology in the media.

**STS 318. Educational Media Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201. Educational Media Design employs the instructional principles of constructivist pedagogy as the process used to develop a solution to develope courseware for K-12 audience. The course builds on the participatory design model of software engineering in order to develop integrated learning environments that support visual and verbal literacy; enables student to be able to plan, organize, and systematically develop instructional materials. This course implements instructional design theory and pedagogy in order to create an actual application for a computer-based environment. Same as IT 380.

**STS 320. Global Evolution of Scientific Thought I: Case Studies from Antiquity through the 19th Century. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Traces the global development of scientific ways of thinking and demonstrates how scientific ideas, methods, and theories both reflect and influence thought in other areas. Special emphasis is on the biographical approach to scientific innovation through analysis of key figures in relation to the societies in which they lived. Attention is paid to the roles of class and gender in scientific practice. Begins with the study of science in the ancient nations of Babylonia, China, and India and ends with an examination of the rise of scientific approaches to social problems in the nineteenth century.

**STS 324. Topics In Sci Tech & Soc. 3 credits, 3 contact hours (3;0;0).**

**STS 325. ST:. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An in-depth examination of a current STS issue. A new topic is addressed each time the course is offered.

**STS 330. The Professional Engineer: History and Context. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of the origins of modern engineering and the context in which engineering has developed. The course includes an analysis of the contemporary engineering culture?its structure and the values which drive it. The student will be expected to confront both the constraints and opportunities presented by the professional world of engineering.

**STS 339. Philosophy and Psychology of Race and Gender. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and STS 210, each with a grade of C or better. Course examines the psychological elements of prejudice, with emphasis on racial cognition and gender bias. Topics covered include the history of essentialism about race and gender; implicit bias; stereotype threat; interventions against biased attitudes; and ethics of race and gender bias. Readings from contemporary philosophy and psychology.

**STS 340. Multiculturalism in a Technological Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Explores the roles of culture and ethnicity in our increasingly technological and global society. The interplay between scientific developments and the specific sociocultural contexts is addressed. Specific case studies from various countries are explored, covering differing levels of technological achievement. Upon completion of the course, students will be able to competently analyze the interaction between a country's scientific development and its political and sociological climate. Special topics are negotiated with students at the start of each class, with the goal of covering all continents and a variety of scientific fields. At least one case study each semester carefully reviews multiculturalism in the American technological culture. Emphasis also is given to the particular roles and responsibilities of the United States as a technological and political leader.

**STS 342. Women in Technological Culture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Takes an interdisciplinary and multicultural approach to issues of gender in science and technology. The issues include the current status and problems of women in non-traditional professions; the historical contributions of women in science and technology; images of women in Western and non-Western cultures; theories of gender difference, past and present; the impact of cultural gender coding on the epistemologies of science and technology; women and Third World development. Course materials include case studies and autobiographical narratives, films, and science fiction as well as historical and sociological analyses. Expressive student writing and group projects are encouraged.

**STS 344. Communications Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Study of communication environments and developing communications technologies as central elements of evolving political and social systems. Analysis of philosophical, military, economic, and technical premises for communications policy and the process of regulation.

**STS 346. Pragmatism and Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Examines the relationship between the American philosophy of pragmatism and the role of technology in the contemporary world. How do philosophical ideas affect the development of technology and science? How has pragmatism shaped the current view of the meaning and value of technological progress? Readings from both the traditional authors of American pragmatism?Peirce, James, and Dewey?and contemporary texts.

**STS 347. Introduction to Music. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 with a grade of C or better. This course is an introduction to the history of music, from ancient to present times, Western, Eastern, folk, world, classical, jazz, rock, and electronic. The class aims to develop in the student an informed and critical ear to make sense of the vast array of music available to our ears today. We also cover how technology has transformed how we experience and create music, from the development of the piano to the computer. The course involves extensive music listening and writing about music. It is a prerequisite for the hands-on electronic music classes that NJIT offeres, STS 349 and STS 325.

**STS 348. Esthetics and Modern Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. The central focus of this course is on the changing conception of beauty as influenced by technological development, especially in twentieth-century United States society. The course examines how technology is echoed in art and philosophy, and how they, in turn, influence future technological considerations.

**STS 349. Advanced Music Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: STS 347. Students will learn the basics of notebook computer-based music composition and production. Emphasis will be on composition and making of music, learning the aesthetics necessary to get the most out of your machine. Course will require extensive work on your own home computer. Computer requirements: A PC or Macintosh system running Ableton Live.

**STS 350. Computers and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, one SS course, completion of a 100-level GUR course in CS, all with a grade of C or better. Examines the historical evolution of computer and information systems and explores their implications in the home, business, government, medicine, and education. Topics include automation and job impact, privacy, and legal and ethical issues.

**STS 351. Minds and Machines. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and STS 210, each with a grade of C or better. An introduction to the philosophy of mind and cognitive science. Topics covered include the computational theory of mind; artificial intelligence; connectionism; embodied theory of mind; and dynamical theories of mind. Readings from recent and contemporary philosophy, psychology and computer science.

**STS 352. Race and Ethnicity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, EPS 202, ECON 201 or their equivalents. Explores the concepts of race and ethnicity in both national and international arenas. Scientific, sociological, political, and global implications are addressed. Upon completion of this course, students will be able to competently address the impact of race on micro and macro levels, from both individual and policy perspectives. Special topics are negotiated with students at the start of each class. Such topics can include immigration, affirmative action, educational curricula, institutional racism, or the impact of multiculturalism on families. Emphasis is on the interaction between race and technology.

**STS 358. Moral Psychology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and STS 210 each with a grade of C or better. An introduction to moral philosophy with emphasis on the biological and psychological mechanisms underlying moral thought, judgment an action. Topics covered include altruism and egoism; utilitarianism, deontology and virtue ethics; the situationist critique of character; and agency and responsibility. Readings draw from classical and contemporary philosophers as well as from current empirical psychology.

**STS 359. Cyberpsychology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 with a grade of C or better and STS 201 or STS 210 or equivalent with a grade of C or better. Introduction to the study of the effects of the internet and cyberspace on the psychology of individuals and groups. Some topics covered include: online identity, online relationships, personality types in cyberspace, transference to computers, addiction to computers and the internet, regressive behavior in cyberspace, online gender-switching, etc.

**STS 360. Ethics and the Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of contemporary environmental problems from the perspective of ethics or moral philosophy. An analysis of the ethical presuppositions and value principles underlying environmental policy. The study of ethical theories and their application to the environmental crisis.

**STS 362. Environmental Economics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, EPS 202, ECON 201 or their equivalents, all with a grade of C or better. Presents a detailed overview of the relationship between political economy and the environment. Draws on diverse case studies including global warming, harvesting of minerals on the ocean's floor, destruction of old growth forests, and contamination of the -nation's water, air, and soils. Explores the economic remedies to the fast-changing relationship between society and nature.

**STS 363. Introduction to Sustainability Studies. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and EPS 202, each with a grade of C or better. The course introduces students to sustainability studies, examines the roots of the concept, and explores its roles as feature of international politics. Particular attention is devoted to the economically, advanced nations and the challenges of planning for a more sustainable future. The course also considers how the sustainability agenda is likely to evolve in an era of climate change and biophysical constraints.

**STS 364. Sustainability Policy and Practice. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201, EPS 202 and STS 363, each with a grade of C or better. Formulation of effective sustainability policies requires appreciation of the linkages between conceptual understanding and empirical practice. The course highlights the macroeconomic drivers of contemporary sustainability challenges. Topics discussed include efficiency improvements, economic relocalization, green consumerism, and efforts to build a green economy.

**STS 378. Literature and Nature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Literature reveals and interprets the natural world. Students examine the ways that nature has been used in non-fiction and fiction. Students also learn the challenge of describing the natural world in their own words. Representative writers include Percy Shelley, Henry David Thoreau, Octavio Paz, Denise Levertov, Gary Snyder, Joyce Carol Oates, and Annie Dillard. Co-listed as LIT 378.

**STS 380. Policy Issues in the Coastal Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of coastal environments from the standpoint of the scientist, the engineer, and the resource manager. Topics include beach and shoreline characteristics, technological innovations to address coastal erosion problems, and current debates in coastal policy and resource management. Case studies are used to illustrate coastal management practices and the scientific, technical, and social constraint to policy formulation.

**STS 381. Field Techniques and Research Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An introduction to research methods. The objectives of the course are to provide opportunity to pursue specialized, in-depth research in a subfield of science, technology and society of the student's choice; to develop skills in problem identification, research design and problem solving; to increase familiarity with methods of data analysis; to strengthen library research skills; to provide an opportunity to gather original field data in a team-oriented environment; and to improve oral and written communication skills.

**STS 382. Geographical Perspectives on the Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Designed to introduce students to the field of geography. Focuses on the natural processes that sculpt the physical and biological terrain, and the environmental interrelationships between human societies and nature. Combining physical, human and environmental perspectives on the earth's surface, explores, in depth, topics such as famine, societal response to natural and technological hazards, and water issues in the United States.

**STS 401. Independent Study. 1 credit, 3 contact hours (0;0;3).**

**STS 403. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**STS 411. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: STS 311 or its equivalent with a grade of C or better, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/ or project. Note: Normal grading applies to this COOP Experience.

**STS 490. Project and Seminar I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: senior standing in the STS program. Each student undertakes a comprehensive study of an issue in science technology and human affairs. The solution requires application of knowledge and skills acquired in course work, self-study, and library research as well as consultation with persons in the academic community, industry, and government. The completed study is submitted as a detailed written report. The seminar meets weekly. Speakers from education, government, and industry address themselves in topics of current interest to STS students.

**STS 491. Project and Seminar II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: STS 490. A continuation of STS 490.

**THTR 101. Living Theatre. 3 credits, 3 contact hours (3;0;0).**
An introduction to the basic elements of theater through an examination of the roles of the playwright, director, designer, and actor. Attend select current plays and professional productions.

**THTR 102. Acting Fundamentals. 3 credits, 3 contact hours (3;0;0).**
Developing acting skills in a studio environment. Work with improvisation comedy and drama, scene study based on known contemporary and classical plays, and basic theater exercises that develop physical skills for character development and performance endurance. Emphasis on vocal skills using presentation exercises and theatrical audition techniques will be developed through the class.

**THTR 208. Movement for Theatre. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). Introduces skill-oriented movement exercises through an exploration of the physical nature of acting and character work. Movement is basic to actor training. The movement exercises used in this course will explore not only the physical age of the characters from plays chosen in class, but also work with the character social movements basedon the cultural history of the times the plays were written or the historical period they represent.

**THTR 209. Voice and Speech for Theatre I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). The objective of the course is for students to learn to use voice as a vocal instrument. Beginning with breath control, students learn how to project the voice, the use of resonators, and the placement of the voice in space. This is an essential training for the actor or public speaker. Exercises will be generated from plays from around the world. The character work from these plays will include the study of dialects, sustainability, phonetics, and culturally specific vocals.

**THTR 210. Voice & Speech for Theater II. 3 credits, 3 contact hours (3;0;0).**
Working with plays, poetry, and narratives, students learn to analyze texts vocally and to explore the relationship between physical and vocal expression.

**THTR 212. From Page to Stage. 3 credits, 3 contact hours (3;0;0).**
The course is an introduction to understanding the relationship between the literary nature of plays and how they are produced for the stage. Attendance to current professional productions and on-campus productions will be used as a launching point for class papers, discussions, and exercises.

**THTR 213. Directing I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). Students will learn major directoral techniques in the production of short plays and other workshop scenarios. There is an emphasis on the process of synthesizing theatrical elements of direction in order to oversee and orchestrate the mounting of a theater production. The goal of the course is for students to learn what directors do to ensure the quality and completeness of theater production by collaborating with a team of individuals involved in stagecraft, costume design, props, lighting design, acting, set design, stage combat, and sound design for the production.

**THTR 215. Acting II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: THTR 102 or permission of instructor. Advanced scene study, audition techniques, and ensemble techniques are explored. Interpretation of scenes from selected dramas for stage performance, evaluation of practiced techniques in character portrayal through dialogue and action. Participation in a performance workshop is stressed.

**THTR 216. Improvisational Theatre Short Form. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). THTR 216 introduces the techniques of short-form improvisational performance through in-class practical exercises that promote spontaneity and creative space work. Students work with game structure and short narratives leading to public performances so the student gains insights only the live setting can impart.

**THTR 217. Improvisational Theatre Long Form. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). This course includes exercises that promote long-form interactive narrative and story development skills. In addition to exploring storytelling this technique is used in other media such as, music, movement, and film. The students will perform multiple times getting feedback only a live show can give.

**THTR 220. Instr Ensemble Performance I. 1 credit, 3 contact hours (0;3;0).**
Prerequistes: permission of course coordinator and conductor This course involves membership in an instrumental music group led by a professional conductor. The group will meet once a week to rehearse concert pieces. Students must play an instrument with a significant level of accomplishment in order to register for this course. There will be continuous assessment of individual performance by the conductor and a final concert in a campus venue. This is one of three performance courses. Musicians may join one or more of these ensembles, wind, string, jazz, etc. In order to register for this course, contact instructor for permission.

**THTR 221. Instr Ensemble Performance II. 1 credit, 3 contact hours (0;0;3).**
Prerequistes: permission of course coordinator and conductor This course involves membership in an instrumental music group led by a professional conductor. The group will meet once a week to rehearse concert pieces. Students must play an instrument with a significant level of accomplishment in order to register for this course. There will be continuous assessment of individual performance by the conductor and a final concert in a campus venue. This is one of three performance courses. Musicians may join one or more of these ensembles, wind, string, jazz, etc. In order to register for this course, contact instructor for permission.

**THTR 222. Instr Ensemble Performance III. 1 credit, 3 contact hours (0;0;3).**
Prerequistes: permission of course coordinator and conductor This course involves membership in an instrumental music group led by a professional conductor. The group will meet once a week to rehearse concert pieces. Students must play an instrument with a significant level of accomplishment in order to register for this course. There will be continuous assessment of individual performance by the conductor and a final concert in a campus venue. This is one of three performance courses. Musicians may join one or more of these ensembles, wind, string, jazz, etc. In order to register for this course, contact instructor for permission.

**THTR 261. Performance I. 3 credits, 3 contact hours (3;0;0).**
Departmental approval required. A lecture/workshop that combines class with a play production. An in-depth study of the author of the play and contemporaries of his/her time will be made throughout the semester. A different style or genre of theater is studied each term the course is offered based on the chosen mainstage production.

**THTR 262. Performance II. 3 credits, 3 contact hours (3;0;0).**
Departmental approval required. A study will be made of the chosen playwright, contemporaries of the writer, and an in-depth study of costume design, music of period, and set design of the play chosen for production. A production team will coordinate the main stage production.

**THTR 310. Theatre History I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Study of Euro-American theater history from Greece and Rome through early post-Renaissance Europe. The course covers the dramatic literature of the times and how the socioeconomic influences reflect the theatrical style, community interaction, and the technical uses of stage devices.

**THTR 315. Theatre History II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Study of Euro-American theatre history from post-Renaissance Europe to present. Dramatic literature will be related to the historical events that reflect theatrical style, political movements, and technical advancements in society.

**THTR 344. American Musical Theater. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Course covers the development of American Musical Theatre decade by decade, starting with the turn of the 20th century until the present day. Examples of music and lyrics are demonstrated in class and students attend contemporary and revival Broadway musicals.

**THTR 365. Principles of Playwriting. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. The course objective is to write and rewrite three short plays during the semester. These new plays will have a first reading and a staged reading in the classroom, followed by analytical discussions about playwriting and the craft's applied techniques. Students will attend two professional plays and write subsequently one experience paper and one research paper; attend both campus shows for discussion and in-class improvisational playwriting exercies. The original plays developed in class will be submitted by the student for playwriting competitions at the end of the semester.

**THTR 396. Internship-Theater. 3 credits, 3 contact hours (0;0;3).**
Open to junior or senior Theater majors or minors or Communication majors with Theater Specialization. Permission of division director or faculty advisor in conjunction with the instructor directing the course. The internship is with a professional performing or media arts organization. The student is expected to work with the host company for professional experience.

**THTR 411. Special Topics in Theatre. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This specialty course will feature a different aspect of theater each semester depending on the area of expertise of the instructor. Some examples: The course could cover playwriting, advanced playwriting, film writing, and musical theater techniques, advanced theater directing, auditioning skills, advanced acting or acting: history and practice.

**THTR 414. Directing II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: THTR 213 or departmental approval. Assistant directing main stage production with faculty director or other independent directing project. Intense study of directing style through practice and research.

**THTR 465. Performance II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: THTR 261 or THTR 262 and HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This is an advanced study of one playwright's work leading to a performance of one of his/her plays. A study will be made of the chosen playwright, contemporaries of the writer, and an in depth study of costume design, music of period, and set design of the play chosen for production.

**THTR 483. Independent Study in Theater I. 3 credits, 3 contact hours (0;0;3).**
By arrangement only through a theater faculty advisor, the student will take on a specialized creative theater project for the semester. This would cover a specific aspect of theatrical production development and cumulate in one of the following depending on the nature of the assignment: a journal or portfolio of completed production work, an original play or screenplay script, or research document.

**THTR 484. Independent Study in Theater II. 3 credits, 3 contact hours (0;0;3).**
This course is for junior and seniors only by arrangement through a theater faculty advisor. The student will take on a more advanced specialized creative theater project for the semester. AS this would cover a specific aspect of theatrical production development, the student will be expected to take on a leadership role in the chosen area of study. Documentation of the project development and completion is required.

# Aerospace Studies

The Aerospace Studies Department is affiliated with the Air Force Reserve Officer Training Corps (AFROTC) based at NJIT, and AFROTC Detachment 490 is committed to graduating outstanding officer leaders for the U.S. Air Force. Students enrolled in AFROTC take classes in aerospace history, leadership and management, national security, and physical fitness. Cadets can compete for excellent scholarship support and receive an exceptional education in preparation for the many career opportunities available while serving as a U.S. Air Force officer after graduation.

Cadets can learn to lead and achieve personal success in careers such as piloting, remote-piloting, engineering, physics, intelligence, space operations, communications, nursing, and many more fields. For more information about aerospace studies at NJIT, visit njit.edu/rotc (http://njit.edu/rotc) or call 973-596-3626, and learn more about AFROTC at afrotc.com (http://www.afrotc.com).



## Aerospace Studies Courses

**AS 111. Foundation of the US Air Force. 1 credit, 2 contact hours (2;0;0).**
Explores the mission and organizational structure of the United States Air Force. Introduces the student to Reserve Officer Training Corps by examining air power, customs and courtesies, officership, and core values. Examines Air Force opportunities, benefits, career choices, and installations which provides information needed to determine whether or not to pursue a career as an Air Force officer. An introduction to effective communication is included. One hour of class, and, two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 112. The Air Force Today II. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: AS 111 or approval of the professor of aerospace studies. Continues with the mission and organizational structure of the Air Force. A macro view of U.S. military history is introduced with emphasis on U.S. air power. Air Force communications is developed with emphasis on interpersonal communications, oral communications, and written communications. Leadership abilities are developed through group leadership problems and Leadership Laboratory. One hour of class and two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 221. Evolution of USAF Air and Space Power. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: AS 112 or approval of the professor of aerospace studies. Examines the development of air power from its earliest beginnings to the present, including in-depth examination of World War I, World War II, Korean Conflict, Vietnam War, Cold War, and Desert Storm. Traces the evolution of air power concepts and doctrine and continues to develop leadership abilities through Leadership Laboratory. One hour of class and two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 222. Air Power Key To Deterence. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: AS 221 or approval of the professor of aerospace studies. Emphasizes the concepts and skills required by the Air Force officer including oral communications, Air Force quality, leadership, followership, ethics, and values. Continues to develop leadership abilities through group leadership problems and Leadership Laboratory. One hour of class and two hours of Leadership Laboratory per week (not required for those with Special Student status).

**AS 301. Aerospace Independent Study. 3 credits, 3 contact hours (0;0;3).**

**AS 333. Leadership and Management I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AS 222 or approval of the professor of aerospace studies. Emphasizes the concepts and skills required by the successful management and leader. Curriculum includes individual motivational and behavioral processes, leadership, communication, and group dynamics, providing the foundation for developing the junior officer's professional skills. Course material stresses decision making, and the use of analytic aids in planning, organizing, and controlling in a changing environment. Develops communication skills through writing and speaking exercises. Three hours of class and two hours of Leadership Laboratory per week. Note: AS 333 may be taken to satisfy the Management GUR.

**AS 334. Leadership and Management II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AS 333 or approval of the professor of aerospace studies. A continuation of AS 333. Organizational and personal ethics, management of change, organizational power, politics, and managerial strategy are discussed within the context of the military. Actual Air Force case studies are used throughout the course. Three hours of class and two hours of Leadership Laboratory per week.

**AS 335. Leadership Lab. 0 credits, 0 contact hours (0;0;0).**

**AS 336. POC Leadership Lab. 0 credits, 0 contact hours (0;0;0).**

**AS 401. Aeropsace Independent Study. 3 credits, 0 contact hours (0;0;0).**

**AS 443. National Security Affairs/Prep Act. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: AS 334 or approval of the professor of aerospace studies. Focusing on the U.S. Armed Forces as an integral element of American society, this course examines a wide variety of topics concerning American civil and military relations and the environment in which U.S. defense policy is formulated. Specific topics include the role of the professional officer in a democratic society, socialization processes within the American military forces, and the requisites for maintaining adequate national security forces. A special emphasis is placed on further refining the student's communications skills in the context of the course material. Three hours of class and one and one-half hours of Leadership Laboratory per week.

**AS 444. Preparation for Active Duty. 3 credits, 0 contact hours (0;0;0).**
Prerequisite: AS 443 or approval of the professor of aerospace studies. Focuses on the role of the Air Force officer while on active duty. Includes responsibilities as an officer, a commander, a leader, and a manager. Topics include a review of military law, nonjudicial punishment, role of the staff judge advocate, laws of armed conflict, military ethics, officer professional development, an officer's social responsibilities, fraternization, personal finances, staff work, and Air Force base services and activities. Concludes with a review of the Air Force Core Values. Three hours of class and two hours of Leadership Laboratory per week.

# Leadership and Aerospace Studies Minor

*Open only to AFROTC students*

| |
|---|
| AS 100 |
| AS 200 |
| AS 300 |
| AS 400 |
| Leadership Lab |
| One elective course (with the approval of the minor coordinator) |

# Biological Sciences

NJIT’s Department of Biological Sciences is federated with Rutgers University-Newark, an affiliation that offers comprehensive opportunities for study and research, with diplomas issued jointly by NJIT and Rutgers. Students thus benefit from the best of both universities. NJIT emphasizes the quantitative and technical aspects of biology, while the focus at Rutgers is on the cellular and molecular aspects of biology, as well as ecology and evolution. Ample opportunities to participate in research at the undergraduate and graduate levels include neural-network function, neuro-immunology, waves and diffusion of ions in the brain, respiratory physiology, population dynamics, and global climate and ecosystem change.

## NJIT Faculty

### B

Bucher, Dirk M., Associate Professor

Bunker, Daniel E., Assistant Professor

### F

Flammang-Lockyer, Brooke E., University Lecturer

Fortune, Eric S., Associate Professor

### G

Garnier, Simon J., Assistant Professor

Golowasch, Jorge P., Professor

### H

Haspel, Gal, Assistant Professor

### N

Nadim, Farzan, Professor

### R

Russell, Gareth J., Associate Professor

### S

Soares, Daphne F., Assistant Professor

Stanko, Maria L., University Lecturer

### T

Trimby, Christopher M., University Lecturer

### W

Wisner, Ellen M., University Lecturer

### Y

Yarotsky, John J., University Lecturer

## Programs

- Biology - B.A. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba)
- Biology - B.S. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/bs)

## **Accelerated Programs** (p. 92)

- Biology - B.A./M.D., D.M.D., D.D.S., O.D. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba-md-dmd-dds-od)
- Biology - B.A./Physical Therapy - Ph.D. (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba-physical-therapy-phd)
- Biology - B.A./Physician Assistant (p. 292)

## **Double Majors** (p. 92)

- Biology and Chemistry - B.S. (p. 295)
- Biological Sciences Minor (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/biological-sciences-minor)
- Cell Biology Concentration (B.A. in Biology) (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba/cell-biology-concentration)
- Ecology and Evolution Concentration (B.A. in Biology) (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba/ecology-evolution-concentration)
- Neurobiology Concentration (B.A. in Biology) (http://catalog.njit.edu/undergraduate/science-liberal-arts/biology/ba/neurobiology-concentration)

## Biological Sciences Courses

**BIOL 200. Concepts in Biology. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 107, MATH 108 or equivalent. This course will introduce student to the study of biology at the beginning of their course of study. Central ideas in the biological sciences will be highlighted, with an emphasis on the process of scientific discovery and investigation. The course will provide the basis for more advanced coursework and learning experiences in the biological sciences as students delve into the curriculum of study.

**BIOL 205. Foundations of Biology: Ecology and Evolution Lecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BIOL 200 with a C or better, co-requisite BIOL 206. This introductory course considers the population level of biological organizations. Topics include Mendelian and population genetics, evolution, and ecology of populations and communities.

**BIOL 206. Foundations of Biology: Ecology and Evolution Lab. 1 credit, 3 contact hours (0;3;0).**
Prerequisite: BIOL 200 with a C or better, Co-requisite BIOL 205. The laboratory reinforces the topics covered in Foundations of Ecology and Evolution Lecture (Biol 205) lecture with hands-on activities and exposes students to current methods of research and analysis in these areas.

**BIOL 222. Evolution. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 101 and R120 102 and BIOL 205 and BIOL 206 with grade of C or better. This course will provide a comprehensive introduction to the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic basis of variation and heredity, natural selection, evolution and development, and speciation.

**BIOL 225. Insects and Human Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 101 and R120 102 (General Biology sequence). This course, through lecture and discussion, will cover the breadth of influence insects have on society, from the provision of ecosystem services to the economic and social costs associated with their role as vectors of disease. Student will learn how insects are used in science, agriculture and indicators of global climate change and water quality. Students will also learn some insect biology and have the opportunity to observe insects (living and dead) to gain a better understanding of the diversity and complexity of these creatures.

**BIOL 250. Biology of Neotropical Habitats: Ecuador and Galapagos Islands. 3 credits, 4 contact hours (2;2;0).**
This course is an introduction to tropical biology and evolution held in Ecuador's Highlands, Rain Forest, and in the Galapagos islands. The course uses a hands-on approach to study the flora and fauna of these unique habitats. The course also addresses the history, politics, and culture of Ecuador, with emphasis on how these issues influence the management and sustainability of Ecuadorian natural resources.

**BIOL 285. Comparative Vertebrate Anatomy. 4 credits, 4 contact hours (3;1;0).**
Prerequistes: R120:201 and 202 (Foundations of Biology: Cell and Molecular Biology); and BIOL 205 and BIOL 206 (Foundations of Biology: Ecology and Evolution), all with grades of C or better. This course introduces students to the groups of vertebrates and explores the anatomical evolution of vertebrates within the context of the functional interrelationships of organs and the changing environments to which vertebrates have adapted. An ideal entry point into the ways living creatures interact with their immediate physical world, we examine how the forms and activities of animals reflect the materials available to nature and consider rules for structural design under environmental forces.

**BIOL 310. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Departmental approval and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**BIOL 315. Principles of Neurobiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 and BIOL 205 and BIOL 206 with a grade of C or better. This course will review neuroscience concepts at a basic level. It will cover basics of cellular physiology, molecular biology and developmental biology of nerve cells, network physiology, behavior, cognition and memory and learning. This course will prepare students who are interested in a neuroscience sequence for their major.

**BIOL 320. Discovering Biological Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102, BIOL 201, BIOL 202, BIOL 205, BIOL 206 all with a grade of C or better. Success in the constantly evolving field of biology necessitates staying current in scientific literature. This requires competency in skills such as analysis of primary sources, synthesis of information from multiple sources, and oral and written communication skills. This course focuses on these competencies. Students will develop skills need to read and analyze scientific literature, and to communicate science. Each semester the content theme of the course will change depending on the expertise of the faculty member teaching the course.

**BIOL 321. Comparative Vertebrate. 4 credits, 4 contact hours (3;1;0).**
Prerequisites: R120 201, R120 202, BIOL 205 and BIOL 206, all with grades of C or better. This course introduces students to the groups of vertebrates and explores the anatomical evolution of vertebrates within the context of the functional interrelationships of organs and the changing environments to which vertebrates have adapted. An ideal entry point into the ways living creatures interact with their immediate physical world, we examine how the forms and activities of animals reflect the materials available to nature and consider rules for structural design under environmental forces.

**BIOL 337. Collective Intel in Biol Syst. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 202, BIOL 205 and BIOL 206 with a grade of C or better. This course will provide an overview of the fundamental principles underlying the organization of animal and human societies. It will include detailed consideration of behavioral, social, and physical processes that are responsible for the coordination of activities in large animal and human groups and social.

**BIOL 338. Ecology of the Dining Hall. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:R120 201 and R120 202 and BIOL 205 and BIOL 206 with a C or better. This course will use the examination of an on-campus ecosystem, the dining hall, as a framework for learning about a number of applied ecological concepts. We will investigate topics such as food webs, nutrient cycling, microbial ecology, and agroecology as they apply to the organisms and biological processes, present in our dining hall. Course work will involve extensive reading and discussion of scientific and popular literature, supplemented by regular class trips to the dining hall and related on-campus facilities.

**BIOL 340. Mammalian Physiology. 4 credits, 6 contact hours (3;3;0).**
Prerequisites: R120 201 and R120 202 and BIOL 205 and BIOL 206 with a grade of C or better. This course will review general principles of the function of the human body as a mammal, with emphasis on the function and regulation of neuromuscular, cardiovascular, respiratory, endocrine, digestive, and excretory systems. The goal is to provide students with the basic knowledge to understand how their own bodies operate.

**BIOL 341. Introduction to Neurophysiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 with a grade of C or better. This course will examine the physiology of neurons such as excitability, impulse conduction, synaptic communication and neural and synaptic plasticity. The objective is to provide students with a basic understanding of neural signaling and communication.

**BIOL 342. Developmental Biology (Embryology). 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 and BIOL 205 and BIOL 206. Descriptive and experimental approaches to molecular, cellular and organismal changes during embryonic development; mechanisms of cell differentiation, organogenesis, morphogenesis, and pattern formation.

**BIOL 344. Physiological Mechanisms. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 340 or R120 340 with a grade of C or better. This course will utilize clinical (pathological) case studies to reinforce physiologic knowledge and provide students a strong basis for future studies in biomedical and health related fields.

**BIOL 345. Comparative Physiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 340 or R120 340 or (R120 141 and R120 142) with grades of C or better. We will use a comparative approach to examine the physiology of animals including major physiological systems, with an emphasis on vertebrates. Topics to be covered include metabolic, temperature, osmotic and ionic regulation; respiration and circulatory transport, digestive, muscle, nervous, and locomotor systems; endocrine regulation and biological rhythms. We will further examine how physiological systems are integrated and thus allow animals to respond, physiologically, in different environment.

**BIOL 346. Neurobiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 202 and BIOL 205 and BIOL 206. This course will examine the basic principles that govern neuronal function, emphasizing cellular, developmental, and physiological aspects. The course begins with cellular properties of neurons and synaptic communication and will review the organization, function, development, and disorders of neural systems.

**BIOL 347. Lab Approaches in Neuroscience. 3 credits, 4 contact hours (1;3;0).**

**BIOL 350. Immunology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 201, R120 202, BIOL 205 and BIOL 206 all with a grade of C or better. The objective of this course is to facilitate an understanding of preliminary knowledge of the immune system in humans and other mammals. Students will be able to translate a basic understanding of the immune system and how that knowledge translates to further understanding medicine, research topics in cell biology, and broad topics in public health policy.

**BIOL 352. Genetics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Biol 200, or R120 201 or Biol 205/206 or R120, 102 or R120 201/202.

**BIOL 368. The Ecology and Evolution of Disease. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120:201, R120:202, BIOL 205, and BIOL 206, and (MATH 111 or MATH 238) with grade of C or better. This course addresses those aspects of ecology and evolutionary biology most relevant to understanding the origin, dynamics and treatment of disease (both infectious and hereditary/genetic). The class will be a mixture of lecture and discussion of case studies. Material covered will include biology, mathematical models, and some aspects of human behavior.

**BIOL 375. Conservation Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 201 and R120 202 and BIOL 205 and BIOL 206 with a grade of C or better. This course will provide a comprehensive introduction to the field of conservation biology, as well as philosophical and economic concerns.

**BIOL 383. Neural Basis of Behavior. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: R120 201 and R120 02 and BIOL 205 and BIOL 206 with a grade of C or better. This lecture course explores the neural mechanisms underlying animal behavior. This course is intended for upper-level undergraduate students who have some background in biology, hence the prerequisite for Foundation of Biology. This courses would also be of interest to graduate students interested in neuroscience, such as, students in the Quantitative Neuroscience (QNS) program, students in the Integrative Neuroscience (INS) program, and students at the Center for Molecular and Behavioral Neuroscience (CMB). It is unnecessary for the students to have taken animal behavior or neurobiology; however, these courses would be helpful.

**BIOL 385. Evolution of Animal Behavior Laboratory. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: BIOL 205, BIOL 206, R120 201 and R120 202 with a grade of C or better. A lab course focusing on research in Animal Behavior. This course will cover foraging, predator avoidance, territoriality, and mate choice. Labs will be inquiry based with students designing experiments to test hypotheses concerning aspects of animal behavior.

**BIOL 398. Visualizing Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Junior standing. This course aims to explore points of intersection between art and Biology. We will first explore important concepts of Biology in a lecture format with readings, based on popular science. Teams of students will develop a product based on their bilogical driven interests and artistic toolkits. Regular individualized meetings will be held between the intructor and each team. A written essay on the creative process and scientific significance of the selected topic will accompany the creative work. A final showcase of the products will be held at the end of the semester.

**BIOL 400. Biology in Science Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: (R120 340 or BIOL 340 or R120 345) and (R120 355 or R120 356 or R120 352) with a grade of C or better. Popular science fiction media will be utilized to initiate thinking critically and creatively about the biological sciences; from the molecular level to whole organism physiology. Students will explore the potential biology of fictitious organisms, and determine real-life analogues. These topics will be used as a vehicle to improve scientific writing and to apply biological knowledge in a new and unique way.

**BIOL 410. Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: BIOL 310. Restriction: departmental approval and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic progam. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**BIOL 440. Cell Biology of Disease: Cells gone Bad!. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: (BIOL 340 or R120 340) and (R120 355 or R120 356) with a grade of C or better. This course will briefly review the normal physiology of mammals and humans and will then extensively explore the basis of many human diseases at the cellular level. The goal is to understand how alterations in normal functions of cells affect the function of the whole system by reviewing current research in the field of cell biology abnormalities.

**BIOL 445. Endocrinology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites:(BIOL 340 or R120 340)and (R120 355 or R120 356) with a grade of C or better. This course will discuss endocrinology from both an enatomical and physicologic view. We will discuss synthesis, distribution and regulation of the entire human endocrine system. The goal is to provide students with a basic knowledge of the complex endocrine system.

**BIOL 447. Systems Neurobiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 315 with a grade of C or better. This course will examine, from a systems perspective, phenomena that relate to neuronal network activity and behavior. Neuronal systems will be studied in detail. The overall goal of the course is to provide students with the basic knowledge of the neurobiological basis of behavior.

**BIOL 448. Neuropathophysiology: Nervous System Gone Bad!. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BIOL 315 or BIOL 340 or R120 340 or BIOL 341 or R120 444 or BIOL 447 with a grade of C or better. This course will briefly examine the normal physiology of the nervous system and then would extensively explore the basis of many neuronal diseases. The goal is to understand how any alteration in normal functions of the nervous system affects the function of the whole system by reviewing current research in the field of nervous system abnormalities.

**BIOL 451. Cell Physiology and Imaging. 4 credits, 4 contact hours (1;3;0).**
Prerequisites: PHYS 111, PHYS 121 and R120 455. This course will examine celluar phenomena, such as subcellular structure, secretion, intracellular calcium regulation, etc., from a physiological perspective and using imaging techniques as a tool to understand them. Cell biology, and optics and the user of microscopes, will be discussed in detail.

**BIOL 462. Comparative Biomechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 201, R120 202, BIOL 205 and BIOL 206 all with a C or better. This course takes a comprehensive look at the mechanical aspects of life. We will examine how the forms and activities of animals and plants reflect the materials available to nature, consider rules for fluid flow and structural design, and explore how organisms contend with environmental forces. Drawing on physics, we look at how animals swim and fly, modes of terrestrial locomotion, organism responses to winds and water currents, circulatory and suspension-feeding systems, the relationship between size and mechanical design, and the links between the properties of biological materials (eg spider silk, jellyfish jelly, and muscle) and their structural and functional roles.

**BIOL 475. Ecological Field Methods and Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 280 or R120 370 with a C or better and permission of instructor. This field-orientated class will study animal and plant communities using a combination of field, laboratory and theory work. The goal of this course is to understand ecological principles and to introduce students to modern methodology for field work, the techniques and instruments used, as well as the theoretical basis for their application. Students will collect data, analyze them and report the results in written and oral format.

**BIOL 491. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Departmental approval required. Research in Biology. Each student works under the supervision of a Biology or associated faculty member. A research paper and poster are required.

**BIOL 492. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Departmental approval required. Research in Biology. Each student works under the supervision of a Biology or associated faculty member.

**BIOL 495. Honors Seminar in Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BIOL 320 with a grade of C or better. The honors seminar allows students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. This course satisfies NJIT's Honors Capstone requirement.

## Rutgers-Newark Courses

100-level courses do not apply to biology majors

**R120 101. General Biology. 4 credits, 0 contact hours (0;0;0).**

**R120 101L. General Biology I. 0 credits, 0 contact hours (0;0;0).**

**R120 102. General Biology. 4 credits, 4 contact hours (4;0;0).**

**R120 102L. General Biology II-Lecture. 0 credits, 0 contact hours (0;0;0).**

**R120 104. Human Health & Disease. 3 credits, 3 contact hours (3;0;0).**

**R120 105. Environ Issues. 3 credits, 3 contact hours (3;0;0).**

**R120 106. General Horticulture. 3 credits, 3 contact hours (3;0;0).**

**R120 107. Horticulture Lab. 1 credit, 1 contact hour (0;1;0).**

**R120 108. Human Sexuality. 3 credits, 3 contact hours (3;0;0).**

**R120 109. Basic Plant Science. 3 credits, 3 contact hours (3;0;0).**

**R120 110. Basic Plant Sci Lab. 1 credit, 0 contact hours (0;0;0).**

**R120 111. Human Biology. 3 credits, 3 contact hours (3;0;0).**

**R120 141. Anatomy & Physiology. 4 credits, 4 contact hours (4;0;0).**

**R120 142. Anatomy & Physiology. 4 credits, 4 contact hours (4;0;0).**

**R120 171. Human Ecology. 3 credits, 3 contact hours (3;0;0).**

**R120 201. Foundations Of Biology. 3 credits, 3 contact hours (3;0;0).**

**R120 202. Foundations Of Biology Lab. 1 credit, 1 contact hour (1;0;0).**

**R120 203. Plant Bio. 3 credits, 0 contact hours (0;0;0).**

**R120 204. Economic Botany. 3 credits, 3 contact hours (3;0;0).**

**R120 205. Environmental Issues. 3 credits, 3 contact hours (3;0;0).**

**R120 206. General Horticulture. 3 credits, 3 contact hours (3;0;0).**

**R120 207. Horticulture Lab. 1 credit, 1 contact hour (1;0;0).**

**R120 208. Human Sexuality. 3 credits, 1 contact hour (1;0;0).**

**R120 211. Plant Kingdom. 4 credits, 4 contact hours (4;0;0).**

**R120 214. Microbiology. 3 credits, 3 contact hours (3;0;0).**

**R120 222. Evolution. 3 credits, 3 contact hours (3;0;0).**

**R120 227. Biol Invertebrates. 4 credits, 4 contact hours (4;0;0).**

**R120 230. Biology Of Seed Plants. 4 credits, 4 contact hours (4;0;0).**

**R120 235. Microbiology. 4 credits, 4 contact hours (4;0;0).**

**R120 237. Environmental Microbiology. 4 credits, 6 contact hours (3;3;0).**

**R120 240. Human Physiology. 3 credits, 3 contact hours (3;0;0).**

**R120 241. Anatomy & Physiology. 4 credits, 4 contact hours (4;0;0).**

**R120 242. Anatomy & Physiology. 4 credits, 4 contact hours (4;0;0).**

**R120 245. Pathophysiology. 3 credits, 3 contact hours (3;0;0).**

**R120 280. Ecology. 3 credits, 3 contact hours (3;0;0).**

**R120 282. Animal Behavior. 3 credits, 3 contact hours (3;0;0).**

**R120 285. Comparative Vertebrate Anatomy. 4 credits, 4 contact hours (4;0;0).**

**R120 303. Molecular Biology. 3 credits, 3 contact hours (3;0;0).**

**R120 311. Flora of New Jersey. 4 credits, 4 contact hours (4;0;0).**

**R120 313. Mycology. 4 credits, 4 contact hours (4;0;0).**

**R120 320. Comp Vert Anatomy. 4 credits, 4 contact hours (4;0;0).**

**R120 322. Evolution. 3 credits, 0 contact hours (0;0;0).**

**R120 323. Developmental Psychology. 3 credits, 3 contact hours (3;0;0).**

**R120 325. Animal Parasites. 3 credits, 3 contact hours (3;0;0).**

**R120 326. Parasitology Lab. 1 credit, 1 contact hour (1;0;0).**

**R120 327. Biol Invertebrates. 4 credits, 4 contact hours (4;0;0).**

**R120 328. Ornithology. 3 credits, 3 contact hours (3;0;0).**

**R120 330. Plant Physiology. 4 credits, 4 contact hours (4;0;0).**

# B.A. in Biology/Physician Assistant

(112 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| BIOL 200 | Concepts in Biology | 4 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| R830 101 | Principles Of Psychology I | 3 |
| Social Science Elective | | 3 |
| | **Term Credits** | **17** |
| **Summer** | | |
| BIOL 310 | Research and Independent Study | 3 |
| GUR Elective | | 3 |
| | **Term Credits** | **6** |
| **Second Year** | | |
| **1st Semester** | | |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| Biology Elective | | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| R120 141 | Anatomy & Physiology | 4 |
| GUR Elective | | 3 |
| | **Term Credits** | **20** |
| **2nd Semester** | | |
| BIOL 340 | Mammalian Physiology | 4 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| R120 142 | Anatomy & Physiology | 4 |
| Biology Ecology / Evolution Cluster Elective | | 3 |
| Physical Education Elective | | 3 |
| | **Term Credits** | **19** |
| **Summer** | | |
| Management GUR Elective | | 3 |
| | **Term Credits** | **3** |
| **Third Year** | | |
| **1st Semester** | | |
| R120 285 | Comparative Vertebrate Anatomy | 4 |
| R120 335 | General Microbiology | 4 |

| | | |
|---|---|---|
| R120 360 | Biochemistry | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| HSS Upper Level Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| R120 352 | Genetics | 3 |
| Biology Elective | | 3 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| HSS Upper Level Elective | | 3 |
| HSS Senior Seminar Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **116** |

## Biology Electives

One course must be taken from each cluster.

### Cluster A – Ecology and Evolution

| | | |
|---|---|---|
| BIOL 222 | Evolution | 3 |
| R120 280 | Ecology | 3 |
| R120 382 | Animal Behavior | 3 |
| R120 370 | Plant Ecology | 3 |

### Cluster B – Functional Organism

| | | |
|---|---|---|
| R120 211 | Plant Kingdom | 4 |
| R120 230 | Biology Of Seed Plants | 4 |
| R120 330 | Plant Physiology | 4 |
| R120 335 | General Microbiology | 4 |
| R120 340 | Mammalian Physiology | 4 |
| or BIOL 340 | Mammalian Physiology | |
| R120 342<br>& R120 343 | Developmental Biology<br>and Developmental Biology Lab | 4 |

### Cluster C – Molecular and Cellular

| | | |
|---|---|---|
| R120 352 | Genetics | 3 |
| R120 355 | Cell Biology | 3 |
| R120 356 | Molecular Biology | 3 |
| R120 360 | Biochemistry | 3 |
| or CHEM 473 | Biochemistry | |

### Laboratory Experience Courses

| | | |
|---|---|---|
| R120 227 | Biol Invertebrates | 4 |
| R120 285 | Comparative Vertebrate Anatomy | 4 |
| R120 311 | Flora of New Jersey | 4 |
| R120 313 | Mycology | 4 |
| R120 325<br>& R120 326 | Animal Parasites<br>and Parasitology Lab | 4 |
| R120 358 | Microanatomy Cells | 4 |
| R120 430 | Plant Growth & Development | 4 |
| R120 481 | Marine Biology | 4 |
| Any course from Functional Organism Cluster | | 4 |

| | | |
|---|---|---|
| R120 328 | Ornithology | 3 |
| R120 371 | Field Study Plant Ecology | 3 |
| R120 381 | Ecological History of North Am | 3 |
| R120 380 | Field Ecology | 3 |
| BIOL 475 | Ecological Field Methods and Analysis | 3 |
| R120 486 | Tropical Field Biology | 2 |

## Biology Electives

| | | |
|---|---|---|
| BIOL 225 | Insects and Human Society | 3 |
| R120 346 | Neurobiology | 3 |
| or BIOL 346 | Neurobiology | |
| R120 350 | Immunology | 3 |
| R120 365 | Evolutions of Humans | 3 |
| BIOL 368 | The Ecology and Evolution of Disease | 3 |
| MATH 371 | Physiology and Medicine | 3 |
| MATH 372 | Population Biology | 3 |
| MATH 373 | Introduction to Mathematical Biology | 3 |
| BIOL 375 | Conservation Biology | 3 |
| BIOL 383 | Neural Basis of Behavior | 3 |
| R120 403 | Biological Ultrastructure | 3 |
| R120 404 | Intro to Neuroanatomy | 4 |
| R120 422 | Biological Invasions | 3 |
| MATH 430 | Analytical and Computational Neuroscience | 3 |
| BIOL 440 | Cell Biology of Disease: Cells gone Bad! | 3 |
| R120 445 | Endocrinology | 3 |
| BIOL 447 | Systems Neurobiology | 3 |
| BIOL 448 | Neuropathophysiology: Nervous System Gone Bad! | 3 |
| R120 451 | Lab Cell Biophysics | 4 |
| R120 452 | Molecular Biol Techniques | 4 |
| R120 455 | Molec Cell Biology | 3 |
| R120 471 | Ecological Physiology | 3 |
| R120 487 | Systems Ecology: Ecosystems in the Landscape | 3 |
| BIOL 491<br>& BIOL 492 | Research and Independent Study<br>and Research and Independent Study | 6 |

## General University Requirements and Electives

| | | |
|---|---|---|
| **Computer Science** | | |
| BNFO 135 | Programming for Bioinformatics | 3 |
| **Management** | | |
| IE 492 | Engineering Management | 3 |
| or MGMT 390 | Principles of Management | |
| **Physical Education** [1] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |
| **Social Science (lower-level)** | | |
| Select two of the following: | | 6 |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved introductory courses in basic social sciences at Rutgers-Newark | | |

| | | |
|---|---|---|
| **English Composition and Cultural History (lower-level)** | | |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| HIST 2XX | History course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level)** | | |
| Select one of the following 300-level courses: | | 3 |
| 3XX | Literature course | |
| 3XX | History course | |
| 3XX | Philosophy course | |
| 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following 300-level courses: | | 3 |
| 3XX | English course | |
| 3XX | History course | |
| 3XX | Literature course | |
| 3XX | Philosophy course | |
| 3XX | Science, Technology and Society course | |
| 3XX | Social Science course | |
| 3XX | Theatre course | |
| ARCH 382 | | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Senior Seminar in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following. Honors College students register for honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

[1] Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

# B.S. in Biology and B.S. in Chemistry

(136 Credits)

| **First Year** | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| CHEM 125 | General Chemistry I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| BIOL 200 | Concepts in Biology | 4 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 124 | General Chemistry Laboratory | 1 |

| | | |
|---|---|---|
| CHEM 126 | General Chemistry II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 112 | Calculus II | 4 |
| Physical Education GUR Elective | | 1 |
| R120 201<br>& R120 202 | Foundations Of Biology<br>and Foundations Of Biology Lab | 4 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| CHEM 221 | Analytical Chemical Methods | 2 |
| CHEM 222 | Analytical Chemistry | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 211 | Calculus III A | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| English Composition and Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Physical Education GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| CHEM 231 | Physical Chemistry I | 3 |
| CHEM 473 | Biochemistry | 3 |
| Math Cognate Elective | | 3-4 |
| Biology Laboratory Elective | | 4 |
| Biology Elective | | 3 |
| | **Term Credits** | **16-17** |
| **2nd Semester** | | |
| CHEM 235 | Physical Chemistry II | 3 |
| MGMT 390 | Principles of Management | 3 |
| Biology Elective | | 3 |
| CHEM 474 | Biochemistry II | 3 |
| ECON 201 | Economics | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CHEM 235A | Physical Chemistry II Laboratory | 2 |
| Biology Elective | | 3 |
| CHEM 480 | Instrumental Analysis | 2 |
| Biology Laboratory Elective | | 4 |
| MATH 333 | Probability and Statistics | 3 |
| CHEM 475 | Biochemistry Lab I | 2 |
| | **Term Credits** | **16** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| CHEM 336 | Physical Chemistry III | 3 |
| Physical Chemistry III Elective | | 3 |
| CHEM 412 | Inorganic Chemistry | 3 |
| Biology Elective | | 3 |
| Select one of the following for Hunamities and Social Sciences (upper-level) Capstone: | | 3 |
| MATH 222 | Differential Equations | |
| MATH 227 | Mathematical Modeling | |
| MATH 337 | Linear Algebra | |
| MATH 340 | Applied Numerical Methods | |
| Open GUR Elective | | 3 |
| | **Term Credits** | **18** |
| | **Total Credits** | **136-137** |

# Biology Electives

One course must be taken from each cluster.

## Cluster A – Ecology and Evolution

| | | |
|---|---|---|
| BIOL 222 | Evolution | 3 |
| R120 280 | Ecology | 3 |
| R120 382 | Animal Behavior | 3 |
| R120 370 | Plant Ecology | 3 |

## Cluster B – Functional Organism

| | | |
|---|---|---|
| R120 211 | Plant Kingdom | 4 |
| R120 230 | Biology Of Seed Plants | 4 |
| R120 330 | Plant Physiology | 4 |
| R120 335 | General Microbiology | 4 |
| R120 340 | Mammalian Physiology | 4 |
| or BIOL 340 | Mammalian Physiology | |
| R120 342<br>& R120 343 | Developmental Biology<br>and Developmental Biology Lab | 4 |

## Cluster C – Molecular and Cellular

| | | |
|---|---|---|
| R120 352 | Genetics | 3 |
| R120 355 | Cell Biology | 3 |
| R120 356 | Molecular Biology | 3 |
| R120 360 | Biochemistry | 3 |
| or CHEM 473 | Biochemistry | |

## Laboratory Experience Courses

| | | |
|---|---|---|
| R120 227 | Biol Invertebrates | 4 |
| R120 285 | Comparative Vertebrate Anatomy | 4 |
| R120 311 | Flora of New Jersey | 4 |
| R120 313 | Mycology | 4 |
| R120 325<br>& R120 326 | Animal Parasites<br>and Parasitology Lab | 4 |
| R120 358 | Microanatomy Cells | 4 |
| R120 430 | Plant Growth & Development | 4 |
| R120 481 | Marine Biology | 4 |
| Any course from Functional Organism Cluster | | 4 |
| R120 328 | Ornithology | 3 |

| | | |
|---|---|---|
| R120 371 | Field Study Plant Ecology | 3 |
| R120 381 | Ecological History of North Am | 3 |
| R120 380 | Field Ecology | 3 |
| BIOL 475 | Ecological Field Methods and Analysis | 3 |
| R120 486 | Tropical Field Biology | 2 |

## Biology Electives

| | | |
|---|---|---|
| BIOL 225 | Insects and Human Society | 3 |
| R120 346 | Neurobiology | 3 |
| or BIOL 346 | Neurobiology | |
| R120 350 | Immunology | 3 |
| R120 365 | Evolutions of Humans | 3 |
| BIOL 368 | The Ecology and Evolution of Disease | 3 |
| MATH 371 | Physiology and Medicine | 3 |
| MATH 372 | Population Biology | 3 |
| MATH 373 | Introduction to Mathematical Biology | 3 |
| BIOL 375 | Conservation Biology | 3 |
| BIOL 383 | Neural Basis of Behavior | 3 |
| R120 403 | Biological Ultrastructure | 3 |
| R120 404 | Intro to Neuroanatomy | 4 |
| R120 422 | Biological Invasions | 3 |
| MATH 430 | Analytical and Computational Neuroscience | 3 |
| BIOL 440 | Cell Biology of Disease: Cells gone Bad! | 3 |
| R120 445 | Endocrinology | 3 |
| BIOL 447 | Systems Neurobiology | 3 |
| BIOL 448 | Neuropathophysiology: Nervous System Gone Bad! | 3 |
| R120 451 | Lab Cell Biophysics | 4 |
| R120 452 | Molecular Biol Techniques | 4 |
| R120 455 | Molec Cell Biology | 3 |
| R120 471 | Ecological Physiology | 3 |
| R120 487 | Systems Ecology: Ecosystems in the Landscape | 3 |
| BIOL 491<br>& BIOL 492 | Research and Independent Study<br>and Research and Independent Study | 6 |

## General University Requirements and Electives

| | | |
|---|---|---|
| **Computer Science** | | |
| BNFO 135 | Programming for Bioinformatics | 3 |
| **Management** | | |
| IE 492 | Engineering Management | 3 |
| or MGMT 390 | Principles of Management | |
| **Physical Education** [1] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |
| **Social Science (lower level)** | | |
| Select two of the following: | | 6 |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved introductory courses in basic social sciences at Rutgers-Newark | | |
| **English Composition and Cultural History (lower-level)** | | |

| | | |
|---|---|---|
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| HIST 2XX | History course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level)** | | |
| Select one of the following 300-level courses: | | 3 |
| 3XX | Literature course | |
| 3XX | History course | |
| 3XX | Philosophy course | |
| 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following 300-level courses: | | 3 |
| 3XX | English course | |
| 3XX | History course | |
| 3XX | Literature course | |
| 3XX | Philosophy course | |
| 3XX | Science, Technology and Society course | |
| 3XX | Social Science course | |
| 3XX | Theatre course | |
| ARCH 382 | | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Senior Seminar in Humanities and Social Sciences (upper-level)** | | |
| Select one of the following. Honors College students select honors section. | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

1 Students who register as full-time undergraduates for two or more consecutive semesters must take two PE courses. Students are urged to complete the requirement as soon as possible.

# Chemistry and Environmental Science

NJIT's Department of Chemistry and Environmental Science provides a unique focus for addressing some of today's most pressing scientific and social challenges. The chemistry program's solid grounding in science, mathematics and engineering, along with lab skills, allows students to apply theory to practical solutions based on chemistry. NJIT has particular strengths in analytical, medical and environmental chemistry. Students can conduct research with faculty mentors with expertise in such areas as energy, pharmaceuticals, materials and environmental chemistry. Through the environmental science program, students acquire a well-rounded background in the field, drawing on chemistry, geology and biological sciences. Students also learn to use computer modeling, data analysis, digital mapping and more — skills that clearly afford a significant advantage in the job market.

## NJIT Faculty

### B

Balasubramanian, Bhavani, University Lecturer

Bonchonsky, Michael P., University Lecturer

Bozzelli, Joseph W., Distinguished Professor

Butherus, Alexander D., University Lecturer

### C

Conley, Robert J., Emeritus

### D

Dauerman, Leonard, Associate Professor

### E

Ellis, Frank B., Senior University Lecturer

### F

Farinas, Edgardo T., Associate Professor

### G

Getzin, Donald, Associate Professor Emeritus

Gilbert, Kathleen M., University Lecturer

Gund, Tamara, Professor

### H

Huang, Haidong, Assistant Professor

### J

Jackson, Nancy L., Professor

### K

Kebbekus, Barbara B., Professor Emeritus

Khalizov, Alexei, Assistant Professor

Krasnoperov, Lev N., Professor

### L

Lambert, Donald G., Associate Professor Emeritus

Lei, George Y., Associate Professor Emeritus

### M

Mitra, Somenath, Distinguished Professor

### P

Petrova, Roumiana S., Senior University Lecturer

### Q

Qiu, Zeyuan, Associate Professor

### S

Skawinski, William, Senior University Lecturer

### V

Venanzi, Carol A., Distinguished Professor Emeritus

## Programs


- BioChemistry - B.S. (p. 306)
- Chemistry - B.S. (p. 311)

- Environmental Science - B.S. (p. 312)

## Accelerated Programs (p. 92)

- Chemistry - B.S. for Pre-Professional Students (p. 304)
- Chemistry Minor (p. 315) (not for Chemical Engineering majors)
- Chemistry Minor (p. 476) (for Chemical Engineering majors)
- Environmental Science Policy Minor (p. 315)

## Chemistry and Environmental Science Courses

**CHEM 105. Applied Chemical Principles. 4 credits, 5 contact hours (3;2;0).**
Prerequisite: high school algebra or equivalent. The fundamentals and relation of chemistry to living in today's society. Suitable laboratory experiments illustrate the course material. Not open to engineering or science students, or students who have completed a college level chemistry course.

**CHEM 108. College Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: a one-year college prep high school chemistry course, high school math including algebra and trigonometry. Delivered as a telecourse, the course provides the first of a two-semester sequence of college chemistry for high school students and other distance learners seeking college credit and/or preparation for the AP Examination. Matriculated undergraduates may not receive credit for this course.

**CHEM 109. College Chemistry II. 3 credits, 4 contact hours (3;1;0).**
Prerequisite: CHEM 108. A continuation of CHEM 108.

**CHEM 121. Fundamentals of Chemical Principles I. 3 credits, 3 contact hours (3;0;0).**
Introduces the basic concepts of chemistry, including chemical reactions, and bonding, electronic and molecular structure, gases and thermochemistry.

**CHEM 122. Fundamentals of Chemical Principles II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Chem 121 with a grade C or better. Continuation of the Chem 121 sequence. Introduces the basic concepts of chemistry, including equilibrium, chemical kinetics, thermodynamics, electrochemistry, and nuclear chemistry.

**CHEM 124. General Chemistry Laboratory. 1 credit, 3 contact hours (0;3;0).**
Corequisite: CHEM 122 or CHEM 123 or CHEM 126 with a grade of C or better. Chemical principles studied in the CHEM 125 and CHEM 126 or CHEM 121, CHEM 122 and CHEM 123 sequence are illustrated and reinforced by performance of laboratory experiments.

**CHEM 125. General Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Co-requisite Math 110, or Math 111, or Math 112 with a C or better. The first semester of a two-semester sequence in chemistry. Introduces the basic concepts of chemistry, including chemical reactions and bonding, electronic and molecular structure, gases and thermochemistry. Students majoring in chemistry or biochemistry should also register for lab Chem 125A.

**CHEM 125A. General Chemistry Lab I. 1 credit, 3 contact hours (0;3;0).**
General Chemistry Lab I is a laboratory course; it is designed to be taken currently with CHEM 125 or CHEM 121. Instructions are in the lab manual and concepts are from the text and lecture of the CHEM 125/121 courses. The experiments are designed to provide undergraduate students with practical experience and train students with laboratory techniques/equipment common to chemistry laboratories.

**CHEM 126. General Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Math 110 or higher and Chem 125 with a C or better The second semester of a two-semester sequence in chemistry. Introduces the basic concepts of chemistry, including equilibrium, chemical kinetics, thermodynamics, and electrochemistry. Students majoring in chemistry or biochemistry should also register for lab Chem126A; all others for lab Chem 124.

**CHEM 126A. Gen Chemistry Lab II. 1 credit, 3 contact hours (0;3;0).**

**CHEM 221. Analytical Chemical Methods. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 222 with grade of C or better. Laboratory introducing quantitative chemical analyses by gravimetry, titration, spectroscopy, chromatography, and potentiometry.

**CHEM 222. Analytical Chemistry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 123 or CHEM 126, CHEM 124 with grade of C or better. Lecture course introducing concepts of chemical analyses by gravimetry, titration, spectroscopy, chromatography, and potentiometry.

**CHEM 231. Physical Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 122 or CHEM 126, PHYS 111 with a grade of C or better. Corequisite: MATH 211. The topics covered include the properties of ideal and non-ideal gases and liquids, solutions, thermochemistry, thermodynamics, the phase rule, and phase equilibria.

**CHEM 235. Physical Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 231 with a grade of C or better. A continuation of CHEM 231. The topics include homogeneous and heterogeneous chemical equilibria, ionic equilibria, electrochemistry, kinetic theory of gases, transport phenomena, kinetics, and irreversible processes.

**CHEM 235A. Physical Chemistry II Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 221, CHEM 235 with a grade of C or better. Corequisite: MATH 225 (special section for chemical engineering and chemistry majors). Laboratory experiments apply and extend the basic knowledge of physical chemistry acquired in the lecture. Reports and presentations are an essential part of the course.

**CHEM 236. Physical Chemistry for Chemical Engineers. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: (CHEM 122 or CHEM 126)and CHEM 124 and (CHE 230 or CHE 232) with a grade C or better. This course will introduce the chemical engineering students to the concepts of order, disorder, chemical equilibrium and phase equilibrium. Credit for this course will not be given if credit for CHEM 235 has been given.

**CHEM 238. Analytical/Organic Chem Lab for Chemical Engineers. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 124 and CHEM 245 with a grade of C or better. This course will offer the CHE students experience in organic and analytical laboratory experiments. These experiments will reinforce concepts learned in the organic chemistry lecture classes. This laboratory course will also provide exposure to analytical and other techniques useful in the chemistry and chemical engineering laboratories.

**CHEM 243. Organic Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 123 or CHEM 126 with a grade of C or better. The preparation and properties of the various classes of organic compounds are discussed, with attention given to industrial sources such as coal and petroleum. Also covers the commercial utilization of these materials in the synthesis of useful products used in areas such as foods, cosmetics, textiles, plastics, and pharmaceuticals.

**CHEM 244. Organic Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 243 with a grade of C or better.

**CHEM 244A. Organic Chemistry II Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 124 with a grade C or better. Corequisite: CHEM 244. Synthesis and characterization of organic compounds are performed in a unique multi-scale manner: micro, macro and a kilo scale.

**CHEM 245. Organic Chemistry for Chemical Engineers. 4 credits, 5 contact hours (5;0;0).**
Prerequisite: CHEM 126 or CHEM 122 with a grade of C or better. This course is a one-semester course(opposed to classic two-semester sequence) to provide chemical engineering students with a basic understanding of organic compounds and their reactions.

**CHEM 246A. Organic Chemistry Laboratory. 4 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 244A with a grade of C or better. This course will cover some common reaction types that are not included in CHEM 244A. The experiments will be carried out in microscale. Students will learn new concepts in organic synthesis, including multi-step synthesis, organometallic reagents, and green chemistry for chemical synthesis, catalytic reactions, protecting groups, and peptide couplings. NMR and IR will be used for compound characterization.

**CHEM 301. Chemical Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: high school algebra and trigonometry or equivalent with a grade of C or better. Designed for engineering technology majors. Not open to students who have completed a college level chemistry course. Covers principles of chemistry, with a focus on chemical energetics and chemistry of materials. Suitable laboratory experiments illus-trate the course material.

**CHEM 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Cannot be used for degree credit.Note: Normal grading applies to this COOP Experience.

**CHEM 311. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CHE 310 with a grade C or better.

**CHEM 336. Physical Chemistry III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 235 with a grade of C or better. An introduction to quantum mechanics, statistical mechanics, spectroscopy, and solid state.

**CHEM 339. Analytical/Physical Chem Lab for Chemical Engineers. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: CHEM 245, or CHEM 236 with a grade of C or better. Co-requisite: MATH 225. This course will offer students an introduction to physical and analytical chemistry laboratory techniques. The application of principles learned in lecture will be reinforced by the experiments done in this lab. They will also provide exposure to analytical and other techniques used in chemistry and chemical engineering.

**CHEM 340. Chemistry and Engineering of Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: CHEM 235, CHEM 244 with a grade of C or better. Emphasizes processing/property relationships for a variety of engineering materials, including polymers, metals, ceramics, composites, semiconductors, optical fibers, and biomaterials. Introduces concepts of chemical structure, bonding and crystallinity. Covers important chemical, physical, electrical, and mechanical properties and corrosion and materials degradation. Also includes materials selection in the chemical process industries.

**CHEM 360. Environmental Chemistry I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126 or CHEM 122 and CHEM 124 or CHEM 125A and CHEM 126A with a grade of C or better. Chemistry of the environment with emphasis on the atmosphere. Included are an introduction to the composition and chemistry of the natural and polluted atmosphere, thermodynamics and kinetics of atmospheric reactions, indoor and outdoor air pollution, air quality and its impact on human health, air quality regulations, and climate change. Examples of specific environmental issues covered in this course are the stratospheric ozone depletion, classical and photochemical smog, acid rain, and climate change.

**CHEM 361. Environmental Chemistry II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 360 with a grade of C or better. Chemistry of the environment, including the hydrosphere and geosphere. Principles of physical, inorganic, and organic chemistry are applied to understand the origins of environmental pollutants, their transport, distribution, and decomposition pathways in water and soil environments.

**CHEM 391. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Restriction: Junior standing in Chemistry. Provides an opportunity to work on a reserch project under the individual guidance of a member of the department.

**CHEM 412. Inorganic Chemistry. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: Prerequisite: CHEM 231 with a grade of C or better. A lecture-recitation-laboratory course in practical inorganic chemistry. Covers the chemistry of most of the elements and their compounds. Preparation in the laboratory is followed by purification and characterization.

**CHEM 437. Applications of Computational Chemistry and Molecular Modeling. 3 credits, 3 contact hours (3;0;0).**
This class introduces students to applications and fundamental aspects of computational chemistry and molecular modeling for application and understanding in organic, bio- or physical chemistry. It is an introductory course involving hands-on applications of computational chemistry and molecular modeling. The course provides training application and computer programs for students to use in determining fundamental thermochemical parameters, elementary reaction paths, and design of molecular structures to try and optimize and/or improve biochemical / pharmaceutical products or industrial chemical processes. Students will use chemical software packages to perform calculations in order to identify optimum interaction structures for pharmaceutical or industrial chemical systems. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium rations in chemical environments. The course is relevant to organic, inorganic, physical bio- and pharmaceutical chemistry. It is also relevant to optimization of chemical engineering processes.

**CHEM 473. Biochemistry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 244 or CHEM 245 with a grade of C or better. Covers the fundamentals of biochemistry including buffers, blood, proteins, enzymes, carbohydrates, fats, and nucleic acids. Emphasis on the relationship of biochemistry to biotechnology and medicine.

**CHEM 474. Biochemistry II. 3 credits, 3 contact hours (3;0;0).**
Biochemistry II will focus on transducing and storing energy, synthesizing the molecules of life, and responding to environmental changes. Topics include basic concepts of metabolism, glycolysis and gluconeogenesis, citric acid cycle, oxidative phosphorylation, photosynthesis, fatty acid metabolism, protein turnover and amino acid catabolism, biosynthesis of amino acids, DNA replication and recombination, RNA synthesis and processing, protein synthesis, control of gene expression, the immune system, and drug development.

**CHEM 475. Biochemistry Lab I. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: CHEM 244 or CHEM 473 with a grade of C or better. This course will offer the chemistry and related (chemical engineering, biology, bioinformatics, bioengineering)students fundamental laboratory approaches for biochemistry and biotechnology. These experiments will reinforce concepts learned in biochemistry lecture classes.

**CHEM 480. Instrumental Analysis. 2 credits, 4 contact hours (0;4;0).**
Prerequisite: CHEM 221, CHEM 222 or equivalent with a grade of C or better. Laboratory exploring the principles of operation of modern instruments for chemical analysis. Ultra-violet and infrared spectroscopy, mass spectrometry, gas chromatography, high performance liquid chromatography, voltametry, and potentiometry are among the instruments utilized. Apply calibration methods, statistical data treatment, and sample preparation techniques are applied.

**CHEM 490. Special Topics in Chemistry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: depends upon the nature of the course given. Course is offered in specific areas as interest develops.

**CHEM 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: senior standing in chemistry or chemical engineering. Provides an opportunity to work on a research project under the individual guidance of a member of the department.

**CHEM 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: CHEM 491 with a grade of C or better. A continuation of CHEM 491.

**EVSC 125. Fundamentals of Environmental Sciences. 3 credits, 3 contact hours (3;0;0).**
An introductory course that will present freshman EVSC students with general concepts and topics on Environment, including chemistry, ecosystems, geological and soil resources, water quality, agricultural and Environment, atmosphere, noise and ionizing radiation.

**EVSC 325. Energy and Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHEM 125 with a grade C or better and PHYS 111 with grade C or better. An advanced course to instruct EVSC students, topics on energy and environmental issues such as introduction to energy, natural energy conservation, environmental issues of energy production and consumption, regulation and legislation related to energy, public policy development in energy and environment.

**EVSC 335. Environmental Law. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 with a grade of C or better. The prerequisite is a college ability to communicate competently in the English language including the ability to research and prepare essay compositions and to articulate the major points in a presentation format. The introduction to Environmental Law will cover the regulatory system developed over time that has forged a complex system of environmental rules influencing industrial and other private and public actions that impact the environment. The course will review these rules from the vantage point of the practicing technical environmental engineer and scientist. Students will become familiar with the background and derivation of these laws as well as the major operational features such as environmental permits and enforcement. Several major environmental cases will be analyzed that give definition to the key features of these laws. Each class module will direct itself to the practical application of these laws.

**EVSC 375. Environmental Biology. 3 credits, 3 contact hours (3;0;0).**
An introductory ecological approach to understanding man's impact and dependence on the natural environment. Broad topics include ecosystems, nutrient cycles, pollution, pest management, conservation of natural resources, energy, and human population.

**EVSC 381. Geomorphology. 3 credits, 3 contact hours (3;0;0).**
This is a course in geomorphology, the study of landforms and the contemporary processes that create and modify them. The course will emphasize earth surface processes and quantitative analysis of landform change. Lectures will stress geomorphic principles and two field-based problems will enable students to apply these principles to contemporary geomorphic problems in engineering and management with a focus on the natural environment.

**EVSC 385. Environmental Microbiology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: R120 101 and R120 102 with minimum grade of C. The main goals of this course are to present an overview of the important microbes involved in environmental microbiology, to discuss the environments where they are found, to learn how they are detected and monitored, and to describe their effects on humans. Traditional lectures and exams will be supplemented with discussions of experimental design and data interpretation by reading current research articles.

**EVSC 391. Research and Independent Study. 3 credits, 3 contact hours (0;0;3).**
Provides an opportunity to work on a research project under the individual guidance of a member of the department.

**EVSC 416. Environmental Toxicology. 3 credits, 3 contact hours (3;0;0).**
The course is intended to explore the general principles of toxicology and apply them to the assessment of acute, subacute and chronic effects of hazardous and toxic chemicals. Qualitative and quantitative measures of toxicity and testing protocols are addressed. The role of toxicology in risk assessment and risk management is discussed.

**EVSC 484. Environmental Analysis. 3 credits, 4 contact hours (2;2;0).**
The analysis of environmental samples is studied from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis, and data treatment.

## Rutgers-Newark Courses

# Accelerated B.S. in Chemistry for Pre-Professional Students

(104 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 125 | General Chemistry I | 3 |
| CS 113 | Introduction to Computer Science | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **16** |

| | | |
|---|---|---|
| **Second Year** | | |
| **1st Semester** | | |
| CHEM 221 | Analytical Chemical Methods | 2 |
| CHEM 222 | Analytical Chemistry | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 211 | Calculus III A | 3 |
| R160 207 | Structure & Bonding | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 231 | Physical Chemistry I | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| R120 101 | General Biology | 4 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Open:GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **Summer** | | |
| CHEM 491H | 3 | |
| CHEM 492H | 3 | |
| | **Term Credits** | **6** |
| **Third Year** | | |
| **1st Semester** | | |
| CHEM 235 | Physical Chemistry II | 3 |
| ECON 201 | Economics | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| CHEM 480 | Instrumental Analysis | 2 |
| CHEM 473 | Biochemistry | 3 |
| Management:GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 340 | Chemistry and Engineering of Materials | 3 |
| CHEM 336 | Physical Chemistry III | 3 |
| CHEM 235A | Physical Chemistry II Laboratory | 2 |
| MATH 225 | Survey of Probability and Statistics [1] | 1 |
| CHEM 412<br>or R160 413 | Inorganic Chemistry<br>or Inorganic Chemistry | 3 |
| Capstone Seminar:GUR Elective | | 3 |
| HSS 491 | Honors Sem In Humanities | |
| R120 102 | General Biology | 4 |
| | **Term Credits** | **19** |
| | **Total Credits** | **111** |

1 Students must take a special section of MATH 225 Survey of Probability and Statistics for chemcial or chemistry majors, in conjunction with CHEM 235A Physical Chemistry II Laboratory

## Electives

**Social Science (lower-level) GUR** [1]

| | | |
|---|---|---|
| Select one of the following Economics courses: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |

| | | |
|---|---|---|
| ECON 266 | Macroeconomics | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take an honors section of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select two of the following: | | 6 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| HIST 2XX | 200-level history course at Rutgers-Newark | |
| **Management GUR** [2] | | |
| Select one of the following: | | 3 |
| IE 492 | Engineering Management | |
| MGMT 390 | Principles of Management | |
| AS 333 | Leadership and Management I | |

1. Student also may take approved introductory courses in basic sciences at Rutgers-Newark to fulfill this requirements.
2. Acceptable only for students taking the aerospace option. Students enrolled in a dual degree program between architecture and management may take HRM 601 Organizational Behavior to fulfill this requirement.

Refer to the **General University Requirements** section for further information on electives.

# B.S. in BioChemistry

(130 Credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| CHEM 125A | General Chemistry Lab I | 1 |
| CS 113<br>or BNFO 135 | Introduction to Computer Science<br>or Programming for Bioinformatics | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| CHEM 221 | Analytical Chemical Methods | 2 |
| CHEM 222 | Analytical Chemistry | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 211 | Calculus III A | 3 |
| R120 101 | General Biology | 4 |
| English Composition and Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 231 | Physical Chemistry I | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| R120 102 | General Biology | 4 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| CHEM 473 | Biochemistry | 3 |
| CHEM 235 | Physical Chemistry II | 3 |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |
| Technical Elective | | 3 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| Physical Education GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| Technical Elective | | 3 |
| CHEM 475 | Biochemistry Lab I | 2 |

| | | |
|---|---|---|
| ECON 201 | Economics | 3 |
| R120 356 | Molecular Biology | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **14** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CHEM 235A | Physical Chemistry II Laboratory | 2 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| R120 352 | Genetics | 3 |
| Technical Elective | | 3 |
| Open GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 480 | Instrumental Analysis | 2 |
| Capstone Seminar Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| Management GUR Elective | | 3 |
| EVSC 385 | Environmental Microbiology | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **127** |

## Specific General University Requirements

| | | |
|---|---|---|
| **Computing Sciences** | | |
| Select at least two credits from the following: | | 2 |
| CS 101 | Computer Programming and Problem Solving | |
| CS 103 | Computer Science with Business Problems | |
| CS 104 | Computer Programming and Graphics Problems | |
| CS 113 | Introduction to Computer Science | |
| CS 115 | Intro. to CS I in C++ | |
| **English Composition and Cultural History (lower-level)** | | |
| Select at least one of the following: | | 6 |
| HUM 100 | English Composition: Reading, Writing, Speaking II | |
| HUM 101<br>& HUM 102 | English Composition: Writing, Speaking, Thinking I<br>and English Composition: Writing, Speaking, Thinking II | |
| Select at least one of the following: | | 3 |
| 100-level or 200-level cultural history course | | |
| HIST 213 | The Twentieth-Century World | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| Rutgers-Newark 200-level history course with prefix 510 or 512 | | |
| **Humanities and Social Sciences Electives (upper-level)** [1] | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philisophy course | |
| STS 3XX | Science, Technology and Society course | |
| R350 XXX | English Literature course | |
| R352 XXX | American Literature course | |
| R510 XXX | History course | |
| R512 XXX | American History course | |
| R730 XXX | Philosophy course | |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philisophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THR 3XX | Theater course | |
| Any 300-level Rutgers-Newark course in humanities, social sciences, fine arts or performing arts [2] | | |
| Select one of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 491 | Honors Sem In Humanities | |
| **Management** [3] | | |
| Select one of the following: | | 3 |
| HRM 301 | Organizational Behavior | |
| MGMT 390 | Principles of Management | |
| ENTR 410 | New Venture Management | |
| IE 492 | Engineering Management | |
| **Mathematics** | | |
| Select one of the following: | | 3 |
| MATH 111 | Calculus I | |
| MATH 113 | Finite Mathematics and Calculus I | |
| or MATH 138 | General Calculus I | |
| Select one of the following: | | 1 |
| MATH 105 | Elementary Probability and Statistics | |
| MATH 114 | Finite Mathematics and Calculus II | |
| MATH 225 | Survey of Probability and Statistics | |
| MATH 244 | Introduction to Probability Theory | |
| MATH 279 | Statistics and Probability for Engineers | |
| MATH 305 | Statistics for Technology | |
| MATH 333 | Probability and Statistics | |
| IE 331 | Applied Statistical Methods | |
| ECE 321 | Random Signals and Noise | |
| MNET 315 | Industrial Statistics | |
| **Natural Sciences** | | |
| Select at least seven credits from the following, including a laboratory experience. | | 7 |
| **Biology** | | |
| R120 101 | General Biology | |
| R120 102 | General Biology | |
| R120 109 | Basic Plant Science | |
| R120 110 | Basic Plant Sci Lab | |
| R120 205 | Environmental Issues | |
| R120 206 | General Horticulture | |
| R120 207 | Horticulture Lab | |
| R120 208 | Human Sexuality | |
| R120 237 | Environmental Microbiology | |
| R120 241 | Anatomy & Physiology | |

| | | |
|---|---|---|
| R120 242 | Anatomy & Physiology | |
| **Chemistry** | | |
| CHEM 122 | Fundamentals of Chemical Principles II | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 124 | General Chemistry Laboratory | |
| CHEM 125 | General Chemistry I | |
| CHEM 126 | General Chemistry II | |
| **Physics** | | |
| PHYS 102 | General Physics | |
| PHYS 102A | General Physics Laboratory | |
| PHYS 103 | General Physics | |
| PHYS 103A | General Physics Laboratory | |
| PHYS 111 | Physics I | |
| PHYS 111A | Physics I Laboratory | |
| PHYS 121 | Physics II | |
| PHYS 121A | Physics II Laboratory | |
| PHYS 202 | Introductory Astronomy and Cosmology | |
| PHYS 202A | Astronomy and Cosmology Laboratory | |
| PHYS 203 | The Earth in Space | |
| PHYS 203A | The Earth in Space Laboratory | |
| **Geology** | | |
| R460 101 | Intro To The Earth | |
| R460 103 | Planet Earth | |
| R460 104 | Planet Earth Lab | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| **Physical Education** | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |
| **Social Sciences (lower-level)** | | |
| Select at least two of the following: | | 6 |
| ECON 265 | Microeconomics | |
| or R220 101 | Intro To Econo-Micro | |
| ECON 266 | Macroeconomics | |
| or R220 102 | Intro To Econ-Macro | |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| R070 203 | Intro Phys Anth & Arch | |
| R070 204 | Intro Cultural Anthro | |
| R202 201 | Intro Criminal Justice | |
| R790 201 | American Government | |
| R790 202 | America & The World | |
| R830 101 | Principles Of Psychology I | |
| R830 102 | Prin Of Psychology | |
| R920 201 | Intro Sociology I | |
| R920 202 | Sociology II | |

1. No more than three of the nine required credits in this category may be fulfilled with a course that is specially required by a student's degree program or college.
2. Prefixes 070, 080, 081, 202, 220, 350, 352, 370, 420, 510, 512, 560, 570, 700, 701, 790, 810, 830, 861, 920, 940, 965, 988.

[3] Students in the aerospace option take AS 333 Leadership and Management I and those in the dual degree program between architecture and management take HRM 301 Organizational Behavior.

Courses that satisfy the General University Requirements are so certified by the University Curriculum Review Committee at the time they are first approved to be offered.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Chemistry

(125 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 125<br>or CHEM 121 | General Chemistry I<br>or Fundamentals of Chemical Principles I | 3 |
| CHEM 125A | General Chemistry Lab I | 1 |
| CS 113<br>or BNFO 135 | Introduction to Computer Science<br>or Programming for Bioinformatics | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 126<br>or CHEM 122 | General Chemistry II<br>or Fundamentals of Chemical Principles II | 3 |
| CHEM 126A | Gen Chemistry Lab II | 1 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| CHEM 221 | Analytical Chemical Methods | 2 |
| CHEM 222 | Analytical Chemistry | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 211 | Calculus III A | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 231 | Physical Chemistry I | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Free Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| CHEM 235 | Physical Chemistry II | 3 |
| ECON 201 | Economics | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 340 | Chemistry and Engineering of Materials | 3 |
| CHEM 336 | Physical Chemistry III | 3 |
| CHEM 235A | Physical Chemistry II Laboratory | 2 |
| MATH 225 | Survey of Probability and Statistics [1] | 1 |
| Open:GUR Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CHEM 473 | Biochemistry | 3 |
| CHEM 412<br>or R160 413 | Inorganic Chemistry<br>or Inorganic Chemistry | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 480 | Instrumental Analysis | 2 |
| Management:GUR Elective | | 3 |
| Capstone Seminar GUR Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **125** |

1 Students must take a special section of MATH 225 Survey of Probability and Statistics for chemical engineering or chemistry majors, in conjunction with CHEM 235A Physical Chemistry II Laboratory

For a listing of GUR and Electives **click here**

*This curriculum represents the maximum number of credits per semester for which a student is advised to register.  A full-time credit load is 12 credits.  First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## Department Regulations

For departmental regulations on prerequisites, grades and withdrawals, consult with the departmental undergraduate advisor. Students cannot receive a B.S. in Chemistry unless they achieve a minimum GPA of 2.0 in chemistry courses.

# B.S. in Environmental Science

(128 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| CHEM 125A | General Chemistry Lab I | 1 |

| | | |
|---|---|---|
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| R120 101 | General Biology | 4 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 126A | Gen Chemistry Lab II | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| R120 102 | General Biology | 4 |
| Physical Education | | 1 |
| EVSC 125 | Fundamentals of Environmental Sciences | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| R460 103 | Planet Earth | 3 |
| R460 104 | Planet Earth Lab | 1 |
| English Composition and Cultural History (lower-level) Elective | | 3 |
| CHEM 222 | Analytical Chemistry | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 243 | Organic Chemistry I | 3 |
| R460 206 | Env Geology | 3 |
| R460 207 | Env Geology Lab | 1 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| BNFO 135<br>or CS 113 | Programming for Bioinformatics<br>or Introduction to Computer Science | 3 |
| CHEM 221 | Analytical Chemical Methods | 2 |
| ECON 201<br>or ECON 265 | Economics<br>or Microeconomics | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| CHEM 360 | Environmental Chemistry I | 3 |
| Elective (Open GUR) | | 3 |
| MGMT 390 | Principles of Management | 3 |
| LIT/HIST/PHIL/STS 300 level | | 3 |
| Technical Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| EVSC 375 | Environmental Biology | 3 |
| R120 380 | Field Ecology | 3 |
| EVSC 325 | Energy and Environment | 3 |
| Free Elective | | 3 |
| CHEM 361 | Environmental Chemistry II | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| R120 335 | General Microbiology | 4 |
| EVSC 484 | Environmental Analysis | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 4 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| EVSC 416 | Environmental Toxicology | 3 |
| Humanities and Social Sciences (upper-level) 4XX HSS Capstone | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **128** |

## Technical Electives

| | | |
|---|---|---|
| **Chemistry** | | |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 473 | Biochemistry | 3 |
| CHEM 231 | Physical Chemistry I | 3 |
| **Environmental Science** | | |
| EVSC 385 | Environmental Microbiology | 3 |
| EVSC 381 | Geomorphology | 3 |
| EVSC 613 | Environmental Problem Solving | 3 |
| **Biology** | | |
| BIOL 222 | Evolution | 3 |
| BIOL 375 | Conservation Biology | 3 |
| BIOL 475 | Ecological Field Methods and Analysis | 3 |
| R120 330 | Plant Physiology | 4 |
| R120 370 | Plant Ecology | 3 |
| R120 371 | Field Study Plant Ecology | 3 |
| R120 381 | Ecological History of North Am | 3 |
| R120 470 | Field Ecology | 3 |
| R120 481 | Marine Biology | 4 |
| R120 352 | Genetics | 3 |
| **Civil and Environmental Engineering** | | |
| CE 342 | Geology | 3 |
| **Environmental Policy and Sustainability** | | |
| EPS 312 | Technology and Policy in Contemporary America | 3 |
| EPS 313 | Environmental History and Policy | 3 |
| EPS 360 | Ethics and the Environment | 3 |
| EPS 362 | Environmental Economics | 3 |
| EPS 380 | Policy Issues in the Coastal Environment | 3 |
| EPS 381 | Field Techniques and Research | 3 |
| **Geology Courses** | | |
| R460 331 | Oceanography | 3 |
| R460 427 | Hydrogeology | 3 |
| **Mathematics** | | |
| MATH 112 | Calculus II | 4 |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Chemistry Minor (not for Chemical Engineering majors)

| | | |
|---|---|---|
| Select A1 or A2: | | 11 |
| **A1** | | |
| CHEM 231 | Physical Chemistry I | |
| CHEM 235 | Physical Chemistry II | |
| CHEM 243 | Organic Chemistry I | |
| CHEM 235A | Physical Chemistry II Laboratory | |
| **A2** | | |
| CHEM 243 | Organic Chemistry I | |
| CHEM 244 | Organic Chemistry II | |
| CHEM 244A | Organic Chemistry II Laboratory | |
| CHEM 337 | | |
| Select two of the following: | | 5-6 |
| CHEM 473 | Biochemistry | |
| CHEM 222 | Analytical Chemistry | |
| CHEM 480 | Instrumental Analysis | |
| CHEM 336 | Physical Chemistry III | |
| CHEM 412 | Inorganic Chemistry | |
| CHEM 440 | | |
| CHEM 491 | Research and Independent Study I | |
| **Total Credits** | | **16-17** |

# Environmental Science and Policy Minor

| | | |
|---|---|---|
| CHEM 360 | Environmental Chemistry I [1] | 3 |
| or CHEM 361 | Environmental Chemistry II | |
| EVSC 375 | Environmental Biology | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Select six credits from the following: | | 6 |
| EVSC 484 | Environmental Analysis | |
| MATH 225 | Survey of Probability and Statistics | |
| EVSC 416 | Environmental Toxicology | |
| R460 206 | Env Geology | |
| R460 207 | Env Geology Lab | |
| EVSC 385 | Environmental Microbiology | |
| CHEM 360 | Environmental Chemistry I [1] | |
| or CHEM 361 | Environmental Chemistry II | |
| R120 380 | Field Ecology | |
| STS 362 | Environmental Economics | 3 |
| **Total Credits** | | **18** |

[1] 1. The first Environmental Chemistry Course counts against the core, the second can be used as an option course.

More **information on this minor** can be found on the Chemistry & Environmental Science website (http://chemistry.njit.edu/academics/undergraduate/minors.php).

# History

The history faculty at NJIT and Rutgers University-Newark comprise a federated department offering an integrated curriculum and a broad selection of degree programs covering major historical periods and regions. The unique perspective to be gained in historical study as an NJIT student is reflected in offerings such as the undergraduate and graduate program in the history of Technology, Environment and Health/Medicine. NJIT's history faculty also administers a distinctive undergraduate pre-law curriculum in Law, Technology, and Culture. In addition to instruction by nationally and internationally recognized scholars, the department offers outstanding resources and opportunities that include preparation for law-related careers; opportunities for original research and writing, with particular emphasis on the craft of historical writing; internships with the New Jersey Historical Society, the Newark Museum and other cultural institutions; participation in teacher-certification programs; use of the extensive library holdings of the Rutgers University system; and active student organizations on the graduate and undergraduate levels.

## NJIT History Faculty

### C

Çelik, Zeynep, Distinguished Professor (NJIT College of Architecture and Design)

### L

Lefkovitz, Alison L., Assistant Professor

### M

Maher, Neil M., Associate Professor

### N

Nocks, Lisa, Senior University Lecturer

### P

Pemberton, Stephen, Associate Professor

Petrick, Elizabeth R., Assistant Professor

### R

Riismandel, Kyle, University Lecturer

### S

Schweizer, Karl W., Professor

Sher, Richard B., Distinguished Professor

## Rutgers-Newark History Faculty

### A

Asen, Daniel, Assistant Professor

### C

Caplan, Karen, Associate Professor

Carruthers, Susan, Professor

Chang, Kornel, Associate Professor

Cowans, Jon, Associate Professor

### D

Diner, Steven J., University Professor

### F

Farney, Gary D., Associate Professor

Feldstein, Ruth, Professor

### G

Giloi, Eva, Associate Professor

Goodman, James, Distinguished Professor

## H

Diner, Steven J., University Professor

## K

Krasovic, Mark, Assistant Professor

## L

Lewis, Jan Ellen, Dean of Faculty and Professor

## M

Monteiro, Lyra D., Assistant Professor

## R

Rizzo, Mary, Assistant Professor

## S

Satter, Beryl, Professor

Stewart-Winter, Timothy, Associate Professor

Strub, Whitney, Associate Professor

## T

Truschke, Audrey, Assistant Professor

## V

Varlik, Nükhet, Associate Professor

# Programs

- History - B.A. (p. 327)
- Law, Technology and Culture - B.A. (p. 329)
- Patent Law, Technology and Culture - B.A. (p. 332)

# Accelerated Programs (p. 92)

- History - B.A. /D.P.T. (p. 323)
- History - B.A./J.D. (p. 325)
- History - B.A./M.D., D.M.D., D.D.S., O.D. (p. 325)
- Pre-Law - B.A./J.D. (p. 327)

- History Minor (p. 342)
- Legal Studies Minor (p. 342)

# History Courses

**HIST 2**. History Elective. 3 credits, 3 contact hours (3;0;0).**

**HIST 213. The Twentieth-Century World. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 and co-requisite HUM 102 with a grade C or better. Uses case studies to provide an interdisciplinary view of the 20th-century world. Selected literary, philosophical, and artistic movements are discussed in the context of the major historical developments of the century. This course satisfies three credits of the GUR in Cultural History.

**HIST 214. Tech & Cult in Amer History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101 with a grade of C or better, HUM 102 prerequisite or co-requisite with a grade of C or better. This course examines the relationship between technology and society throughout the history of the United States. We analyze the roles and impacts of major technological innovations within their cultural and historical contexts, seeking to understand how these contexts shaped and were shaped by these technologies.

**HIST 310. Co-op in Law, Technology, Culture and History I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Students gain work experience related to their major in Law, Technology and Culture. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report.

**HIST 311. Co-op in Law, Technology, Culture and History II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R 510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Students gain work experience related to their major in Law, Technology and Culture. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report.

**HIST 312. Prof Development in Law. 1 credit, 1 contact hour (1;0;0).**
Prerequisite : Sophomor standing. This course is designed to enhance professional development for students who hope to attend law school or another graduate program. It will provide students with the skills necessary to apply to, be accepted into, and succeed in law school or other graduate program. It will meet workshop-style for three hours for five weeks.

**HIST 334. Environmental History of North America. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 throughR510 299 or R512 200 through R 512 299 or their equivalents with a grade of C or better. The history of interactions between humans and their natural environment on the North American Continent. Considers perceptions of, use of, and alteration of the environment. Traces the cultural, intellectual, economic, political and technological transformations from early colonial times to the late 20th century. Addresses the diverse environmentalisms that have emerged the last several decades.

**HIST 341. The American Experience. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R 510 299 or R512 200 through R 512 299 or their equivalents with a grade of C or better. American history from the colonies to the 20th century, with concentration on several selected themes basic to an understanding of the changing cultural patterns and social values of American civilization.

**HIST 343. African-American History I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Introduction to African-American history from pre-colonial West Africa to emancipation in the mid-19th century. Topics include the African slave trade, the economics and politics of slavery, gender and culture in the slave community, and the free black experience in both the north and south.

**HIST 344. African-American History II. 3 credits, 3 contact hours (3;0;0).**
HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214, R510 200 through R510 299, R512 200 through R512 299 or their equivalents with a grade of C or better. Introduction to African-American history from the mid-19th century to the present. Covers race relations and the civil rights movement, as well as migration, black social and political thought, gender roles, and class formation.

**HIST 345. Communication through the Ages. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Modes of communication, ancient and modern, in their social and cultural context?from cave painting to computers. Topics include literacy and economic development in the West; the technological revolution in media beginning with Daguerre, Samuel Morse, and Alexander Graham Bell; the institutional development of mass media and popular culture; and contemporary trends in world communication and interaction.

**HIST 351. Ancient Greece and the Persian Empire. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R51 2 200 through R512 299 or their equivalents with a grade of C or better. The political, institutional, and cultural developments of Ancient Greece and the Persian Empire from the Mycenaean period to the King's Peace (386 B.C.).

**HIST 352. The Hellenistic States and the Roman Republic. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R5102299 or their equivalents with a grade of C or better. The political and cultural developments of the Hellenistic states and their influence on the Republic of Rome to 30 B.C.

**HIST 361. The Founding of the American Nation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. North America in the colonial and revolutionary periods, with emphasis on patterns of cultural and institutional development from early settlement through the ratification of the Constitution.

**HIST 362. Sex, Gender, and the Law in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines how the US legal system has dealt with the problems of sex and gender. Surveys laws that dictated different roles for men and women as well as seemingly gender-neutral laws that affected men and women differently. Tracks the designation of sexual acts as legal or illegal and the ways that race, class, and nationality complicated these relationships.

**HIST 363. The United States as a World Power. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. American domestic and foreign policy in the 20th century. Topics include imperialism, the Progressive Era, the Depression, the New Deal, World Wars I and II, the Cold War, America and the world today.

**HIST 364. American Law in the World. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Concerns the history of American law as a product and catalyst of world politics by considering in global context the transformation of central doctrines of regulation, property rights, and civil liberties from the Declaration of Independence through the War on Terror.

**HIST 365. Comparative Colonial History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. A comparative analysis of the relationship between expanding Western nations and selected regions of Africa, Asia, and South America, from 1500 to 1970. A case study approach illuminates key historical processes, with a special emphasis on economic development and cultural change in colonial settings. Topics include European perceptions of culturally different peoples, race relations in colonial societies, forms of rebellion and resistance to European rule, nationalist movements.

**HIST 366. Gender, Race and Identity in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Surveys the social construction of gender in America from the s17th century to the present. Examines the changing gender roles and relations that have characterized and structured the historical experiences of different racial and ethnic groups. In a multicultural framework, covers the impact that colonization, industrialization, slavery, immigration and migration, urbanization, war, and social movements have had on the ways that women and men think of themselves in terms of gender as well as their respective roles in families and larger social networks.

**HIST 367. International Law and Diplomacy in History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines the origins, evolution, and application of diplomacy and international law from the 15th century to the present. Topics include the rise of modern diplomacy in Renaissance Italy; the emergence of international law and professionalization of diplomacy in early modern Europe; the development of international law and diplomatic theory in the 18th and 19th centuries; the codification of international law; and adaptation of international law to transnationalism and globalism in the 20th century.

**HIST 369. Law and Society in History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Uses historical case studies to illustrate and evaluate various approaches to the study of law and society. Topics include criminality and the rise of incarceration as a legal penalty in the 19th century; the comparative law of slavery; and the evolution of American Indian law.

**HIST 370. Legal issues in the History of Media. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better.Investigates the development and impact of media law and policy in the United States. Examines how media law and policy affect media content, industry behavior, and consumer rights. Analyzes the values and ideas, as well as political and cultural contexts, that have guided continuities and transformations in media law and policy. Topics include indecency and obscenity, copyright and intellectual property, legal protections for children, and media ownership regulation.

**HIST 372. Contemporary Europe. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better. European society in the 20th century, Nationalism, imperialism, totalitarianism, movements toward European unity, and prominent cultural developments.

**HIST 373. The Rise of Modern Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines the development of modern science in the western world from the origins of the Scientific Revolution to 1900. Explores how science challenged the revealed universe of Christianity, changed the curriculum in schools and universities, and altered the world view of philosophers. This course covers the achievements of Copernicus, Galileo, Newton, Darwin, Einstein, and other leading scientific innovators, but it also weaves the expansion of scientific knowledge into the larger fabric of European intellectual history.

**HIST 374. Modern Russian Civilization. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Russia under the last tsars, the 1917 upheavals, rise of the Soviet state to world power under Lenin, Stalin, and others, until the collapse of the communist dictatorship.

**HIST 375. Legal Issues in Environmental History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better.Examines the role of law in the formation of human relationships with the natural world. The course will focus on the management and regulation of the human use of natural resources in a variety of historical contexts, but particularly in the United States from colonial times to the present. Through readings and class discussion, students will explore a number of recurring themes, including the transformation from customary rules governing access to local resources to state enforced laws.

**HIST 377. Cities in History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 99 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines social, cultural and economic changes in urban areas. Regions and themes vary and may include urbanization in Europe, the rise of cities in Latin America, and urban change in contemporary America.

**HIST 378. Medicine and Health Law in Modern America. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R520 299 or their equivalents with a grade of C or better. Examines the legal and ethical aspects of medical and public health practice in the United States from 1900 to the present. Topics include the rights and responsibilities of physicians and patients, the roles of government in promoting health, the rise of health law and bioethics, the tensions between civil liberties and public health, as well as evolving notions of harm, liability, uncertainty, and proof as they relate to the history of medical and public health practice.

**HIST 379. History of Medicine. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better.Focuses on the evolving institutions, values, concepts, and techniques through which doctors attempted to control the impact of disease and preserve the health of Americans, beginning with the shaman and colonial physician through post-World War II changes in the system of medical care.

**HIST 380. History of Public Health. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Attempts to protect the health of human populations from the Black Death in medieval Europe to recent threats from epidemics and chemical and biological terrorism. Shiftings patterns of disease and the emergence and growth of public health as a domain of expert knowledge and policy. Topics include: epidemiology and statistical modes of inquiry; the tension between civil liberties and public health; the economics of health and disease; and the relationship between medicine and public health.

**HIST 381. Germs Genes and Body: Sci. and Tech. in Modern Medicine. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Examines how science and technology came to play critical roles in the rise of modern medicine. Readings, lectures, and discussion focus on the specific innovations in ideas, practices, and technologies that helped transform Western medicine in the 19th and 20th centuries. The course also considers how medicine and the biomedical sciences both inform and reflect attitudes about the human body in Western society.

**HIST 382. War and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. The evolution of warfare and the impact of war on political, economic, cultural, and social institutions, including the two World Wars and post-1945 conflicts.

**HIST 383. The Making of Modern Thought. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. The formation of contemporary images of human nature since the mid-19th century. Emphasis on Marx, Darwin, and Freud and their legacy to 20th century thought. Theories of the family, sexuality, and the changing role of women in society are explored.

**HIST 384. Invention and Regulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: The 200 level cututral history GUR, understood as Hum 211, Hum 212, Hist 213 or Hist 214 or any Rutgers 200 level course in R510 or 512. This course examines how the law has affected technological development in the United States from its founding to today. We cover four broad technical categories: industrialization, transportation, communication, information technology.We analyze the invention of technology within issues of patent and copyright, funding and regulation of technology through legislation, and legal challenges to technology. Our goal is to understand change in law and technology in historical and cultural context.

**HIST 385. Technology and Society in European and World History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 99 or their equivalents with a grade of C or better. An introduction to the social history of European and global tech-nology from the Middle Ages to the second Industrial Revolution of the late 19th century. Emphasis on such themes as the process of tech-nological innovation, the nature of technological systems, the diffusion of technology, the interaction of Western and non-Western technology, the changing relations of science and technology, and the role of technology in broader historical movements.

**HIST 386. Technology in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. Survey of the history of American technology emphasizing the social and economic environments of technological change. Topics include the transfer of technology in building canals and cities, the rise of the factory system, the emergence of the American system of manufacture, and the development of major technological systems such as the railroad, telegraph, electric light and power, and automobile production and use. Focus on the professionalization of engineering practice, the industrialization of invention, and the growing links between engineers and corporate capitalism in the 20th century.

**HIST 387. Computers, Innovators and Hist. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: Hum 101, Hum 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. This course traces the development of computer technology from its theoretical origins in the 19th century, through the transformation from analog to digital computers and the emergence of personal computing in the 20th century, up to the present. Topics include the place of computer technology in society, how computers & people shape each other, who & what was involved in innovating computers, the cultural context of such innovation, as well as how the uses and users of computers have evolved.

**HIST 388. Britain in the 20th Century. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214, R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Survey of British history from the death of Queen Victoria (1901) to that of Diana, Princess of Wales (1997); emphasis on Britain’s social, cultural and political transformation. Topics include causes and impact of the World Wars, the turn from Empire to Europe, rise and critique of the welfare state, and foreign relations.

**HIST 390. Historical Problems of the 20th Century through Film. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents R510 200 through R510 299 or R512 200 through R512 299 or their equivalents with a grade of C or better. A study of selected problems in the 20th century using film as a window into history. Such topics as the rise of Nazi Germany, America in the thirties, World War II and American society, the development of cities, and the emergence of the Third World will be considered. In any one semester only two topics will be selected for study. The material for the course will include documentary films, newsreels, TV news films, and theatrical feature films as well as selected readings.

**HIST 391. Industrial Revolution in World. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or equivalents R510 200 through R 510 299 or R512 200 through R 512 299 or equivalents with a grade of C or better. This course covers the Industrial Revolution from its emergence in Britain in the 18th century to its expansion to America, Western Europe, and Japan. Topics include the practical need for new forms of power, links between invention, empire, the impact of technical advance on the labor force, colonialism and slavery, and 19th century socio-cultural change.

**HIST 401. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents with a grade of C or better in addition to a junior or senior standing; and before registering, permission from one of the following: NJIT history department chairperson, associate chairperson or history minor advisor. Pursuit of special interests in history not covered in a regular elective course. A history faculty member provides guidance and assigns readings and papers. Note: Normal grading applies to this COOP Experience.

**HIST 402. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 101, HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents with a grade of C or better in addition to a junior or senior standing; and before registering, permission from one of the following: NJIT history department chairperson, associate chairperson or history minor advisor. Pursuit of special interests in history not covered in a regular elective course. A history faculty member provides guidance and assigns readings and papers. Note: Normal grading applies to this COOP Experience.

**HIST 489. Seminar-Readings. 3 credits, 3 contact hours (3;0;0).**
prerequisites: Completion of the GUR in English (3 credits), Cultural History (6 credits), Basic Social Sciences (6 credits) an upper level History course (3 credits) and senior standing. Intended to combine study of specific topics, which vary each year, with attention to the methods for researching and writing history, these small classes for history majors in their senior year prepare students for the following semester's research project and culminate in a brief paper describing a proposed topic and the historical documents and sources to be used.

**HIST 490. Seminar Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Completion of the GUR in English and Cultural History, R510:315 or R510:316 Perspectives in History, and HSS 404 History Senior Seminar. This one-semester-long seminar allows students to apply the skills they learn in the History major to specific topics that vary semester by semester. In these small classes, students conduct research with attention to historical methods. With close guidance from instructors, students explore local archives, design a paper topic of their individual interest in conjunction with the professor, and write a research paper.

## Rutgers-Newark Courses

**R510 101. Western Civilization. 3 credits, 3 contact hours (3;0;0).**

**R510 102. History Of Western Civ. 3 credits, 3 contact hours (3;0;0).**

**R510 201. Hist Of West Civ. 3 credits, 3 contact hours (3;0;0).**

**R510 202. History Of West. Civ.. 3 credits, 3 contact hours (3;0;0).**

**R510 205. Hist Western Civ. 3 credits, 3 contact hours (3;0;0).**

**R510 207. Hist Of Latin Amer. 3 credits, 3 contact hours (3;0;0).**

**R510 208. History Of Latin America. 3 credits, 0 contact hours (0;0;0).**

**R510 213. 20th Century World. 3 credits, 3 contact hours (3;0;0).**

**R510 226. ST:. 3 credits, 3 contact hours (3;0;0).**

**R510 227. ST:. 3 credits, 3 contact hours (3;0;0).**

**R510 236. Ancient World. 3 credits, 3 contact hours (3;0;0).**

**R510 255. Ancient Greece & Persian Empir. 3 credits, 3 contact hours (3;0;0).**

**R510 256. Roman Civilization. 3 credits, 3 contact hours (3;0;0).**

**R510 257. Golden Age Of Europe. 3 credits, 3 contact hours (3;0;0).**

**R510 258. Golden Age Of Europe. 3 credits, 3 contact hours (3;0;0).**

**R510 262. Hist Rus & Soviet Union. 3 credits, 3 contact hours (3;0;0).**

**R510 263. History Of Africa. 3 credits, 3 contact hours (3;0;0).**

**R510 264. History Of Africa. 3 credits, 3 contact hours (3;0;0).**

**R510 272. Peoples Republic China. 3 credits, 3 contact hours (3;0;0).**

**R510 280. South Asia up to 1750. 3 credits, 3 contact hours (3;0;0).**

**R510 286. The Ancient Near Est. 3 credits, 3 contact hours (3;0;0).**

**R510 287. Hist Islamic Civ. 3 credits, 0 contact hours (0;0;0).**

**R510 288. Hist Of Islamic Civ.. 3 credits, 0 contact hours (0;0;0).**

**R510 289. Perspective in History. 3 credits, 3 contact hours (3;0;0).**

**R510 290. Perspectives in History. 3 credits, 3 contact hours (3;0;0).**

**R510 297. Far Eastern History. 3 credits, 0 contact hours (0;0;0).**

**R510 298. Far Eastern History. 3 credits, 0 contact hours (0;0;0).**

**R510 300. The Ottoman Empire. 3 credits, 3 contact hours (3;0;0).**

**R510 301. Film And History. 3 credits, 3 contact hours (3;0;0).**

**R510 302. History Of Democracy. 3 credits, 0 contact hours (0;0;0).**

**R510 305. Ancient Sport. 3 credits, 3 contact hours (3;0;0).**

**R510 306. Greek & Roman City. 3 credits, 3 contact hours (3;0;0).**

**R510 307. South Asia Up To 1750. 3 credits, 3 contact hours (3;0;0).**

**R510 308. South Asia Since 1750. 3 credits, 3 contact hours (3;0;0).**

**R510 311. Latin Amer & The Us. 3 credits, 3 contact hours (3;0;0).**

**R510 313. Cinema & Society 20th Century. 3 credits, 3 contact hours (3;0;0).**

**R510 314. Film and Colonialism. 3 credits, 3 contact hours (3;0;0).**

**R510 315. Perspectives in History. 3 credits, 3 contact hours (3;0;0).**

**R510 316. Perpectives in History. 3 credits, 3 contact hours (3;0;0).**

**R510 317. History Of The Caribbean. 3 credits, 3 contact hours (3;0;0).**

**R510 319. Classical World. 3 credits, 3 contact hours (3;0;0).**

**R510 320. Roman History. 3 credits, 3 contact hours (3;0;0).**

**R510 321. Military History. 3 credits, 3 contact hours (3;0;0).**

**R510 323. History Of Puerto Rico. 3 credits, 3 contact hours (3;0;0).**

**R510 324. History Of Puerto Rico. 3 credits, 3 contact hours (3;0;0).**

**R510 325. The Ancient World. 3 credits, 3 contact hours (3;0;0).**

**R510 327. Civil Of Middle Ages. 3 credits, 3 contact hours (3;0;0).**

# Accelerated B.A. in History/D.P.T.

## Major Requirements

The accelerated B.A. in history requires 36 credits of history courses with a grade of C or higher. The history courses may include offerings at NJIT (HIST prefix) and Rutgers (510 and 512 prefixes). The accelerated history student must complete a minimum of 107 total undergraduate credits, inclusive of NJIT's General University Requirements (p. 93), prior to advancing to professional training in their fourth year. Each student's program of study is subject to approval by an advisor or by the chairperson of the departmen

Students in the B.A./D.P.T. program follow the curriculum for the 7-Year Accelerated Programs in History (B.A.) and Medicine (M.D.)/Dentistry (D.M.D. or D.D.S.) or Optometry (O.D.) (p. 325), with the following difference: Students can take R120 141 Anatomy & Physiology and R120 142 Anatomy & Physiology (4 credits each) in place of R120 102 General Biology and one free elective.

## Required History Courses for Accelerated B.A./D.P.T.

| | | |
|---|---|---|
| **Western Civilization** | | |
| R510 201 | Hist Of West Civ | 3 |
| R510 202 | History Of West. Civ. | 3 |
| **American History** | | |
| Six credits in U.S. History courses (any level) | | 6 |
| **Global/Comparative History** | | |
| Six credits in Asian, African, Latin American, World, or Comparative History courses (any level) | | 6 |
| **History of Medicine/Health** | | |
| Select two of the following: [1] | | 6 |
| HIST 378 | Medicine and Health Law in Modern America | |
| HIST 379 | History of Medicine | |
| HIST 380 | History of Public Health | |
| HIST 381 | Germs Genes and Body: Sci. and Tech. in Modern Medicine | |
| **Historical Methodology & Research** | | |
| R510 316 | Perpectives in History | 3 |
| Select one of the following two-semester Senior History Seminars: [2, 3] | | 6 |
| R510 489<br>& R510 490 | Seminar:Readings<br>and Seminar:Research [4] | |
| HIST 489<br>& HIST 490 | Seminar-Readings<br>and Seminar Research [4] | |
| **Free History Electives** | | |
| Three credits in history (upper level) [5] | | 3 |
| **Total Credits** | | **36** |

1. At least one of these courses must be taken in an honors section. Each history of medicine/health course can count either as an American History course or as a course in Global/Comparative History (as determined by the academic advisor).
2. Successful completion of a R510 316 Perpectives in History and HSS 404 Humanities Senior Seminar - History are required prior to enrollment in HIST 490 Seminar Research or R510 490 Seminar:Research.
3. All majors write a research paper that incorporates methods of historiography and research learned in the seminar. An honors level of scholarship is expected from students enrolled in the Albert Dorman Honors College.
4. Majors must enroll for the section of 490 that continues their specific section of 489.
5. Must be HSS 404 Humanities Senior Seminar - History if upper-level HSS GUR not otherwise satisfied.

## 6-Year Accelerated Program in History (B.A.) and Physical Therapy (DPT)

(107 credits at NJIT)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| R510 201 | Hist Of West Civ | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |

| | | |
|---|---|---|
| CHEM 125 | General Chemistry I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R510 202 | History Of West. Civ. | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| CHEM 126 | General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **18** |
| **Summer** | | |
| BIOL 200 | Concepts in Biology | 4 |
| R120 102 | General Biology | 4 |
| | **Term Credits** | **8** |
| **Second Year** | | |
| **1st Semester** | | |
| American History Elective | | 3 |
| Global/Comparative History Elective | | 3 |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R510 316 | Perpectives in History | 3 |
| Global/Comparative History Elective | | 3 |
| History of Medicine/Health Elective | | 3 |
| Social Sciences (lower-level): GUR Elective | | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| R510 489<br>or HIST 489 | Seminar:Readings<br>or Seminar-Readings | 3 |
| HSS 404 | Humanities Senior Seminar - History | 3 |
| History of Medicine/Health Elective | | 3 |
| Management: GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| R510 490<br>or HIST 490 | Seminar:Research<br>or Seminar Research | 3 |
| Upper Level History Elective | | 3 |
| Free Elective | | 3 |

| | | |
|---|---|---|
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **107** |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Accelerated B.A. in History/J.D.

## 6-Year Accelerated Program in History (B.A.) and Law (J.D.)

(123 credits: 105 at NJIT and 18 in the first year at Law School)

1. Students complete a total of 105 credits at NJIT instead of 120. The remaining 15 credits of coursework for the B.A. are taken during the first year of law school.
2. Students complete all NJIT course requirements (105 credits) in their three years at NJIT. Twelve of these 105 credits are taken during the first two summers at NJIT or by taking 3 extra credits during particular semesters.
3. Students complete the minor in Legal Studies (15 credits). Courses that are counted for the minor cannot also be counted for the major.
4. Students take 9 credits of free electives instead of 42.
5. Students fulfill all the requirements of the Albert Dorman Honors College.

# Accelerated B.A. in History/M.D., D.M.D., D.D.S., O.D.

## Major Requirements

The accelerated B.A. in history requires 36 credits of history courses with a grade of C or higher. The history courses may include offerings at NJIT (HIST prefix) and Rutgers (510 and 512 prefixes). The accelerated history student must complete a minimum of 107 total undergraduate credits, inclusive of NJIT's General University Requirements (p. 93), prior to advancing to professional training in their fourth year. Each student's program of study is subject to approval by an advisor or by the chairperson of the department.

### Required History Courses for Accelerated B.A./M.D., D.M.D., D.D.S., or O.D.

| | | |
|---|---|---|
| **Western Civilization** | | |
| R510 201 | Hist Of West Civ | 3 |
| R510 202 | History Of West. Civ. | 3 |
| **American History** | | |
| Six credits in U.S. History courses (any level) | | 6 |
| **Global/Comparative History** | | |
| Six credits in Asian, African, Latin American, World, or Comparative History courses (any level) | | 6 |
| **History of Medicine/Health** | | |
| Select two of the following: [1] | | 6 |
| HIST 378 | Medicine and Health Law in Modern America | |
| HIST 379 | History of Medicine | |
| HIST 380 | History of Public Health | |
| HIST 381 | Germs Genes and Body: Sci. and Tech. in Modern Medicine | |
| **Historical Methodology & Research** | | |
| R510 316 | Perpectives in History | 3 |
| Select one of the following two-semester Senior History Seminars: [2, 3] | | 6 |
| R510 489<br>& R510 490 | Seminar:Readings<br>and Seminar:Research [4] | |
| HIST 489<br>& HIST 490 | Seminar-Readings<br>and Seminar Research [4] | |
| **Free History Electives** | | |

| | |
|---|---|
| Three credits in history (upper level) [5] | 3 |
| **Total Credits** | **36** |

[1] At least one of these courses must be taken in an honors section. Each history of medicine/health course can count either as an American History course or as a course in Global/Comparative History (as determined by the academic advisor).

[2] Successful completion of a R510 316 Perpectives in History and HSS 404 Humanities Senior Seminar - History are required prior to enrollment in HIST 490 Seminar Research or R510 490 Seminar:Research.

[3] All majors write a research paper that incorporates methods of historiography and research learned in the seminar. An honors level of scholarship is expected from students enrolled in the Albert Dorman Honors College.

[4] Majors must enroll for the section of 490 that continues their specific section of 489.

[5] Must be HSS 404 Humanities Senior Seminar - History if upper-level HSS GUR not otherwise satisfied.

## 7-Year Accelerated Program in History (B.A.) and Medicine (M.D.)/Dentistry (D.M.D. or D.D.S.) or Optometry (O.D.).

(107 credits at NJIT)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| R510 201 | Hist Of West Civ | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| CHEM 125 | General Chemistry I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R510 202 | History Of West. Civ. | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| CHEM 126 | General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| STS 210<br>or R830 101 | General Psychology<br>or Principles Of Psychology I | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **18** |
| **Summer** | | |
| BIOL 200 | Concepts in Biology | 4 |
| R120 102 | General Biology | 4 |
| | **Term Credits** | **8** |
| **Second Year** | | |
| **1st Semester** | | |
| American History Elective | | 3 |
| Global/Comparative History Elective | | 3 |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R510 316 | Perpectives in History | 3 |

| | | |
|---|---|---|
| Global/Comparative History Elective | | 3 |
| History of Medicine/Health Elective | | 3 |
| Social Sciences (lower-level): GUR Elective | | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| R510 489<br>or HIST 489 | Seminar:Readings<br>or Seminar-Readings | 3 |
| HSS 404 | Humanities Senior Seminar - History | 3 |
| History of Medicine/Health Elective | | 3 |
| Management: GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| R510 490<br>or HIST 490 | Seminar:Research<br>or Seminar Research | 3 |
| Upper Level History Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **107** |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Accelerated B.A. in Pre-Law/J.D.

## 6-Year Accelerated Curriculum in Law, Technology and Culture (B.A.) and Law (J.D.)

(105 credits at NJIT + the first year of Law School)

The accelerated pre-law curriculum in Law, Technology and Culture (LTC) differs from the standard LTC curriculum in the following ways:

1. Students take a total of 105 credits at NJIT during three years of study. The B.A. is granted from NJIT after successful completion of the first year of law school.
2. In order to complete all NJIT course requirements in their three years at NJIT, students take 12 of their required 105 credits during the summers after their first and second years or as an overload during fall and spring semesters.
3. Students take 6 credits of free electives instead of 24.
4. Students fulfill all the requirements of the Albert Dorman Honors College, and an honors level of scholarship is expected in projects or theses submitted in HSS 404 Humanities Senior Seminar - History.

# B.A. in History

## Major Requirements

The major requires 36 credits of history courses with a grade of C or higher. These courses may include offerings at NJIT (HIST prefix) and Rutgers (510 and 512 prefixes). The B.A. in history also requires a minimum of 120 total credits, including completion of the General University Requirements (p. 93). Each student's program of study is subject to approval by an advisor or by the chairperson of the department. Specific requirements are as follows:

| | | |
|---|---|---|
| **Western Civilization** | | |
| R510 201 | Hist Of West Civ [1] | 3 |
| R510 202 | History Of West. Civ. [1] | 3 |

| | | |
|---|---|---|
| **American History** | | |
| Six credits in U.S. History courses (any level) | | 6 |
| **Global/Comparative History** | | |
| Six credits in Asian, African, Latin American, World, or Comparative History courses (any level) | | 6 |
| **Historical Methodology & Research** | | |
| R510 316 | Perpectives in History | 3 |
| Select one of the following two-semester Senior History Seminars: [2, 3, 4] | | 6 |
| R510 489<br>& R510 490 | Seminar:Readings<br>and Seminar:Research [5] | |
| HIST 489<br>& HIST 490 | Seminar-Readings<br>and Seminar Research [5] | |
| **History Electives** | | |
| Nine credits in history [6] | | 9 |
| **Total Credits** | | **36** |

1. Students who transfer into the history major after fulfilling the GUR in cultural history with different courses may, at the discretion of their advisor, substitute other courses for R510 201 Hist Of West Civ and R510 202 History Of West. Civ..
2. Qualified juniors may enroll in R510 489 Seminar:Readings or HIST 489 Seminar-Readings with permission.
3. Successful completion of a Perspectives in History course and HSS 404 Humanities Senior Seminar - History are required prior to enrollment in HIST 490 Seminar Research or R510 490 Seminar:Research.
4. All majors write a research paper that incorporates methods of historiography and research learned in the seminar. An honors level of scholarship is expected from students enrolled in the Albert Dorman Honors College.
5. Majors must enroll for the section of 490 that continues their specific section of 489.
6. At least six of the nine history elective credits must be taken at the 300 level or higher.

# B.A. in History

(120 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| MATH 101 | Foundations of Mathematics for the Liberal Arts | 3 |
| PHYS 204 | Biophysics of Life | 3 |
| STS 201 | Understanding Technological Society | 3 |
| R510 201 | Hist Of West Civ | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| CS 103 | Computer Science with Business Problems | 3 |
| R510 202 | History Of West. Civ. | 3 |
| Natural Sciences: GUR Elective | | 4 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| American History Elective | | 3 |
| Global or Comparative History Elective | | 3 |
| Social Sciences (lower-level): GUR Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| American History Elective | | 3 |
| Global or Comparative History Elective | | 3 |
| Social Science or STS Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| R510 316 | Perpectives in History | 3 |
| Management: GUR Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| HSS 404 | Humanities Senior Seminar - History | 3 |
| History Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| R510 489<br>or HIST 489 | Seminar:Readings<br>or Seminar-Readings | 3 |
| History Upper Level Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| R510 490<br>or HIST 490 | Seminar:Research<br>or Seminar Research | 3 |
| History Upper Level Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **12** |
| | **Total Credits** | **120** |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.A. in Law, Technology and Culture

## Major Requirements

The Law, Technology and Culture (LTC) B.A. requires 51 credits of major courses with a grade of C or higher. These courses may include offerings at NJIT and Rutgers-Newark. The B.A. in LTC also requires a minimum of 120 total credits, including completion of the General University Requirements (p. 93). Each student's program of study is subject to approval by an advisor or by the chairperson of the department.

## The 51 credits of LTC major courses are taken from the following four categories:

(1) Nine credits of legal foundations core courses, which treat aspects of the law in relation to history, philosophy, business, and basic principles of jurisprudence and legal thought, writing, and research:

**Legal Foundations Core Courses**

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| HIST 361 | The Founding of the American Nation | |
| HIST 362 | Sex, Gender, and the Law in American History | |
| HIST 364 | American Law in the World | |
| HIST 369 | Law and Society in History | |
| MGMT 290 | Business Law I | |
| PHIL 300 | Philosophy of Law and Social Justice | |
| STS 300 | Legal Reasoning, Writing, and Technology | |
| R790 304 | Intro Law And Legal Res | |
| **Total Credits** | | **9** |

(2) Twelve credits of LTC core courses, which treat the history, policy, and practice of law in relation to engineering, environment, health, information technology, and media:

**LTC Core Courses**

| | | |
|---|---|---|
| Select four of the following: | | 12 |
| EVSC 335 | Environmental Law | |
| HIST 370 | Legal issues in the History of Media | |
| HIST 375 | Legal Issues in Environmental History | |
| HIST 378 | Medicine and Health Law in Modern America | |
| IE 447 | Legal Aspects of Engineering | |
| IT 331 | Privacy and Information Technology | |
| IT 332 | Digital Crime | |
| IT 400 | Information Technology and the Law | |
| R790 382 | Environm Pol & Policy | |
| **Total Credits** | | **12** |

(3) Twenty-four credits of law-related electives and other approved courses offered at NJIT and Rutgers-Newark that fit each student's special interests. Examples include:

**Law-Related Electives** [1]

| | | |
|---|---|---|
| Select eight of the following: | | 24 |
| HIST 373 | The Rise of Modern Science | |
| IE 472 | Product Liability Engineering | |
| R202 201 | Intro Criminal Justice | |
| R512 265 | Amer Legal Hist | |
| R512 266 | American Legal History II | |
| R202 305 | Case Process:Law & Courts | |
| R512 379 | Us Hist In The Court | |
| R790 356 | Sex Law & Public Pol | |
| R790 367 | Jurisprudence and Legal Theory | |
| R790 381 | Judicial Process | |
| R790 387 | International Law | |
| R790 401<br>& R790 402 | Amer Constitutl Dev<br>and Amer Constitutl Dev | |
| R790 409 | Law & Public Policy (writing intensive) | |
| R920 349 | Law & Society | |
| **Total Credits** | | **24** |

[1] Students who wish to pursue a specialty in law in relation to a specific scientific, technological, environmental, medical, or media field (such as health policy or intellectual property on the Internet), legal field (such as environmental law, criminal law, or international law), or interdisciplinary thematic field (such as gender studies) may count up to 9 credits of advisor-approved courses in that field toward the electives requirement for the major. For example, a student interested in environmental law might take HIST 334 Environmental History of North America and 6 credits of courses in environmental science and/or environmental policy for elective course credit in the major.

(4) Six credits of focused senior coursework: HSS 404 Humanities Senior Seminar - History, in which students prepare a project or write a thesis in a relevant field, and HIST 310 Co-op in Law, Technology, Culture and History I, which provides a hands-on, law-related experience as an intern in a law firm, non-profit or government agency, science- or technology-based corporation, or other relevant organization.

| **Law-Focused Senior Courses** | | |
|---|---|---|
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| HSS 404 | Humanities Senior Seminar - History (Must Be Approved Law-Related HSS 404) | 3 |
| **Total Credits** | | **6** |

## B. A. in Law, Technology and Culture

(120 credits minimum)

| **First Year** | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Select one of the following: | | 3-4 |
| MATH 101 | Foundations of Mathematics for the Liberal Arts | |
| MATH 111 | Calculus I | |
| MATH 131 | Calculus A | |
| MGMT 290 | Business Law I | 3 |
| PHYS 204 | Biophysics of Life | 3 |
| Social Science: GUR Elective | | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15-16** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| CS 100 | Roadmap to Computing | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Law Related Elective | | 3 |
| Natural Science with Lab: GUR Elective | | 4 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| Law Related Elective | | 3 |
| Law Related Elective | | 3 |
| Cultural History: GUR Elective | | 3 |
| Social Sciences: GUR Elective | | 3 |
| Free Elective | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Law Technology and Culture Core Elective | | 3 |
| Legal Foundations Elective | | 3 |
| Law Related Elective | | 3 |
| Free Elective | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |

| | | |
|---|---|---|
| **Third Year** | | |
| **1st Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Law Related Elective | | 3 |
| Legal Foundations Elective | | 3 |
| Social Science: GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Law Related Elective | | 3 |
| Legal Foundations Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| HSS 404 | Humanities Senior Seminar - History | 3 |
| MGMT 390<br>or HRM 301 | Principles of Management<br>or Organizational Behavior | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Law Related Elective | | 3 |
| Law Related Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **12** |
| | **Total Credits** | **120-121** |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.A. in Patent Law, Technology and Culture

## Major Requirements

The patent law, technology, and culture major requires a minimum of 51 credits of LTC major courses with a grade of C or higher. These courses may include offerings at NJIT and Rutgers-Newark. The patent law B.A. also requires a minimum of 120 total credits, including completion of the General University Requirements (p. 93). Each student's program of study is subject to approval by an advisor or by the chairperson of the department.

Students in the patent law curriculum program follow the standard curriculum for the Law, Technology and Culture B.A. (p. 329) while focusing their science-based coursework around a specific discipline (biology, chemistry, or physics). The curricular options for the Patent Law concentration are as follows:

### Biology Options (B.A. or B.S.)

Students choosing the biology option must complete 8 credits of approved chemistry or physics courses and 24 credits of approved courses in biology, botany, microbiology, or molecular biology. The 8 semester hours in chemistry or physics must be obtained in two sequential courses, each course including a lab. Only biology courses for biology majors will be accepted. Subject to the approval of an advisor, students can earn a double-major B.A. in LTC and biology with 124 total credits. It is also possible to earn a double-major B.S. degree in LTC and Biology with 128 total credits.*

## Chemistry Options (B.A. or B.S.)

Students choosing the chemistry option must complete 30 credits of approved chemistry courses. Only chemistry courses for chemistry majors will be accepted. Subject to the approval of an advisor, students can earn a double-major B.S. in LTC and chemistry with 125 total credits.*

## Physics Options (B.A. or B.S.)

Students choosing the physics option must complete 24 credits of approved physics courses. Only physics courses for physics majors will be accepted. Subject to the approval of an advisor, students can earn a double-major B.S. in LTC and applied physics with 127 total credits. Students doing the B.S. in Applied Physics and LTC choose to study one of two concentrations: either Astronomy or Optical Science and Engineering.*

## General Science Option (B.A.)

Students choosing the general science option must complete 8 credits of approved chemistry or physics courses and 32 credits of approved courses in chemistry, physics, biology, botany, microbiology, molecular biology, or engineering. The 8 semester hours of chemistry or 8 semester hours of physics must be obtained in two sequential courses, each course including a lab. Only courses for science or engineering majors will be accepted.*

***Note**: The science courses in each Patent Law, Technology and Culture major are taken in place of:

- 7-8 credits of the Natural Sciences GUR electives
- up to 24 credits of Law-Related electives
- up to 24 credits of Free Electives to fulfill 24 credits of Free Electives (as mandated by the U.S. Patent and Trademark Office).

# B.A. in Patent Law, Technology and Culture

(120 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| CS 100 | Roadmap to Computing | 3 |
| MATH 111 | Calculus I | 4 |
| MGMT 290 | Business Law I | 3 |
| Natural Sciences: GUR Elective | | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Legal Foundations Elective | | 3 |
| Natural Science with Laboratory: GUR Elective | | 4 |
| Social Science: GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Legal Foundations Elective | | 3 |
| Cultural History: GUR Elective | | 3 |
| Social Sciences: GUR Elective | | 3 |
| Natural Science [1] | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Law Related Elective | | 3 |
| Natural Science with Lab [1] | | 4 |
| Free Elective | | 3 |

| | | |
|---|---|---|
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Law Related Elective | | 3 |
| Natural Science [1] | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Law Technology and Culture Core Elective | | 3 |
| Law Related Elective | | 3 |
| Natural Science with Lab [1] | | 4 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| HSS 404 | Humanities Senior Seminar - History | 3 |
| MGMT 390<br>or HRM 301 | Principles of Management<br>or Organizational Behavior | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **12** |
| **2nd Semester** | | |
| Law Related Elective | | 3 |
| Law Related Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **12** |
| | **Total Credits** | **120** |

[1] Science courses count as law-related electives in the patent law, technology and culture curriculum.

# B.A. Double Major in Biology & Law, Technology and Culture

(124 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| BIOL 200 | Concepts in Biology | 4 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| MATH 138 | General Calculus I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |

| | | |
|---|---|---|
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| MATH 238 | General Calculus II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| CHEM 243 | Organic Chemistry I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| HIST 213 | The Twentieth-Century World | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Biology Cluster Elective | | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| Social Science: GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| Biology Functional Laboratory Elective | | 3 |
| Biology Cluster Elective | | 3 |
| Management: GUR Elective | | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |
| Legal Foundations Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Biology Laboratory Elective | | 3 |
| Biology Elective | | 3 |
| HIST 378 | Medicine and Health Law in Modern America | 3 |
| Social Science: GUR Elective | | 3 |
| Legal Foundations Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Biology Laboratory Elective | | 3 |
| Biology Elective | | 3 |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| HSS 404 | Humanities Senior Seminar - History (LTC Section) | 3 |
| Legal Foundations Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Biology Elective | | 3 |

| | | |
|---|---|---|
| HIST 375<br>or EVSC 335 | Legal Issues in Environmental History<br>or Environmental Law | 3 |
| IT 400<br>or IT 331<br>or IT 332 | Information Technology and the Law<br>or Privacy and Information Technology<br>or Digital Crime | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **124** |

# B.S. Double Major in Biology & Law, Technology and Culture

(128 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| BIOL 200 | Concepts in Biology | 4 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| BNFO 135 | Programming for Bioinformatics | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| CHEM 243 | Organic Chemistry I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 211 | Calculus III A | 3 |
| BNFO 236 | Programming For Bioinfo II | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| Math Elective | | 3-4 |
| MGMT 290 | Business Law I | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16-17** |
| **Third Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| Biology Functional Laboratory Elective | | 4 |
| Biology Cluster Elective | | 3 |
| MATH 333 | Probability and Statistics | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| Legal Foundations Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Biology Laboratory Elective | | 3 |
| Biology Cluster Elective | | 4 |
| HIST 378 | Medicine and Health Law in Modern America | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Biology Laboratory Elective | | 3 |
| Biology Cluster Elective | | 3 |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| IT 400<br>or IT 331<br>or IT 332 | Information Technology and the Law<br>or Privacy and Information Technology<br>or Digital Crime | 3 |
| Legal Foundations Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Biology Elective | | 3 |
| Biology Elective | | 3 |
| Legal Foundations Elective | | 3 |
| HSS 404 | Humanities Senior Seminar - History (LTC Section) | 3 |
| HIST 375<br>or EVSC 335 | Legal Issues in Environmental History<br>or Environmental Law | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **128-129** |

## B.S. Double Major in Chemistry & Law, Technology and Culture

(125 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| CHEM 125A | General Chemistry Lab I | 1 |
| CS 113<br>or BNFO 135 | Introduction to Computer Science<br>or Programming for Bioinformatics | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |

| | | |
|---|---|---|
| CHEM 124 | General Chemistry Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| CHEM 221 | Analytical Chemical Methods | 2 |
| CHEM 222 | Analytical Chemistry | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 211 | Calculus III A | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 231 | Physical Chemistry I | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| MGMT 290 | Business Law I | 3 |
| IT 400<br>or IT 331<br>or IT 332 | Information Technology and the Law<br>or Privacy and Information Technology<br>or Digital Crime | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| CHEM 235 | Physical Chemistry II | 3 |
| ECON 201 | Economics | 3 |
| Legal Foundations Elective | | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |
| HIST 375<br>or EVSC 335 | Legal Issues in Environmental History<br>or Environmental Law | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CHEM 340 | Chemistry and Engineering of Materials | 3 |
| CHEM 336 | Physical Chemistry III | 3 |
| CHEM 235A | Physical Chemistry II Laboratory | 2 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| Legal Foundations Elective | | 3 |
| HIST 378 | Medicine and Health Law in Modern America | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CHEM 473 | Biochemistry | 3 |
| CHEM 412<br>or R160 413 | Inorganic Chemistry<br>or Inorganic Chemistry | 3 |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |

| | | |
|---|---|---|
| CHEM 480 | Instrumental Analysis | 2 |
| HSS 404 | Humanities Senior Seminar - History (LTC Section) | 3 |
| Management: GUR Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **125** |

## B.S. Double Major in Physics & Law, Technology and Culture - Astronomy Option

(127 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| CS 113<br>or CS 115 | Introduction to Computer Science<br>or Intro. to CS I in C++ | 3 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 211 | Calculus III A | 3 |
| MATH 225A | Survey of Probability and Statistics | 1 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| HIST 213 | The Twentieth-Century World | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 328 | Mathematical Methods for Scientists and Engineers | 3 |
| PHYS 335 | Introductory Thermodynamics | 3 |
| Legal Foundations Elective | | 3 |
| Legal Foundations Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| PHYS 418 | Fundamentals of Optical Imaging | 3 |

| | | |
|---|---|---|
| PHYS 432 | Electromagnetism I | 3 |
| PHYS 320 | Astronomy and Astrophysics I | 3 |
| PHYS 430 | Classical Mechanics I | 3 |
| Legal Foundations Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| PHYS 433 | Electromagnetism II | 3 |
| PHYS 321 | Astronomy and Astrophysics II | 3 |
| Math Elective | | 3 |
| HSS 404 | Humanities Senior Seminar - History (LTC Section) | 3 |
| IT 400<br>or IT 331<br>or IT 332 | Information Technology and the Law<br>or Privacy and Information Technology<br>or Digital Crime | 3 |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| PHYS 420 | Special Relativity | 3 |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| Elective (Math/Physics/Computer Science) | | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |
| Management: GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| PHYS 322 | Observational Astronomy | 3 |
| PHYS 421 | General Relativity | 3 |
| PHYS 450 | Advanced Physics Laboratory | 3 |
| HIST 378 | Medicine and Health Law in Modern America | 3 |
| HIST 375<br>or EVSC 335 | Legal Issues in Environmental History<br>or Environmental Law | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

# B.S. Double Major in Physics & Law, Technology and Culture - Optical Science & Engineering Option

(127 credits minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| CS 113<br>or CS 115 | Introduction to Computer Science<br>or Intro. to CS I in C++ | 3 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |

| | | |
|---|---|---|
| MATH 112 | Calculus II | 4 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 211 | Calculus III A | 3 |
| MATH 225A | Survey of Probability and Statistics | 1 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Legal Foundations Elective | | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 328 | Mathematical Methods for Scientists and Engineers | 3 |
| PHYS 335 | Introductory Thermodynamics | 3 |
| Legal Foundations Elective | | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| OPSE 301 | Introduction to Optical Science and Engineering | 3 |
| PHYS 418 | Fundamentals of Optical Imaging | 3 |
| PHYS 430 | Classical Mechanics I | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| HIST 310 | Co-op in Law, Technology, Culture and History I | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| PHYS 433 | Electromagnetism II | 3 |
| PHYS 446 | Solid State Physics | 3 |
| OPSE 402 | High Power Laser and Photonics Applications | 3 |
| Legal Foundations Elective | | 3 |
| HIST 378 | Medicine and Health Law in Modern America | 3 |
| Elective (Physics/OPSE) | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| IT 400<br>or IT 331<br>or IT 332 | Information Technology and the Law<br>or Privacy and Information Technology<br>or Digital Crime | 3 |
| Management: GUR Elective | | 3 |
| HIST 375<br>or EVSC 335 | Legal Issues in Environmental History<br>or Environmental Law | 3 |
| Elective (Physics/OPSE/EE) | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| OPSE 610 | Virtual Instrumentation | 3 |
| PHYS 450 | Advanced Physics Laboratory | 3 |

| | | |
|---|---|---|
| Elective (Physics/EE) | | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |
| HSS 404 | Humanities Senior Seminar - History (LTC Section) | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Global Studies Minor

(15 credits)

Five courses with global content including four upper division courses approved by the minor coordinator.

# History Minor

(15 credits)

Five upper division courses, at least four in history, approved by the minor coordinator.

# Legal Studies Minor

(15 credits)

Five law-related upper division courses approved by the minor coordinator.

# Humanities

The Humanities Department (http://humanities.njit.edu) is dedicated through general university requirements, electives and various undergraduate and graduate programs of study including those culminating in bachelor's and master's degrees, to offering research opportunities, seminars and colloquia that investigate the artistic, cultural and social contexts informing contemporary society. The department’s instructional staff places special emphasis on teaching and research in the following areas: communication with particular regard to contemporary media, journalism and all forms of writing; the interplay of science, technology and society; the theatre; philosophy and professional ethics; literature; English as a second language; the study of cultural artifacts from around the globe; the visual arts, including film; and music.

## NJIT Faculty

### A

Arnowitz, Mark G., Director

Ascarelli, Miriam F., University Lecturer

### C

Castronova, Louise, Senior University Lecturer

Cohen, Maurie, Professor

Curley, Jonathan R., Senior University Lecturer

### D

Donahue, Dennis P., Senior University Lecturer

### E

Egan, John A., University Lecturer

Esche, John N., University Lecturer

Estrada, Daniel J., University Lecturer

## F

Fleischer, Doris Z., Senior University Lecturer

Funkhouser, Christopher T., Professor

## H

Henry, Rolanne, Senior University Lecturer

Holbrook, J. Britt, Assistant Professor

Hunt, Theresa A., University Lecturer

## J

Johnson, Carol S., Associate Professor

Jorjani, Jason, University Lecturer

## K

Katz, Eric, Professor and Chair

Khichi, Narendra-Neel, University Lecturer

Kimmelman, Burt J., Professor

King, Paul, W., University Lecturer

Klobucar, Philip Andrew, Associate Professor

Kmiec, David M., University Lecturer

## L

Lipuma, James M., Senior University Lecturer

Longo, Bernadette C., Associate Professor

## M

McRae, Calista A. Assistant Professor

## O

O'Neill, Megan E., Assistant Professor

O'Sullivan, William, University Lecturer

## P

Pardi, Nina L., Senior University Lecturer

Paris, Jerome, Director

## R

Rittenhouse, Michele R., Director

Rothenberg, David B., Distinguished Professor

## S

Siemann, Catherine A., University Lecturer

Steffen, Nancy L., Associate Professor

## W

Waltz-Cummings, Anika E., University Lecturer

Wells, Louis A., University Lecturer

Wolf, John M., University Lecturer

## Programs

- Communication and Media - B.A. (p. 367)
- Communication and Media - B.S. (p. 375)
- Science, Technology & Society - B.S. (p. 384)
- Theatre Arts and Technology - B.A. (p. 372)

## **Accelerated Programs** (p. 92)

- Communication and Media - B.S./Medicine, Dentistry, Physical Therapy, and Optometry (p. 361)
- Communication and Media - B.A./J.D. (p. 370) (with Seton Hall School of Law)
- Communication and Media - B.S./J.D. (p. 358) (with Seton Hall School of Law)
- Science, Technology & Society - B.S./J.D. (p. 381) (with Seton Hall School of Law)
- Science, Technology & Society - B.S./M.D., D.D.S., O.D. (p. 364)

## **Double Majors** (p. 92)

- Science, Technology & Society and Business Information Systems - B.S. (p. 379)
- Communication Minor (p. 387)
- Electronic Creative Writing Minor (p. 387)
- Global Studies Minor (http://catalog.njit.edu/undergraduate/science-liberal-arts/humanities/global-studies-minor)
- Journalism Minor (p. 388)
- Literature Minor (p. 388)
- Philosophy and Applied Ethics Minor (p. 388)
- Science, Technology & Society Minor (p. 388)
- Technology, Gender and Diversity Minor (p. 388)
- Theatre Arts and Technology Minor (p. 388)

## Humanities Courses

**COM 266. Foundations of Game Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Hum 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. IT 201 and IT 265, all with a grade of C or better. This class introduces students to many of the tools and production methodologies needed for electron games. This class will focus heavily on content control and story handling through the use of scripting and game development tools. Students will learn a few scripting languages that are used in the games industry, such as Unreal Script and LUA and use them to create a new game experience.

**COM 303. Video Narrative. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Introduces various multimedia resources and environments in order to develop new strategies for both reading and writing within a visually-based, screen-oriented culture. Students will study different historical and theoretical lineages in videography, and learn hands-on techniques and technologies to produce independent media works of their own.

**COM 310. Interpersonal Communication. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and one of the following: HUM 211, HUM 212, HUM 213 all with a grade of C or better. This course surveys theory and research related to interpersonal communication. The course focuses on effectively managing personal and professional relationships. The course's format consists of lectures, group discussions, experiential activities, and written assignments that require students' active involvement.

**COM 321. Technology & Tactics of Sound. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, one of the following: HUM 211, 212, HIST 213, 214 This course provides an introduction to sound and its manifold uses and functions in the digital era. The course offers students an effective primer in the science of how sound has been measured and understood historically as a media format.

**COM 325. Special Topics in Communication. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Varies according to topic. The study of new and/or advanced topics in an area of Communication, not regularly covered in any other Humanities course at the 300-level. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**COM 335. 3-D Modeling and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. IT 201 with a grade of C or better or permission of program advisor. This class introduces students to the concepts of 3D modeling and animation, and putting those concepts into action by working with software. This class will be a hands-on, project focused course, using 3D modeling packages, taking students from design to final render.

**COM 345. Character Modeling and Animation. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. COM 335 with a grade of C or better. This class builds on the concepts of 3D modeling and animation, applying those techniques to character creation and animation. This class focuses on the considerations and techniques involved in the creation and animation of character in 3D.

**COM 350. Digital Video Production. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Instruction in the creation and editing of non-linear digital video; emphasis on tream production of a short film; individual editing skills with Final Cut Pro editing software; development and editing of a variety of graphic formats and digital images; formulation of a script treatment; and development of a storyboard. Topics covered include: digital multi-media production; web-casting; interactive television; data-casting;CD and DVD production.

**COM 351. Documentary Studies. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This course will allow students to study the methods by which documentary work is conducted and to complete a documentary project of their own. The course will connect the qualitative methods of the social sciences and the humanistic concerns of the arts by allowing students to study documentary subjects as captured by non-fiction, photography, film, tape recorder, and the World Wide Web. Special emphasis will be placed on narrative and metaphor.

**COM 352. Photojournalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Through hands-on writing and photography supervised by the instructor, students develop competencies in discovering and creating an interdisciplinary viewpoint using a variety of writing methods and photographic viewpoints. Special focus on interpreting architecture and architectural detail, nature's conflict and place in urban and suburban environs, and the human interface with nature and man-made spaces. Particular emphasis is placed on the creative process and critical revision.

**COM 369. Digital Poetry. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An investigation of activities taken up by poets who integrate computer technology in their works. Students discuss and evaluate virtues of the dynamics presented in an array of titles that include algorithmic programming, graphical artistry, videography, holography, hypermedia, and sonic design in order to build an understanding of the combined values of these disparate forms of expression.

**COM 376. Game Design Studio. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. COM 266, COM 335 and COM 345, all with a grade of C or better. This class challenges students to apply what they have learned in previous courses about game design. Students work in groups to design and create games for various platforms. Groups will work closely with the instructor to get constant feedback and criticism on their work. Students will complete case studies of various game genres. Students will work on one large project and complete it in stages, as a project would in the industry.

**COM 390. Electronic Writing Workshop. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A practice-oriented workshop for creative expression in a variety of electronic formats with the specific goal of facilitating individual writing projects for screen and performance. Topics in literary theory will be combined with current criticism in electronic writing, media and screen studies to produce new cultural works in a variety of digital sub-genres, including soundscapes, hypertext poetry, animation, code poems, interactive games, digital video and wiki poems.

**ENG 095. General Skills in English as a Second Language. 5 credits, 5 contact hours (5;0;0).**
Intended for students in need of extensive practice in speaking, listening, reading, and writing in English prior to enrolling in HSS 099S.

**ENG 101. College Composition I. 3 credits, 3 contact hours (3;0;0).**

**ENG 200. Communicating in Organizations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to understand the need for writing in an information-based corporate culture. Students write intensively in a variety of forms for a variety of audiences. Attention is given to editing, graphic design, communications ethics, and desktop publishing. At the conclusion of the course, students prepare a portfolio of their work.

**ENG 302. Communication Theory. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This course will introduce students to communication theory and practice. The course begins with a review of contemporary communication theory. After covering five selected theories--semiotic, visual, cultural, social, and reception--students will be required to apply a selected theory to a computer-mediated case study. Students will also be required to perform a collaborative field study. Through the course, students will be expected to read critically, to research peer-reviewed sources thoroughly, to present effective oral briefings, and to write analytic reports.

**ENG 333. Cybertext. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Through theoretical readings and electronic research, students explore and compare information structuring in print and digital media, particularly how digital technology influences the dynamics of text. Interactivity, visual communication and developments in the realm of cybernetics are addressed in the course. Materials presented in creative, technical and commercial areas were studied.

**ENG 336. Advanced Composition. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Involves composing in-depth, persuasive research essays designed to address the aims of discourse (expressive, referential, literary, and persuasive), using current media tools (text, graphics, audio, animaation and video) and venues (print and electronic), in several iterations.

**ENG 339. Practical Journalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A descriptive and analytic survey of news systems. Assignments include practice in writing straight news items, sports writing, feature writing, science writing, interviewing, and editing?with emphasis on understanding methods. The survey of printed and broadcast news systems includes the influence of technological, economic, legal, ethical, and historical factors.

**ENG 340. Oral Presentations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Instruction and practice in effective oral presentations. Students deliver a wide range of presentations adapted to the needs of a variety of audiences. Topics include voice and diction, presentation skills, the effective use of visual aids, reporting technical mate-rial and audience analysis.

**ENG 346. Journalism in American History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores how the media - defined as print as well as electronic media (television, radio and online modes of communication)have influenced different events and social movements at various points in time. Topics will include the role of William Randolph Hearst's newspapers in creating support for the Spanish-American War; press coverage of the women's suffrage movement; the role of television in ending the Vietnam war.

**ENG 347. Technical, Professional and Scientific Writing for Publication. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. The purpose of this course is to acquaint students with samples from significant technical, professional and scientific writing, sharpen skills in identifying theses and the major supporting elements in these works, while making judgments on their contributions. In addition, students will be required to demonstrate their ability to do the necessary research to integrate related sources other than the assigned texts.

**ENG 348. Literary Journalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Students will read and analyze the works of literary journalists from the 18th century to the present day. Close reading and analytical writing as well as some journalistic writing.

**ENG 349. Advanced Journalism Skills. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Through hands-on writing and reporting supervised by the instructor, students learn competencies needed in various journalistic specialties. Special focus on how to cover science and technology, social issues, culture and the arts, sports, business and consumer news. Particular emphasis on copy-editing.

**ENG 350. The Newsroom. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This is an advanced journalism course. Students will work closely with the instructor in order to write news and feature stories, commentaries and critiques, and will be encouraged to publish their work in The Vector and other publications.

**ENG 351. Online Journalism. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A study of how news is covered on the World Wide Web, and the impact of online news on society and politics. History of news online. Differences between print, broadcast and online-what are the strengths and weaknesses inherent to each medium? Analysis of the websites of different news organizations-from the New York Times to CNN to special interest e-zines to blogs.

**ENG 352. Technical Writing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An advanced writing course. Combines current theory with actual practice to prepare students as technical writers. Analyze complex communication situations and design appropriate responses through tasks that involve problem solving, rhetorical theory, document design, oral presentations, writing teams, audience awareness, ethical considerations, and gender equity issues.

**ENG 353. Composing Documents for Print. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores information structuring via print and digital media; how computer technology has influenced the ways in which information is presented in modern culture. Focuses on the optimal ways to prepare and present information for technical and commercial use. Important concepts such as visual literacy and effective design are discussed and addressed.

**ENG 354. Composing Documents for the Web. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Seminar and laboratory-based course designed for BA/BS majors; open to others with appropriate backgrounds and interests and permission of instructor. Follow up of ENG 353, explores information structuring via digital media, and how computer technology has influenced the ways in which information is presented in contemporary culture. Through guided interactive research, presents information for technical, commercial, and artistic use. Projects involve use of HTML editors, NJIT networks, and graphical and animation software.

**ENG 355. Television News Writing and Production. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This course consists of lectures and hands-on practice with the basics of television news writing and production and a field trip to a television station. After learning the fundamentals, the class will then begin its own news production by refining the video taped "packages" and integrating them into a studio newscast they will write and produce while guided by the instructor and with technical support from the staff of Instructional Technology and Media Services. The semester culminates in a final program that can be delivered to the campus community through ITMS's cable network.

**ENG 364. Theory of Rhetoric. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines theories of rhetoric from ancient to contemporary times. Special attention is paid to Aristotle, Peter Ramus, James Kinneavy, Walter Ong, and -Jurgen Habermas. Focuses on the ways in which theories inform the practice of communication. In the course project, students design and conduct field research based on rhetorical theory.

**ENG 369. Creative Writing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Focuses on the complexities of creating literary texts. Analyzes student writing in genres such as fiction, creative non-fiction, poetry, and drama. Considers these genres from theoretical perspectives. Topics include character development, plot, dia-logue; meter, rhyme, figurative language; audience analysis, ethos, and narrative theory. Students write, edit and critique their own work with the aim of publication.

**ENG 490. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**ENG 491. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**ENG 496. Senior Project-Communication and Media. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Intended for Communication and Media majors only. For professional and technical communication majors only. Provides students with a capstone experience. Offers PTC students the opportunity to enhance their understanding of communication through their integration of skills and knowledge gained in prior courses. The resultant research thesis or field project, of substantial length and originality, represents the culmination of the undergraduate disciplinary experience. Utilizing both a seminar and workshop approach, entails intense and sustained collaboration between student and instructor, and cooperation among students.

**HSS 403. Humanities Senior Seminar - Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students are required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 404. Humanities Senior Seminar - History. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Completion of either the LIT/HIST/PHIL/STS or Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students are required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 405. Humanities Senior Seminar - Philosophy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 406. Humanities Senior Seminar - English. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 407. Humanities Senior Seminar - Theater. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 408. Humanities Senior Seminar - Science, Technology, and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 409. Humanities Senior Seminar - Social Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Basic Social Sciences (6 credits) and either the Lit/Hist/Phil/STS (3 credits) or the Open Elective in Humanities and Social Science (3 credits). The remaining 300-level course may be taken as a co-requisite of the seminar. The capstone seminars allow students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. A list of capstone seminars is published each semester in the course registration bulletin.

**HSS 491. Honors Sem In Humanities. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better; completion of either the Lit/Hist/Phil/STS or the Open Elective in Humanities and Social Science, with a grade of C or better. The subjects are announced at the time of registration. Each seminar is limited to 16 students. These courses satisfy the Capstone Seminar in Humanities and Social Science Electives GUR for students enrolled in the honors college only.

**HUM 099. English Composition: Reading, Writing, Speaking I. 3 credits, 3 contact hours (3;0;0).**
Focuses on developing the reading and writing skills necessary for success in a college curriculum. Emphasizes structuring and organizing effective sentences and paragraphs; drafting and revising; preparing summaries; building vocabulary; developing grammatical fluency; formulating a thesis, and other steps toward writing expository essays. Mandatory writing workshops are held in conjunction with the course work.

**HUM 099S. English Composition: Reading, Writing, Speaking I. 6 credits, 6 contact hours (6;0;0).**
Prerequisites: None, unless placement test result requires ENG 095. The first course of the two-semester composition sequence HUM 099S-HUM 100-SL. Intended for students whom English is a second language. Emphasizes reading strategies, building vocabulary, grammar, developing a thesis, organizing an essay, editing and writing different kinds of expository essays. Frequent oral presentations. Weekly writing labs are held in conjunction with the course work.

**HUM 100. English Composition: Reading, Writing, Speaking II. 3 credits, 3 contact hours (3;0;0).**

**HUM 101. English Composition: Writing, Speaking, Thinking I. 3 credits, 3 contact hours (3;0;0).**
Entrance is determined by placement test score or completion of HUM 099 with a grade of C or better. Focuses on developing written and oral communication skills; emphasizes writing expository and research essays; preparing oral reports; drafting, revising, editing; evaluation and proper documentation of source material; using rhetorical strategies such as narration and argument.

**HUM 102. English Composition: Writing, Speaking, Thinking II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 with a grade of C or better. Focuses on enhanced written and oral communication skills; emphasizes reading and interpretation of literary forms; critical analysis; methods of research using print and on-line sources; report writing and writing about literature.

**HUM 2**. Humanities Elective. 3 credits, 3 contact hours (3;0;0).**

**HUM 211. The Pre-Modern World. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 and HUM 102 with a grade of C or better. Case studies focus on differing forms of material culture, belief systems, aesthetic norms, and artistic productions to develop an understanding of ancient and medieval world views. This course satisfies three credits of the GUR in Cultural History.

**HUM 212. The Modern World. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 and HUM 102 with a grade of C or better. Uses case studies to examine such key processes as the expansion of global trade and the formation of a global economy, European perceptions of non-Western cultures, and the roots and legacy of imperialism. This course satisfies 3 credits of the Cultural History GUR. Honors Note: See HUM 101.

**HUM 230. Introduction to Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Hum 101, Hum 102 with a C or better An introduction to literary studies, this course focuses on close reading and critical writing.. Students will investigate and reflect on standard literary genres; make claims about how the content and form of each connect; find and present evidence for such claims. Students will carefully consider their own writing at a slow pace to understand, ultimately, how a literary text operates as a work of art, as well as to learn how to communicate powerfully and persuasively in a variety of settings.

**HUM 251. Ethical Issues in Business. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 with a grade of C or better. An examination of the ethical problems and moral foundations of business from the perspective of moral philosophy. Among the questions explored are: What are the rights of employees and employers in the workplace? Do corporations and managers have an obligation to society at large? What is the relationship between personal and business morality? Is there a moral justification for the free market?.

**HUM 325. Humanities Special Topics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Varies according to topic. The study of new and/or advanced topics in an area of the humanities, not regularly covered in any other HUM, LIT, ENG OR HSS course at the 300-level. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. A student may register for no more than two semesters of special topics courses.

**HUM 401. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**HUM ELEC. Humanities Elective. 3 credits, 3 contact hours (3;0;0).**

**LIT 320. American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A survey of major works of American literature. Provides a foundation for understanding the currents of American thought and experiences. Special emphasis is paid to American literature within a global context.

**LIT 321. British Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A survey of the major works of British literature. Provides a foundation for understanding the currents of British thought and experience. Special emphasis is paid to British literature within a global context.

**LIT 330. World Literature I: North America, Latin America and the Caribbean, Australia and Oceania. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Enhances understanding of other cultures and of past and contemporary global interactions.

**LIT 331. World Literature II: Africa and the Middle East, Asia, and Europe. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Enhances the under-standing of other cultures and of past and contemporary global interactions.

**LIT 340. Contemporary Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Focuses on the study of literary works published within the last ten years. Considers how contemporary issues and problems are addressed in a variety of literary works.

**LIT 350. Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores the short story and the novel from varied countries and eras. Emphasis is given to narrative methods, representative themes, and global perspectives.

**LIT 352. 20th Century European Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines themes ranging from war and occupation, revolution, Fascism, and Communism to individual liberation and self-discovery, existen-tialism, absurdism, and feminism.

**LIT 355. Poetry. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores the problems, devices, and techniques of poetry'sound, rhythm, meter; diction and tone; connotation, metaphor, and symbol?as a means of demystifying the reading of poems. Emphasis is given to the place and purpose of poetry in a technological society.

**LIT 360. Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Follows the development of play structure from folkloric origins to contemporary theater. Emphasis is on text, history of text development, and the changing purpose of theatrical presentations.

**LIT 361. 20th Century American Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines the development of 20th century American drama with emphasis on the ways, often experimental, in which the playwrights reflect the spirit of the times.

**LIT 362. Non-Western Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores clas-sical and contemporary theater and drama in China, Japan, India, Africa, and the Middle East.

**LIT 363. Ethnic and Minority Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Using con-tem-porary dramas as social, historical, and cultural artifacts, examines the experience of Latinos, Asian Americans, Native Americans, and African Americans.

**LIT 364. Modern Continental and British Drama. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An examination of some of the dramas from the late nineteenth and twentieth centuries with the purpose of gaining some understanding of how dramatists, in both subject matter and technique, reflect the spirit of the times. Representative playwrights include Ibsen, Shaw, Wilde, Strindberg, Synge, Chekhov, O'Casey, Pirandello, Anouilh, Brecht, Ionesco, and Pinter.

**LIT 365. Non-Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines the ways that writers examine cultural issues through the use of literary non-fiction. Emphasis is placed on autobiographical, persuasive, and narrative techniques.

**LIT 370. Literature and Diversity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to explore the literature of human difference, including the literature of cross-cultural experience and sexual difference.

**LIT 372. African-American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to explore themes and styles particular to literary works by and about African-Americans.

**LIT 374. Women and Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Allows students to explore literature by and about women from around the world. Special attention is paid to autobiographical narratives.

**LIT 376. Latin American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines the ways that writers of Latin America and the Caribbean explore their respective culture through techniques such as dream, myth, and legend to achieve an authentic and unique -vision. Special emphasis is given to 20th-century authors.

**LIT 378. Literature and Nature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Literature as it reveals and interprets the natural world. Examines the ways that nature has been used in fiction, drama, poetry, and non-fiction. Students learn to describe the natural world in their writing. Co-listed as STS 378.

**LIT 380. Historical Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Sources of fiction and drama are often based on historical personalities and actual incidents. Examines a number of such works. Original historical material is compared with the literary work it inspired, thus providing insights into the nature of the creative process and the purposes of the historian and the creative writer.

**LIT 382. The Comic Tradition in English and American Literature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Presents great comic works from the 14th century to the present. Students study verse narratives, plays, novels, and essays. Emphasis is given to the classical roots and international connections of the comic tradition in English, the relationship between form and function in comedy, and elucidation of comedy's social and philosophical ends.

**LIT 384. Musical Theater Adaptations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or betterThe content of this course is primarily literary. It examines the original texts that are used for theatrical adaptations in contemporary Broadway and Off-Broadway musicals. The origin stories are drawn from literature, graphic novels, and cultural folk stories. Students will attend selected musicals.

**LIT 386. Science Fiction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Explores the distinctive characteristics of science fiction as a literary genre and its function as a social criticism. Special attention is given to the ways in which cultural gender coding surfaces in the text. Films and video are used.

**LIT 388. The Russian Novel and Short Story. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Focuses on Russian fiction of the 19th and 20th centuries. Approaches material both as evidence of artistic vision and as social documents of Russian history.

**PHIL 300. Philosophy of Law and Social Justice. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Introduction to philosophical issues concerning law, using lectures and case studies. Topics covered will include: the interpretation of legal texts; the foundation of moral obligation to obey the law; the nature of rights; and the function of punishment.

**PHIL 331. Problems in Philosophy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An examination of problems of a social, ethical, esthetic, religious, and scientific nature, and a study of the related principles and methods of philosophy. Readings are chosen from a wide range of periods and schools from the Greeks to the present, with some application of philosophical analysis to individual and societal problems.

**PHIL 333. Moral Philosophy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A critical discussion of the history and fundamental elements of ethical thought. Examines topics such as the basic ethical theories, the nature of right and wrong, the significance of moral choice, the structure of the moral life, and the place of reason in ethics. Readings from both classical and modern philosophers.

**PHIL 334. Engineering Ethics and Technological Practice: Philosophical Perspectives on Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. A philosophical examination of the nature of engineering practice and applied technology. Considers such questions as: How do the societal functions of engineers and the practical application of technologies relate to basic moral and intellectual values? What moral obligations are implied by the uses of technology? What are the ethical duties of engineers in the practice of their careers? How are technological practice and engineering related to questions about knowledge and reality?.

**PHIL 337. World Religions. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An introduction to five world religions which make strong claims to be in some sense universal: Hinduism, Judaism, Buddhism, Christianity, and Islam, with special attention to their impact on contemporary politics, gender, economics, and culture. Study of selected scriptures, major customs, representative figures, and one or two works of art from each religious tradition.

**PHIL 340. Ethical Issues in Public Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Course premise is the inevitability of ethical issues in public policy decision making. Societal forces such as government, industry, economics, public interest, and science can play various roles in shaping public policy and are related to ethical concerns. Focuses on both historic and current public policy case studies.

**PHIL 350. Representative Philosophies. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. The ideas of a few great thinkers, from a variety of historical periods. Shows at first hand how these philosophers accelerated intellectual progress and how their work may contribute to the solution of modern problems.

**PHIL 351. Biomedical Ethics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An examination of the ethical problems and moral foundations of medicine. Among the issues explored are the changing nature of the doctor/patient relationship, increased patient autonomy, advance directives, the rationing of care, doctor-assisted suicide, and "the right to die." Honors Note: See HSS 101.

**PHIL 355. The Philosophy of Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. An investigation into the foundations and implications of modern science, with special emphasis on the influence of philosophy on scientific thought, and on philosophic questions.

**PHIL 380. Philosophy of Language. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Examines tradition, formation and change in the ways that language shapes thought. Special attention is paid to the relationships between language and religion, as well as language and science.

**STS 100. Social Science and CSLA Research. 3 credits, 3 contact hours (3;0;0).**
This course introduces the content and methodologies of CSLA disciplines, provides examples of research problems through the lens of the social sciences and gives students an understanding of each major and an overview of the social, historical, and ethical influences on contemporary sciences, and the changing relationships among science, technology and culture. Each week CSLA researchers lecture on applied approaches to problem solving in their domains.

**STS 101. Foundations of Science, Technology and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. This course introduces students to the multi-disciplinary study of science, technology and society. Through a combination of lectures by the STS teaching staff and external speakers, as well as classic and contemporary readings and case studies that exemplify the field's core content, students examine the social, aesthetic, environmental, economic and political constructs that contextualize the development and proliferation of mechanical and digital technologies with which we interact.

**STS 2**. Science Tech and Society Elect. 3 credits, 3 contact hours (3;0;0).**

**STS 201. Understanding Technological Society. 3 credits, 3 contact hours (3;0;0).**
A problem-centered and task-oriented course that integrates social science theory and practice into the leading public issues of a technological society. Students learn critical thinking through hands-on assignments. The course emphasizes student understanding of social institutions that directly affect technological development and professional careers.

**STS 205. Intro to Research Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 102. This course is intended to give second year undergraduate students an understanding of what research is, what it is used for, how it is conducted, and how it is reported. It provides an overview of applying the scientific method to real-life research, including ethical concerns, qualitative and quantitative methods (and how and when they should be used), and how to critically evaluate published research findings.

**STS 210. General Psychology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 with a grade of C or better. Introduction to the study of human behavior. Topics include motivation, perception, learning, cognitive development, personality and emotion, individual difference, and biological basis of behavior, as well as methodology in psychological research.

**STS 221. Sociology. 3 credits, 3 contact hours (3;0;0).**
An examination of modern society and culture, analyzing the forces for stability and change. Topics covered include the individual and society (socialization, conformity, alienation, and class structure), social institutions (religion, law, education, family, state), social processes (conflicts and harmony, cohesion and dissolution, power, authority, and revolution), urbanization, industrialization, and technological change.

**STS 257. Technology, Society and Culture: An American View. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. This course will examine several key cases in the way technology fits into society. The politics, sociology, and ethics of technological development will be investigated. Topics include several significant advances of the twentieth century: nuclear warfare, fast food, the simplicity movement, and futuristic enhancement. What do all these things have to do with one another?.

**STS 258. Technology, Society and Culture: A Global View. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. This course will investigate the issues and problems inherent in the globalization of technology and culture at the beginning of this new millennium. Countries and economies are becoming more entwined in each others identities and economies, and cultural diversity is both threatened and proliferating at one and the same time. How much can the world's markets continue to grow and connect? How does the spread of information change what we know about one another? Should we be afraid of progress? Does the world understand the United States? Do we understand the world? How can "Growth" or "development" be sustained? How can we guide its change?.

**STS 300. Legal Reasoning, Writing, and Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101. Integrates the process of legal research and fundamentals of legal writing with analysis of law. Focuses upon legal reasoning through analysis of fact and upon the logic of law in judicial opinions, statutory construction, and constitutional interpretation as contemporary issues are analyzed.

**STS 301. Independent Study. 1 credit, 3 contact hours (0;0;3).**
Prerequisites: junior standing in the STS program and written approval of the program director. Consists of self-paced study on an individual or small group basis in a specific area integral to a student's STS concentration but not available on a regular course basis.

**STS 302. Independent Study. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: junior standing in the STS program and written approval of the program director. See STS 301.

**STS 303. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: junior standing in the STS program and written approval of the program director. See STS 301.

**STS 304. Writing about Science, Technology and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Develop abilities to write lucidly and speak forcefully about the interrelationship of science, technology and society. Learn to articulate a sense of purpose in order to choose the appropriate methods for reporting issues in a technological society. Effective development and transfer of technical knowledge in a complex world.

**STS 306. American Mosaic: Understanding Cultural Diversity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of multiculturalism in the United States. The course provides students with a methodological framework for understanding cultural diversity in the United States and around the world.

**STS 307. Fundamentals of Research in STS. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Focuses on research methods in the field of science, technology and society. Focuses on the following methods: problem statement and hypothesis formulation; research design in science, technology and society; data sources; and data acquisition and analysis.

**STS 308. Technology and Global Development: Introduction to STS. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Introduces the important public issues that technology brings to the modern world, such as energy development and environmental pollution. Emphasizes the close connections between science and technology, social institutions, and cultural values. Also analyzes today's "global village", the changing relations between East and West and the Third World, and worldwide development and environmental issues.

**STS 309. Advocacy and the Law. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ENG 300, SS 300 both with a grade of C or better. Offers opportunities to explore the retrieval and use of legal and law-related materials while developing skills in oral advocacy and in writing persuasive legal documents, such as motion memoranda and briefs. Includes learning to listen to participants in the legal process as well as developing effective styles and forms of speech in the classroom.

**STS 310. Technology and Human Values. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Examines the interactions between science, technology and human values. Specifically, explores psychological, moral, and philosophical consequences of, and humanistic responses to, technological change. Readings, essays, fiction, and research articles treat such topics as the philosophical foundations of modern science, scientism, technicism; the impact of technology on images of man found in modern literature; and the moral implications of various kinds of recent technology.

**STS 311. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op Office. Mandatory participation in seminars and completion of a -report. Note: Normal grading applies to this COOP Experience.

**STS 312. Technology and Policy in Contemporary America. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. A study of technology and politics in recent America. Focuses on the role of the federal government in shaping technology, especially through funding technological innovations and applications. Topics will include the origins of technology policy in World War II, the influence of the Cold War, the science and technology policy advisory system, and political and cultural influences on technology policy.

**STS 313. Environmental History and Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Covers the rise of the modern environmental debate, and examines its current priorities and values, politics and economics, and impacts on industry and society. Students review the role of regulatory agencies, private industry, public interest groups, and the media. Current major issues in New Jersey are considered, as well as environmental debate on a national and global level.

**STS 316. Mass Communications, Technology and Culture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Uses the tools of the humanities and social sciences to study the interplay between technology and mass culture. Focuses on motion pictures, electronic music, and television as both technologies and as forms of art. Devotes special attention to the portrayal of science and technology in the media.

**STS 318. Educational Media Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IT 201. Educational Media Design employs the instructional principles of constructivist pedagogy as the process used to develop a solution to develope courseware for K-12 audience. The course builds on the participatory design model of software engineering in order to develop integrated learning environments that support visual and verbal literacy; enables student to be able to plan, organize, and systematically develop instructional materials. This course implements instructional design theory and pedagogy in order to create an actual application for a computer-based environment. Same as IT 380.

**STS 320. Global Evolution of Scientific Thought I: Case Studies from Antiquity through the 19th Century. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Traces the global development of scientific ways of thinking and demonstrates how scientific ideas, methods, and theories both reflect and influence thought in other areas. Special emphasis is on the biographical approach to scientific innovation through analysis of key figures in relation to the societies in which they lived. Attention is paid to the roles of class and gender in scientific practice. Begins with the study of science in the ancient nations of Babylonia, China, and India and ends with an examination of the rise of scientific approaches to social problems in the nineteenth century.

**STS 324. Topics In Sci Tech & Soc. 3 credits, 3 contact hours (3;0;0).**

**STS 325. ST:. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An in-depth examination of a current STS issue. A new topic is addressed each time the course is offered.

**STS 330. The Professional Engineer: History and Context. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of the origins of modern engineering and the context in which engineering has developed. The course includes an analysis of the contemporary engineering culture?its structure and the values which drive it. The student will be expected to confront both the constraints and opportunities presented by the professional world of engineering.

**STS 339. Philosophy and Psychology of Race and Gender. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and STS 210, each with a grade of C or better. Course examines the psychological elements of prejudice, with emphasis on racial cognition and gender bias. Topics covered include the history of essentialism about race and gender; implicit bias; stereotype threat; interventions against biased attitudes; and ethics of race and gender bias. Readings from contemporary philosophy and psychology.

**STS 340. Multiculturalism in a Technological Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Explores the roles of culture and ethnicity in our increasingly technological and global society. The interplay between scientific developments and the specific sociocultural contexts is addressed. Specific case studies from various countries are explored, covering differing levels of technological achievement. Upon completion of the course, students will be able to competently analyze the interaction between a country's scientific development and its political and sociological climate. Special topics are negotiated with students at the start of each class, with the goal of covering all continents and a variety of scientific fields. At least one case study each semester carefully reviews multiculturalism in the American technological culture. Emphasis also is given to the particular roles and responsibilities of the United States as a technological and political leader.

**STS 342. Women in Technological Culture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Takes an interdisciplinary and multicultural approach to issues of gender in science and technology. The issues include the current status and problems of women in non-traditional professions; the historical contributions of women in science and technology; images of women in Western and non-Western cultures; theories of gender difference, past and present; the impact of cultural gender coding on the epistemologies of science and technology; women and Third World development. Course materials include case studies and autobiographical narratives, films, and science fiction as well as historical and sociological analyses. Expressive student writing and group projects are encouraged.

**STS 344. Communications Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Study of communication environments and developing communications technologies as central elements of evolving political and social systems. Analysis of philosophical, military, economic, and technical premises for communications policy and the process of regulation.

**STS 346. Pragmatism and Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Examines the relationship between the American philosophy of pragmatism and the role of technology in the contemporary world. How do philosophical ideas affect the development of technology and science? How has pragmatism shaped the current view of the meaning and value of technological progress? Readings from both the traditional authors of American pragmatism?Peirce, James, and Dewey?and contemporary texts.

**STS 347. Introduction to Music. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HUM 101 with a grade of C or better. This course is an introduction to the history of music, from ancient to present times, Western, Eastern, folk, world, classical, jazz, rock, and electronic. The class aims to develop in the student an informed and critical ear to make sense of the vast array of music available to our ears today. We also cover how technology has transformed how we experience and create music, from the development of the piano to the computer. The course involves extensive music listening and writing about music. It is a prerequisite for the hands-on electronic music classes that NJIT offeres, STS 349 and STS 325.

**STS 348. Esthetics and Modern Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. The central focus of this course is on the changing conception of beauty as influenced by technological development, especially in twentieth-century United States society. The course examines how technology is echoed in art and philosophy, and how they, in turn, influence future technological considerations.

**STS 349. Advanced Music Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: STS 347. Students will learn the basics of notebook computer-based music composition and production. Emphasis will be on composition and making of music, learning the aesthetics necessary to get the most out of your machine. Course will require extensive work on your own home computer. Computer requirements: A PC or Macintosh system running Ableton Live.

**STS 350. Computers and Society. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, one SS course, completion of a 100-level GUR course in CS, all with a grade of C or better. Examines the historical evolution of computer and information systems and explores their implications in the home, business, government, medicine, and education. Topics include automation and job impact, privacy, and legal and ethical issues.

**STS 351. Minds and Machines. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and STS 210, each with a grade of C or better. An introduction to the philosophy of mind and cognitive science. Topics covered include the computational theory of mind; artificial intelligence; connectionism; embodied theory of mind; and dynamical theories of mind. Readings from recent and contemporary philosophy, psychology and computer science.

**STS 352. Race and Ethnicity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, EPS 202, ECON 201 or their equivalents. Explores the concepts of race and ethnicity in both national and international arenas. Scientific, sociological, political, and global implications are addressed. Upon completion of this course, students will be able to competently address the impact of race on micro and macro levels, from both individual and policy perspectives. Special topics are negotiated with students at the start of each class. Such topics can include immigration, affirmative action, educational curricula, institutional racism, or the impact of multiculturalism on families. Emphasis is on the interaction between race and technology.

**STS 358. Moral Psychology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and STS 210 each with a grade of C or better. An introduction to moral philosophy with emphasis on the biological and psychological mechanisms underlying moral thought, judgment an action. Topics covered include altruism and egoism; utilitarianism, deontology and virtue ethics; the situationist critique of character; and agency and responsibility. Readings draw from classical and contemporary philosophers as well as from current empirical psychology.

**STS 359. Cyberpsychology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 with a grade of C or better and STS 201 or STS 210 or equivalent with a grade of C or better. Introduction to the study of the effects of the internet and cyberspace on the psychology of individuals and groups. Some topics covered include: online identity, online relationships, personality types in cyberspace, transference to computers, addiction to computers and the internet, regressive behavior in cyberspace, online gender-switching, etc.

**STS 360. Ethics and the Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of contemporary environmental problems from the perspective of ethics or moral philosophy. An analysis of the ethical presuppositions and value principles underlying environmental policy. The study of ethical theories and their application to the environmental crisis.

**STS 362. Environmental Economics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, EPS 202, ECON 201 or their equivalents, all with a grade of C or better. Presents a detailed overview of the relationship between political economy and the environment. Draws on diverse case studies including global warming, harvesting of minerals on the ocean's floor, destruction of old growth forests, and contamination of the -nation's water, air, and soils. Explores the economic remedies to the fast-changing relationship between society and nature.

**STS 363. Introduction to Sustainability Studies. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201 and EPS 202, each with a grade of C or better. The course introduces students to sustainability studies, examines the roots of the concept, and explores its roles as feature of international politics. Particular attention is devoted to the economically, advanced nations and the challenges of planning for a more sustainable future. The course also considers how the sustainability agenda is likely to evolve in an era of climate change and biophysical constraints.

**STS 364. Sustainability Policy and Practice. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: STS 201, EPS 202 and STS 363, each with a grade of C or better. Formulation of effective sustainability policies requires appreciation of the linkages between conceptual understanding and empirical practice. The course highlights the macroeconomic drivers of contemporary sustainability challenges. Topics discussed include efficiency improvements, economic relocalization, green consumerism, and efforts to build a green economy.

**STS 378. Literature and Nature. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Literature reveals and interprets the natural world. Students examine the ways that nature has been used in non-fiction and fiction. Students also learn the challenge of describing the natural world in their own words. Representative writers include Percy Shelley, Henry David Thoreau, Octavio Paz, Denise Levertov, Gary Snyder, Joyce Carol Oates, and Annie Dillard. Co-listed as LIT 378.

**STS 380. Policy Issues in the Coastal Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An examination of coastal environments from the standpoint of the scientist, the engineer, and the resource manager. Topics include beach and shoreline characteristics, technological innovations to address coastal erosion problems, and current debates in coastal policy and resource management. Case studies are used to illustrate coastal management practices and the scientific, technical, and social constraint to policy formulation.

**STS 381. Field Techniques and Research Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. An introduction to research methods. The objectives of the course are to provide opportunity to pursue specialized, in-depth research in a subfield of science, technology and society of the student's choice; to develop skills in problem identification, research design and problem solving; to increase familiarity with methods of data analysis; to strengthen library research skills; to provide an opportunity to gather original field data in a team-oriented environment; and to improve oral and written communication skills.

**STS 382. Geographical Perspectives on the Environment. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Designed to introduce students to the field of geography. Focuses on the natural processes that sculpt the physical and biological terrain, and the environmental interrelationships between human societies and nature. Combining physical, human and environmental perspectives on the earth's surface, explores, in depth, topics such as famine, societal response to natural and technological hazards, and water issues in the United States.

**STS 401. Independent Study. 1 credit, 3 contact hours (0;0;3).**

**STS 403. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**STS 411. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: STS 311 or its equivalent with a grade of C or better, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**STS 490. Project and Seminar I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: senior standing in the STS program. Each student undertakes a comprehensive study of an issue in science technology and human affairs. The solution requires application of knowledge and skills acquired in course work, self-study, and library research as well as consultation with persons in the academic community, industry, and government. The completed study is submitted as a detailed written report. The seminar meets weekly. Speakers from education, government, and industry address themselves in topics of current interest to STS students.

**STS 491. Project and Seminar II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: STS 490. A continuation of STS 490.

**THTR 101. Living Theatre. 3 credits, 3 contact hours (3;0;0).**
An introduction to the basic elements of theater through an examination of the roles of the playwright, director, designer, and actor. Attend select current plays and professional productions.

**THTR 102. Acting Fundamentals. 3 credits, 3 contact hours (3;0;0).**
Developing acting skills in a studio environment. Work with improvisation comedy and drama, scene study based on known contemporary and classical plays, and basic theater exercises that develop physical skills for character development and performance endurance. Emphasis on vocal skills using presentation exercises and theatrical audition techniques will be developed through the class.

**THTR 208. Movement for Theatre. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). Introduces skill-oriented movement exercises through an exploration of the physical nature of acting and character work. Movement is basic to actor training. The movement exercises used in this course will explore not only the physical age of the characters from plays chosen in class, but also work with the character social movements basedon the cultural history of the times the plays were written or the historical period they represent.

**THTR 209. Voice and Speech for Theatre I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). The objective of the course is for students to learn to use voice as a vocal instrument. Beginning with breath control, students learn how to project the voice, the use of resonators, and the placement of the voice in space. This is an essential training for the actor or public speaker. Exercises will be generated from plays from around the world. The character work from these plays will include the study of dialects, sustainability, phonetics, and culturally specific vocals.

**THTR 210. Voice & Speech for Theater II. 3 credits, 3 contact hours (3;0;0).**
Working with plays, poetry, and narratives, students learn to analyze texts vocally and to explore the relationship between physical and vocal expression.

**THTR 212. From Page to Stage. 3 credits, 3 contact hours (3;0;0).**
The course is an introduction to understanding the relationship between the literary nature of plays and how they are produced for the stage. Attendance to current professional productions and on-campus productions will be used as a launching point for class papers, discussions, and exercises.

**THTR 213. Directing I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 101, HUM 102, and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). Students will learn major directoral techniques in the production of short plays and other workshop scenarios. There is an emphasis on the process of synthesizing theatrical elements of direction in order to oversee and orchestrate the mounting of a theater production. The goal of the course is for students to learn what directors do to ensure the quality and completeness of theater production by collaborating with a team of individuals involved in stagecraft, costume design, props, lighting design, acting, set design, stage combat, and sound design for the production.

**THTR 215. Acting II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: THTR 102 or permission of instructor. Advanced scene study, audition techniques, and ensemble techniques are explored. Interpretation of scenes from selected dramas for stage performance, evaluation of practiced techniques in character portrayal through dialogue and action. Participation in a performance workshop is stressed.

**THTR 216. Improvisational Theatre Short Form. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and Cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). THTR 216 introduces the techniques of short-form improvisational performance through in-class practical exercises that promote spontaneity and creative space work. Students work with game structure and short narratives leading to public performances so the student gains insights only the live setting can impart.

**THTR 217. Improvisational Theatre Long Form. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and cultural History (select from Hum 211, Hum 212, Hist 213 or Hist 214). This course includes exercises that promote long-form interactive narrative and story development skills. In addition to exploring storytelling this technique is used in other media such as, music, movement, and film. The students will perform multiple times getting feedback only a live show can give.

**THTR 220. Instr Ensemble Performance I. 1 credit, 3 contact hours (0;3;0).**
Prerequistes: permission of course coordinator and conductor This course involves membership in an instrumental music group led by a professional conductor. The group will meet once a week to rehearse concert pieces. Students must play an instrument with a significant level of accomplishment in order to register for this course. There will be continuous assessment of individual performance by the conductor and a final concert in a campus venue. This is one of three performance courses. Musicians may join one or more of these ensembles, wind, string, jazz, etc. In order to register for this course, contact instructor for permission.

**THTR 221. Instr Ensemble Performance II. 1 credit, 3 contact hours (0;0;3).**
Prerequistes: permission of course coordinator and conductor This course involves membership in an instrumental music group led by a professional conductor. The group will meet once a week to rehearse concert pieces. Students must play an instrument with a significant level of accomplishment in order to register for this course. There will be continuous assessment of individual performance by the conductor and a final concert in a campus venue. This is one of three performance courses. Musicians may join one or more of these ensembles, wind, string, jazz, etc. In order to register for this course, contact instructor for permission.

**THTR 222. Instr Ensemble Performance III. 1 credit, 3 contact hours (0;0;3).**
Prerequistes: permission of course coordinator and conductor This course involves membership in an instrumental music group led by a professional conductor. The group will meet once a week to rehearse concert pieces. Students must play an instrument with a significant level of accomplishment in order to register for this course. There will be continuous assessment of individual performance by the conductor and a final concert in a campus venue. This is one of three performance courses. Musicians may join one or more of these ensembles, wind, string, jazz, etc. In order to register for this course, contact instructor for permission.

**THTR 261. Performance I. 3 credits, 3 contact hours (3;0;0).**
Departmental approval required. A lecture/workshop that combines class with a play production. An in-depth study of the author of the play and contemporaries of his/her time will be made throughout the semester. A different style or genre of theater is studied each term the course is offered based on the chosen mainstage production.

**THTR 262. Performance II. 3 credits, 3 contact hours (3;0;0).**
Departmental approval required. A study will be made of the chosen playwright, contemporaries of the writer, and an in-depth study of costume design, music of period, and set design of the play chosen for production. A production team will coordinate the main stage production.

**THTR 310. Theatre History I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Study of Euro-American theater history from Greece and Rome through early post-Renaissance Europe. The course covers the dramatic literature of the times and how the socioeconomic influences reflect the theatrical style, community interaction, and the technical uses of stage devices.

**THTR 315. Theatre History II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. Study of Euro-American theatre history from post-Renaissance Europe to present. Dramatic literature will be related to the historical events that reflect theatrical style, political movements, and technical advancements in society.

**THTR 344. American Musical Theater. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. EPS 202 or its equivalent with a grade of C or better. Course covers the development of American Musical Theatre decade by decade, starting with the turn of the 20th century until the present day. Examples of music and lyrics are demonstrated in class and students attend contemporary and revival Broadway musicals.

**THTR 365. Principles of Playwriting. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. The course objective is to write and rewrite three short plays during the semester. These new plays will have a first reading and a staged reading in the classroom, followed by analytical discussions about playwriting and the craft's applied techniques. Students will attend two professional plays and write subsequently one experience paper and one research paper; attend both campus shows for discussion and in-class improvisational playwriting exercies. The original plays developed in class will be submitted by the student for playwriting competitions at the end of the semester.

**THTR 396. Internship-Theater. 3 credits, 3 contact hours (0;0;3).**
Open to junior or senior Theater majors or minors or Communication majors with Theater Specialization. Permission of division director or faculty advisor in conjunction with the instructor directing the course. The internship is with a professional performing or media arts organization. The student is expected to work with the host company for professional experience.

**THTR 411. Special Topics in Theatre. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This specialty course will feature a different aspect of theater each semester depending on the area of expertise of the instructor. Some examples: The course could cover playwriting, advanced playwriting, film writing, and musical theater techniques, advanced theater directing, auditioning skills, advanced acting or acting: history and practice.

**THTR 414. Directing II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: THTR 213 or departmental approval. Assistant directing main stage production with faculty director or other independent directing project. Intense study of directing style through practice and research.

**THTR 465. Performance II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: THTR 261 or THTR 262 and HUM 102 and one from among Hum 211, Hum 212, Hist 213 or Hist 214 or their equivalents, all with a grade of C or better. This is an advanced study of one playwright's work leading to a performance of one of his/her plays. A study will be made of the chosen playwright, contemporaries of the writer, and an in depth study of costume design, music of period, and set design of the play chosen for production.

**THTR 483. Independent Study in Theater I. 3 credits, 3 contact hours (0;0;3).**
By arrangement only through a theater faculty advisor, the student will take on a specialized creative theater project for the semester. This would cover a specific aspect of theatrical production development and cumulate in one of the following depending on the nature of the assignment: a journal or portfolio of completed production work, an original play or screenplay script, or research document.

**THTR 484. Independent Study in Theater II. 3 credits, 3 contact hours (0;0;3).**
This course is for junior and seniors only by arrangement through a theater faculty advisor. The student will take on a more advanced specialized creative theater project for the semester. AS this would cover a specific aspect of theatrical production development, the student will be expected to take on a leadership role in the chosen area of study. Documentation of the project development and completion is required.

# Accelerated B.S. in Communication and Media/J.D.

(107 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 116<br>or MATH 138 | Mathematics of Design<br>or General Calculus I | 3 |
| CS 113<br>or CS 103 | Introduction to Computer Science<br>or Computer Science with Business Problems | 3 |
| Physical Science Lab | | 1 |
| Physical Education:GUR | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| IS 270 | Designing the Multimedia Experience | 3 |
| IT 201 | Information Design Techniques | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| MATH 105 | Elementary Probability and Statistics | 3 |
| ENG 352 | Technical Writing | 3 |
| Physical Education:GUR | | 1 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| | **Term Credits** | **16** |
| **Summer** | | |
| ECON 201 | Economics | 3 |
| Physical Science | | 3 |
| | **Term Credits** | **6** |
| **Second Year** | | |
| **1st Semester** | | |
| ENG 333 | Cybertext | 3 |
| ENG 302 | Communication Theory | 3 |
| ENG 353 | Composing Documents for Print | 3 |
| HSS Elective | | 3 |
| ENG 339 | Practical Journalism | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |

| | | |
|---|---|---|
| MGMT 390 | Principles of Management | 3 |
| ENG 340 | Oral Presentations | 3 |
| ENG 354 | Composing Documents for the Web | 3 |
| HIST 345 | Communication through the Ages | 3 |
| COM 303 | Video Narrative | 3 |
| | **Term Credits** | **15** |
| **Summer** | | |
| HSS Elective | | 3 |
| Concentration Elective-Law Policy | | 3 |
| | **Term Credits** | **6** |
| **Third Year** | | |
| **1st Semester** | | |
| Track Option Elective | | 3 |
| Track Option Elective | | 3 |
| PTC Elective | | 3 |
| Concentration Elective- Law Policy | | 3 |
| Concentration Elective- Law Policy | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ENG 496 | Senior Project-Communication and Media | 3 |
| HSS Honors Capstone | | 3 |
| Track Option Elective | | 3 |
| Track Option Elective | | 3 |
| Concentration Elective-Law /Policy | | 3 |
| Select one of the following: | | 3 |
| LIT 350 | Fiction | |
| LIT 355 | Poetry | |
| LIT 360 | Drama | |
| LIT 365 | Non-Fiction | |
| | **Term Credits** | **18** |
| | **Total Credits** | **108** |

The Three year undergraduate component contains only 107 credits but assumes acceptance into a law school program-the first year of law school replaces the credits of the fourth year of the undergraduate major.

## Electives

| | | |
|---|---|---|
| **Social Sciences (lower-level) GUR** [1] | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |

| | | |
|---|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select on of the following: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level Rutgers-Newark course | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| R510 2XX | 200-level history course at Rutgers-Newark | |
| R512 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Natural Sciences GUR** | | |
| Seven credits from courses in biology, botany, chemistry, geology, physics [2] | | 7 |
| **Physical Education GUR** | | |
| PE 1XX | Physical education course | 1 |
| Physical Education course | | 1 |

## Foreign Language (I, II, III, IV) Electives

B.S. students concentrating in Literature can take 12 credits of a foreign language in lieu of literature courses. The language and choice of courses is determined in consultation with the advisor.

## Art or Architecture Electives

A number of courses offered by the New Jersey School of Architecture or Rutgers-Newark can be used to fulfill this requirement. See the advisor for appropriate courses.

## Technology Electives

See the advisor for appropriate courses.

## Communication and Media Track Options

- Digital Expression
- Journalism
- Literature
- Media Arts
- Professional and Technical Communication
- Theatre Arts

All concentrations require courses (twenty-four credits) and should be selected in consultation with the program director from a variety of NJIT and Rutgers-Newark course offerings.

Please consult the Humanities Department website for specific course listing. http://humanities.njit.edu/

# Accelerated B.S. in Communication and Media/Medicine, Dentistry, Physical Therapy, and Optometry

(115 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| CS 113<br>or CS 103 | Introduction to Computer Science<br>or Computer Science with Business Problems | 3 |
| General Bio I with Lab | | 3 |
| Physical Education:GUR | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| ECON 201 | Economics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| General Bio 2 | | 3 |
| ENG 352 | Technical Writing | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **16** |
| **Summer** | | |
| IT 201 | Information Design Techniques | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| IS 270 | Designing the Multimedia Experience | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| | **Term Credits** | **13** |
| **Second Year** | | |
| **1st Semester** | | |
| Track Option Elective | | 3 |
| ENG 302 | Communication Theory | 3 |
| ENG 353 | Composing Documents for Print | 3 |
| CHEM 125 | General Chemistry I | 3 |
| ENG 339 | Practical Journalism | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Track Option Elective | | 3 |
| ENG 354 | Composing Documents for the Web | 3 |
| ENG 333 | Cybertext | 3 |
| Track Option Elective | | 3 |
| HSS Elective | | 3 |
| CHEM 126 | General Chemistry II | 3 |

| | | |
|---|---|---|
| CHEM 124 | General Chemistry Laboratory | 1 |
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **22** |
| **Summer** | | |
| HSS Elective | | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| | **Term Credits** | **7** |
| **Third Year** | | |
| **1st Semester** | | |
| EPS 202 | Society, Technology, and the Environment | 3 |
| HSS Honors Capstone Elective | | 3 |
| ENG 340 | Oral Presentations | 3 |
| ENG 496 | Senior Project-Communication and Media | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| HIST 345 | Communication through the Ages | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| Concentration Elective-Medical Sci./Policy Elective | | 3 |
| Concentration Elective-Medical Sci./Policy Elective | | 3 |
| Concentration Elective-Medical Sci./Policy Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **119** |

The three year undergraduate component contains only 115 credits but assumes acceptance into a medical school program-the first year of medical school replaces the credits of the fourth year of the undergraduate major.

## Concentration Elective (Medical Sci./Policy)

Students should select from the following courses and other electives, in consultation with their advisor.

| | | |
|---|---|---|
| R120 104 | Human Health & Disease | 3 |
| R120 205 | Environmental Issues | 3 |
| HIST 379 | History of Medicine | 3 |
| HIST 380 | History of Public Health | 3 |
| HIST 381 | Germs Genes and Body: Sci. and Tech. in Modern Medicine | 3 |

# Electives

| | | |
|---|---|---|
| **Social Sciences (lower-level) GUR** [1] | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |

| | | |
|---|---|---|
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level Rutgers-Newark course | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| R510 2XX | 200-level history course at Rutgers-Newark | |
| R512 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Natural Sciences GUR** | | |
| Seven credits from courses in biology, botany, chemistry, geology, physics [2] | | 7 |
| **Physical Education GUR** | | |
| PE 1XX | Physical education course | 1 |
| Physical Education course | | 1 |

## Foreign Language (I, II, III, IV) Electives

B.S. students concentrating in Literature can take 12 credits of a foreign language in lieu of literature courses. The language and choice of courses is determined in consultation with the advisor.

## Art or Architecture Electives

A number of courses offered by the New Jersey School of Architecture or Rutgers-Newark can be used to fulfill this requirement. See the advisor for appropriate courses.

## Technology Electives

See the advisor for appropriate courses.

## Communication and Media Track Options

- Digital Expression
- Journalism
- Literature
- Media Arts
- Professional and Technical Communication

- Theatre Arts

All concentrations require courses (twenty-four credits) and should be selected in consultation with the program director from a variety of NJIT and Rutgers-Newark course offerings.

Please consult the Humanities Department website for specific course listing. http://humanities.njit.edu/

# Accelerated B.S. in Science, Technology & Society and M.D./ D.M.D./ D.D.S./ O.D.

## B. S. in STS/MD-Three Year Undergraduate Component of Seven Year Medical/Dental/ Optometry Program

(117 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111<br>or MATH 138 | Calculus I<br>or General Calculus I | 3-4 |
| Select one of the following: | | 3 |
| CS 113 | Introduction to Computer Science | |
| CS 104 | Computer Programming and Graphics Problems (Select one of the following:) | |
| CS 103 | Computer Science with Business Problems | |
| R120 101 | General Biology | 4 |
| STS 201 | Understanding Technological Society | 3 |
| Physical Education:GUR | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17-18** |
| **2nd Semester** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| ECON 201 | Economics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Lab Science-Biology | | 4 |
| Physical Education | | 4 |
| | **Term Credits** | **17** |
| **Summer** | | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| STS 308 | Technology and Global Development: Introduction to STS | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| | **Term Credits** | **10** |
| **Second Year** | | |
| **1st Semester** | | |
| 300 level STS Specialization | | 3 |
| STS 304 | Writing about Science, Technology and Society | 3 |
| PHIL 351 | Biomedical Ethics | 3 |
| CHEM 125H | 3 | |

| | | | |
|---|---|---|---|
| 300 level STS Specialization | | | 3 |
| | **Term Credits** | | **15** |
| **2nd Semester** | | | |
| MGMT 390H | | 3 | |
| STS 310 | Technology and Human Values | | 3 |
| STS 310H | | 3 | |
| STS 307 | Fundamentals of Research in STS | | 3 |
| CHEM 126H | | 3 | |
| CHEM 124H | | 1 | |
| | **Term Credits** | | **16** |
| **Summer** | | | |
| 300 level STS Specialization | | | 3 |
| 300 level STS Elective | | | 3 |
| PHYS 121 | Physics II | | 3 |
| PHYS 121A | Physics II Laboratory | | 1 |
| | **Term Credits** | | **10** |
| **Third Year** | | | |
| **1st Semester** | | | |
| Free Elective | | | 3 |
| STS 490 | Project and Seminar I | | 3 |
| Humanities and Social Sciences (upper-level) Honors Capstone | | | 3 |
| CHEM 243 | Organic Chemistry I | | 3 |
| | **Term Credits** | | **12** |
| **2nd Semester** | | | |
| STS 491 | Project and Seminar II | | 3 |
| CHEM 244 | Organic Chemistry II | | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | | 2 |
| Concentration Elective-Medical Sci./Policy [1] | | | 3 |
| Concentration Elective-Medical Sci./Policy [1] | | | 3 |
| Concentration Elective-Medical Sci./Policy [1] | | | 3 |
| | **Term Credits** | | **17** |
| | **Total Credits** | | **114-115** |

1 Concentration Elective-Medical Science/Policy. Students should select from the following courses and other electives, in consultation with their advisor: R120 104 Human Health & Disease, R120 205 Environmental Issues, HIST 379 History of Medicine, HIST 380 History of Public Health, HIST 381 Germs Genes and Body: Sci. and Tech. in Modern Medicine.

The three year undergraduate component contains only 109 credits but assumes acceptance into a medical school program-the first year of medical school replaces the credits of the fourth year of the undergraduate major.

## GUR Requirements

| | | |
|---|---|---|
| **Social Science (lower-level) GUR [1]** | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| LIT 3XX | Literature course | |

| | | |
|---|---|---|
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Physical Education GUR** | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

[1] Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electives

| | |
|---|---|
| **Major Option** | |
| Select appropriate electives in consultation with an advisor [1] | 18 |
| **Free Electives** | |
| Students select appropriate electives in consultation with an advisor. | |

[1] Usually the Director of the STS Program. Courses may be selected from different disciplines but must comprise a coherent program of study within an option.

Refer to the **General University Requirements** for further information on electives.

## Specializations

- Mind, Behavior, and Society
- Environmental and Sustainability Studies
- Race and Gender in Science in Technology
- Politics, History, and Ethics in Science and Technology

- Music, Literature, and Culture in a Technological Society

## Co-op

Co-op courses replace electives with the approval of an advisor. In science, technology and society, STS 311 Co-op Work Experience I and STS 411 Co-op Work Experience II are taken for degree credit.

# B.A. in Communication and Media

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| Select one of the following: | | 3 |
| CS 101 | Computer Programming and Problem Solving | |
| CS 104 | Computer Programming and Graphics Problems | |
| CS 113 | Introduction to Computer Science | |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 101 | Foundations of Mathematics for the Liberal Arts | 3 |
| Natural Sciences:GUR Elective | | 3 |
| Natural Sciences Lab:GUR Elective | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| Social Science (lower-level) Elective | | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Natural Sciences:GUR Elective | | 3 |
| Free Elective 1 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| COM 303 | Video Narrative [1] | 3 |
| ENG 353 | Composing Documents for Print [1] | 3 |
| Basic Social Science | | 3 |
| Track Option Elective 1 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| HIST 345 | Communication through the Ages | 3 |
| ENG 354 | Composing Documents for the Web [1] | 3 |
| ENG 339 | Practical Journalism [1] | 3 |
| Track Option Elective 2 | | 3 |
| Track Option Elective 3 | | 3 |
| Free Elective 2 | | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ENG 333 | Cybertext [1] | 3 |
| Open GUR Elective | | 3 |
| Track Option Elective 4 | | 3 |
| Track Option Elective 5 | | 3 |
| Free Elective 3 | | 3 |
| | **Term Credits** | **15** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| MGMT 390 | Principles of Management | 3 |
| Free Elective 4 | | 3 |
| ENG 340 | Oral Presentations [1] | 3 |
| Track Option Elective 6 | | 3 |
| Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| COM 321 | Technology & Tactics of Sound | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ENG 302 | Communication Theory [1] | 3 |
| ENG 490 | Co-op Work Experience I [1] | 3 |
| Track Option Elective 7 | | 3 |
| Track Option Elective 8 | | 3 |
| Free Elective 5 | | 3 |
| Free Elective 6 | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ENG 491 | Co-op Work Experience II [1] | 3 |
| ENG 496 | Senior Project-Communication and Media [1] | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level) : GUR Elective | | 3 |
| Free Elective 7 | | 3 |
| Free Elective 8 | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

[1] Communication and media core courses

Summary:

| Code | Title | Credits |
|---|---|---|
| 12-course core | | 36 |
| 8-course focus | | 24 |
| 8 free electives | | 24 |
| GUR | | 48 |
| **Total Credits** | | **132** |

For information on General University Requirements (GUR), please **click here**.

# Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Approved introductory course at Rutgers-Newark | | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved introductory course at Rutgers-Newark | | |
| **Humanities and Social Sciences (upper-level) GUR** | | |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level Rutgers-Newark course | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| R510 2XX | 200-level history course at Rutgers-Newark | |
| R512 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| All students, except those enrolled in the honors college, select one of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| Students enrolled in the honors college, select an honors section of the courses above. | | |
| **Natural Sciences GUR** | | |
| Seven credits from courses in biology, botany, chemistry, geology, physics, including lab credit | | 7 |
| **Physical Education GUR** | | |
| PE 1XX | Physical education course | 1 |
| Physical Education course | | 1 |

## Art or Architecture Electives

A number of courses offered by the New Jersey School of Architecture or Rutgers-Newark can be used to fulfill this requirement. See the advisor for appropriate courses.

## Technology Electives

See the advisor for appropriate courses.

# Communication and Media Track Options

- Digital Expression
- Journalism
- Literature
- Media Arts

- Professional and Technical Communication
- Theatre Arts

All concentrations require courses (twenty-four credits) and should be selected in consultation with the program director from a variety of NJIT and Rutgers-Newark course offerings.

Please consult the Humanities Department website for specific course listing. http://humanities.njit.edu/

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.A. in Communication and Media/J.D.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Select one of the following: | | 4 |
| MATH 111 | Calculus I | |
| MATH 116 | Mathematics of Design | |
| MATH 138 | General Calculus I | |
| CS 113<br>or CS 103 | Introduction to Computer Science<br>or Computer Science with Business Problems | 3 |
| Lab Science | | 4 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World (Select one of the following:) | |
| HUM 212 | The Modern World (Select one of the following:) | |
| HIST 213 | The Twentieth-Century World (Select one of the following:) | |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Lab Science | | 4 |
| ENG 352 | Technical Writing | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **Summer** | | |
| ECON 201 | Economics | 3 |
| IT 201 | Information Design Techniques | 3 |
| | **Term Credits** | **6** |
| **Second Year** | | |
| **1st Semester** | | |
| Track Option Elective | | 3 |
| Law/Polic Elective | | 3 |
| ENG 353 | Composing Documents for Print | 3 |
| HUM Elective | | 3 |
| ENG 339 | Practical Journalism | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ENG 340 | Oral Presentations | 3 |
| ENG 354 | Composing Documents for the Web | 3 |
| HUM Elective | | 2 |
| HIST 345 | Communication through the Ages | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |

| | | |
|---|---|---|
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **17** |
| **Summer** | | |
| ENG 336 | Advanced Composition | 3 |
| | **Term Credits** | **3** |
| **Third Year** | | |
| **1st Semester** | | |
| COM 303 | Video Narrative | 3 |
| Track Option Elective [1] | | 3 |
| ENG 369 | Creative Writing | 3 |
| Concentration Elective - Law Policy | | 3 |
| Concentration Elective - Law Policy | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ENG 496 | Senior Project-Communication and Media | 3 |
| Track Option Elective [1] | | 3 |
| Track Option Elective [1] | | 3 |
| Select one of the following: | | 3 |
| LIT 350 | Fiction | |
| LIT 355 | Poetry | |
| LIT 360 | Drama | |
| LIT 365 | Non-Fiction | |
| HSS Honors Capstone | | 3 |
| Concentration Elective - Law Policy | | 3 |
| | **Term Credits** | **18** |
| | **Total Credits** | **105** |

[1] Course to be approved by program director; numerous courses at NJIT and Rutgers-Newark apply.

The three year undergraduate component contains only 105 credits but assumes acceptance into a law school program-the first year of law school replaces the credits of the fourth year of the undergraduate major.

## Electives

| | | |
|---|---|---|
| **Social Sciences (lower-level) GUR** [1] | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| ENG 3XX | English course | |

| | | |
|---|---|---|
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level Rutgers-Newark course | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| R510 2XX | 200-level history course at Rutgers-Newark | |
| R512 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following. Honors College students register for honors section. | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Natural Sciences GUR** | | |
| Seven credits from courses in biology, botany, chemistry, geology, physics [2] | | 7 |
| **Physical Education GUR** | | |
| PE 1XX | Physical education course | 1 |
| Physical Education course | | 1 |

## Art or Architecture Electives

A number of courses offered by the New Jersey School of Architecture or Rutgers-Newark can be used to fulfill this requirement. See the advisor for appropriate courses.

## Technology Electives

See the advisor for appropriate courses.

## Communication and Media Track Options

- Digital Expression
- Journalism
- Literature
- Media Arts
- Professional and Technical Communication
- Theatre Arts

All concentrations require courses (twenty-four credits) and should be selected in consultation with the program director from a variety of NJIT and Rutgers-Newark course offerings.

Please consult the Humanities Department website for specific course listing. http://humanities.njit.edu/

# B.A. in Theatre Arts and Technology

(126 credits)

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 101 | Foundations of Mathematics for the Liberal Arts | 3 |
| Science GUR Elective | | 3 |
| Science GUR Lab Elective | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education | | 1 |
| Select one of the following: | | 3 |
| CS 100 | Roadmap to Computing | |
| CS 101 | Computer Programming and Problem Solving | |
| CS 103 | Computer Science with Business Problems | |
| CS 104 | Computer Programming and Graphics Problems | |
| CS 113 | Introduction to Computer Science | |
| CS 115 | Intro. to CS I in C++ | |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Social Science Elective | | 3 |
| PHYS 202<br>or PHYS 203 | Introductory Astronomy and Cosmology<br>or The Earth in Space | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| THTR 101<br>or THTR 212 | Living Theatre<br>or From Page to Stage | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| Physical Education | | 1 |
| Social Science Elective | | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| THTR 102 | Acting Fundamentals | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MGMT 390 | Principles of Management | 3 |
| 300 level Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| R088 103 | Theater Tech I | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| Select one of the following: | | 3 |
| R088 259 | Production I | |
| R088 260 | Production II | |
| R088 467 | Production III | |
| THTR 310 | Theatre History I | 3 |
| Theatre Specialization Elective | | 3 |

| | | |
|---|---|---|
| Theatre Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| THTR 315 | Theatre History II | 3 |
| Theatre Specialization Elective | | 3 |
| Theatre Specialization Elective | | 3 |
| Theatre Elective | | 3 |
| Open GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| HSS 407 | Humanities Senior Seminar - Theater | 3 |
| THTR 365 | Principles of Playwriting | 3 |
| Theatre Specialization Elective | | 3 |
| Theatre Specialization Elective | | 3 |
| Theatre Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| THTR 411 | Special Topics in Theatre | 3 |
| Theatre Specialization Elective | | 3 |
| Theatre Specialization Elective | | 3 |
| Theatre Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **126** |

| | |
|---|---|
| **Theatre Electives** | |
| Courses from additional major that apply directly to technology or additional theatre courses can count toward these electives. | 12 |
| **Free Electives** | |
| Courses from additional major can count toward these electives. | 24 |

## Specialization Options

A total of 21 specialization credits are required.

## Technical Theatre

| | | |
|---|---|---|
| THTR 209 | Voice and Speech for Theatre I | 3 |
| or THTR 210 | Voice & Speech for Theater II | |
| R088 250 | Intro to Scene & Lighting Des | 3 |
| R088 409 | Stage Management | 3 |
| THTR 483 | Independent Study in Theater I | 3 |
| Select one of the following: | | 3 |
| R088 259 | Production I | |
| R088 260 | Production II | |
| R088 467 | Production III | |

## Performance

| | | |
|---|---|---|
| THTR 208 | Movement for Theatre | 3 |
| THTR 209 | Voice and Speech for Theatre I | 3 |
| or THTR 210 | Voice & Speech for Theater II | |

| | | |
|---|---|---|
| Select two of the following: | | 6 |
| THTR 261 | Performance I | |
| THTR 262 | Performance II | |
| THTR 465 | Performance II | |
| THTR 213 | Directing I | |

## Writing for Stage and Media

| | | |
|---|---|---|
| R089 445 | Drama Writing for TV | 3 |
| Select one of the following: | | 3 |
| LIT 360 | Drama | |
| LIT 361 | 20th Century American Drama | |
| LIT 362 | Non-Western Drama | |
| LIT 364 | Modern Continental and British Drama | |
| LIT 384 | Musical Theater Adaptations | |
| THTR 483 | Independent Study in Theater I | 3 |
| Select two of the following: | | 6 |
| THTR 261 | Performance I | |
| THTR 262 | Performance II | |
| THTR 465 | Performance II | |

## Communication and Media

| | | |
|---|---|---|
| COM 350 | Digital Video Production | 3 |
| COM 303 | Video Narrative | 3 |
| ENG 339 | Practical Journalism | 3 |
| ENG 340 | Oral Presentations | 3 |
| COM 351 | Documentary Studies | 3 |
| Elective by Advisement | | 6 |

## Music and Technology

| | | |
|---|---|---|
| THTR 344 | American Musical Theater | 3 |
| LIT 384 | Musical Theater Adaptations | 3 |
| Select one of the following: | | 3 |
| THTR 261 | Performance I | |
| THTR 262 | Performance II | |
| THTR 465 | Performance II | |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Communication and Media

(128 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| Select one of the following: | | 3 |
| CS 101 | Computer Programming and Problem Solving | |
| CS 104 | Computer Programming and Graphics Problems | |
| CS 113 | Introduction to Computer Science | |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 101 | Foundations of Mathematics for the Liberal Arts | 3 |
| Natural Sciences:GUR Elective | | 3 |
| Natural Sciences Lab:GUR Elective | | 1 |

| | | |
|---|---|---|
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| Social Science (lower-level) Elective | | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Natural Sciences:GUR Elective | | 3 |
| Free Elective 1 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| COM 303 | Video Narrative [1] | 3 |
| ENG 353 | Composing Documents for Print [1] | 3 |
| Basic Social Science | | 3 |
| Track Option Elective 1 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| HIST 345 | Communication through the Ages | 3 |
| ENG 354 | Composing Documents for the Web [1] | 3 |
| ENG 339 | Practical Journalism [1] | 3 |
| Track Option Elective 2 | | 3 |
| Track Option Elective 3 | | 3 |
| Free Elective 2 | | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| ENG 333 | Cybertext [1] | 3 |
| Open GUR Elective | | 3 |
| Track Option Elective 4 | | 3 |
| Track Option Elective 5 | | 3 |
| Free Elective 3 | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MGMT 390 | Principles of Management | 3 |
| Free Elective 4 | | 3 |
| ENG 340 | Oral Presentations [1] | 3 |
| Track Option Elective 6 | | 3 |
| Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| COM 321 | Technology & Tactics of Sound | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ENG 302 | Communication Theory [1] | 3 |
| ENG 490 | Co-op Work Experience I [1] | 3 |
| Track Option Elective 7 | | 3 |
| Track Option Elective 8 | | 3 |
| Free Elective 5 | | 3 |
| Free Elective 6 | | 3 |
| | **Term Credits** | **18** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| ENG 491 | Co-op Work Experience II [1] | 3 |
| ENG 496 | Senior Project-Communication and Media [1] | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level) : GUR Elective | | 3 |
| Free Elective 7 | | 3 |
| Free Elective 8 | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

[1] Communication and media core courses

Summary:

| Code | Title | Credits |
|---|---|---|
| 12-course core | | 36 |
| 8-course focus | | 24 |
| 8 free electives | | 24 |
| GUR | | 48 |
| **Total Credits** | | **132** |

For information on General University Requirements (GUR), please **click here**.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Social Sciences (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Approved introductory course at Rutgers-Newark | | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved introductory course at Rutgers-Newark | | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | 3 |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theatre course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level Rutgers-Newark course | |
| **English Composition and Cultural History (lower-level) GUR** | | |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | 3 |
| HUM 212 | The Modern World | 3 |
| HIST 213 | The Twentieth-Century World | 3 |
| R510 2XX | 200-level history course at Rutgers-Newark | |
| R512 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| All students, except those enrolled in the honors college, select one of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| Students enrolled in the honors college, select an honors section of the courses above. | | |
| **Natural Sciences GUR** | | |
| Seven credits from courses in biology, botany, chemistry, geology, physics, including lab credit | | 7 |
| **Physical Education GUR** | | |
| PE 1XX | Physical education course | 1 |
| Physical Education course | | 1 |

## Foreign Language (I, II, III, IV) Electives

B.S. students concentrating in Literature can take 12 credits of a foreign language in lieu of literature courses. The language and choice of courses is determined in consultation with the advisor.

## Art or Architecture Electives

A number of courses offered by the New Jersey School of Architecture or Rutgers-Newark can be used to fulfill this requirement. See the advisor for appropriate courses.

## Technology Electives

See the advisor for appropriate courses.

# Communication and Media Track Options

- Digital Expression
- Journalism
- Literature
- Media Arts
- Professional and Technical Communication
- Theatre Arts

All concentrations require courses (twenty-four credits) and should be selected in consultation with the program director from a variety of NJIT and Rutgers-Newark course offerings.

Please consult the Humanities Department website for specific course listing. http://humanities.njit.edu/

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Science, Technology & Society and B.S. in Business and Information Systems

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 100 | Roadmap to Computing | 3 |
| MATH 138 | General Calculus I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Science with Lab | | 4 |
| STS 201 | Understanding Technological Society | 3 |
| Physical Education GUR | | 1 |
| CS 107 | Computing as a Career (Physical Education GUR) | 1 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Science with Lab | | 3 |
| ECON 201 | Economics | 3 |
| Physical Education GUR | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MGMT 216 | Business Statistics | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| IS 245 | Information Technology Systems: Hardware/Software | 3 |
| ACCT 117 | Survey of Accounting | 3 |
| STS 308 | Technology and Global Development: Introduction to STS | 3 |
| CS 207 | Computing and Effective Communication | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| IS 265 | Introduction to Information Systems | 3 |
| IS 334 | | 3 |
| IS 350 | Computers, Society and Ethics | 3 |
| STS 310 | Technology and Human Values | 3 |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| 300 Level STS Specialization | | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| STS 304 | Writing about Science, Technology and Society | 3 |
| 300 level STS Specialization | | 3 |
| 300 level STS Elective | | 3 |
| IS 344 | Computing Applications in Business | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| | **Term Credits** | **15** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| IS 390 | Requirements Analysis and Systems Design | 3 |
| STS 307 | Fundamentals of Research in STS | 3 |
| 300 level STS Specialization | | 3 |
| HRM 301 | Organizational Behavior | 3 |
| OM 375 | Management Science | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| STS 490 | Project and Seminar I | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| IS 455 | IS Mgmt & Business Processes | 3 |
| MGMT 491 | International Business | 3 |
| 300 level STS Elective | | 3 |
| CS 407 | Professional Development in Computing | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Humanities and Social Sciences (upper-level) Capstone Seminar | | 3 |
| IS 491 | Senior Project | 3 |
| MGMT 492 | Business Policy | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| STS 491 | Project and Seminar II | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

## GUR Requirements

| | | |
|---|---|---|
| **Social Science (lower-level) GUR** | | |
| Select one of the following Economics courses: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Approved courses at Rutgers-Newark | | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved courses at Rutgers-Newark | | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Electives in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |

| | | |
|---|---|---|
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| All students, except those enrolled in the honors college, take one of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| Students enrolled in the honors college take one from: | | 3 |
| HSS 408H | | |
| HSS 491H | | |
| **Physical Education GUR** | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

## Electives

| | |
|---|---|
| **Major Option** | |
| Select appropriate electives in consultation with an advisor [1] | 18 |
| **Free Electives** | |
| Students select appropriate electives in consultation with an advisor | |

[1] Usually the Director of the STS Program. Courses may be selected from different disciplines but must comprise a coherent program of study within an option.

Refer to the **General University Requirements** for further information on electives.

## Specializations

- Mind, Behavior, and Society
- Environmental and Sustainability Studies
- Race and Gender in Science in Technology
- Politics, History, and Ethics in Science and Technology
- Music, Literature, and Culture in a Technological Society

## Co-op

Co-op courses replace electives with the approval of an advisor. In science, technology and society, STS 311 Co-op Work Experience I and STS 411 Co-op Work Experience II are taken for degree credit.

# B.S. in Science, Technology & Society and J.D.

## B. S. in STS/JD Curriculum (Seton Hall Law School)

(124 credits)

**First Year**

| | | |
|---|---|---|
| **1st Semester** | | |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111<br>or MATH 138 | Calculus I<br>or General Calculus I | 3-4 |
| CS 113<br>or CS 104 | Introduction to Computer Science<br>or Computer Programming and Graphics Problems | 3 |
| STS 201 | Understanding Technological Society | 3 |
| Lab Science | | 3 |
| Physical Education:GUR | | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| ECON 201 | Economics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| Lab Science | | 4 |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **Summer** | | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| STS 308 | Technology and Global Development: Introduction to STS | 3 |
| | **Term Credits** | **6** |
| **Second Year** | | |
| **1st Semester** | | |
| 300 level STS Specialization | | 3 |
| STS 304 | Writing about Science, Technology and Society | 3 |
| STS 310 | Technology and Human Values | 3 |
| 300 level STS Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| 300 level STS Specialization | | 3 |
| STS 307 | Fundamentals of Research in STS | 3 |
| 300 level STS Elective | | 3 |
| Free Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Summer** | | |
| MGMT 390 | Principles of Management | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **6** |
| **Third Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| 300 level STS Specialization | | 3 |
| Free Elective | | 3 |
| STS 490 | Project and Seminar I | 3 |
| Humanities and Social Sciences (upper-level) Honors Capstone [1] | | 3 |
| ENG 300 | 3 | |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| STS 491 | Project and Seminar II | 3 |
| Concentration Elective-Law/Policy [1] | | 3 |
| Concentration Elective-Law/Policy [1] | | 3 |
| Concentration Elective-Law/Policy [1] | | 3 |
| Concentration Elective-Law/Policy [1] | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| SHLS credits counted toward degree | | 17-19 |
| | **Term Credits** | **17-19** |
| | **Total Credits** | **124-126** |

[1] Satisfies Legal Studies minor requirement

## GUR Requirements

| | | |
|---|---|---|
| **Social Science (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Approved courses at Rutgers-Newark | | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved courses at Rutgers-Newark | | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Electives in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |

| | | |
|---|---|---|
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Physical Education GUR** | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

## Electives

| | |
|---|---|
| **Major Option** | |
| Select appropriate electives in consultation with an advisor [1] | 18 |
| **Free Electives** | |
| Students select appropriate electives in consultation with an advisor | |

1 Usually the Director of the STS Program. Courses may be selected from different disciplines but must comprise a coherent program of study within an option.

Refer to the **General University Requirements** for further information on electives.

## Specializations

- Mind, Behavior, and Society
- Environmental and Sustainability Studies
- Race and Gender in Science in Technology
- Politics, History, and Ethics in Science and Technology
- Music, Literature, and Culture in a Technological Society

## Co-op

Co-op courses replace electives with the approval of an advisor. In science, technology and society, STS 311 Co-op Work Experience I and STS 411 Co-op Work Experience II are taken for degree credit.

# B.S. in Science, Technology and Society

(124 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 101 | Foundations of Mathematics for the Liberal Arts | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Natural Science GUR Elective | | 3 |
| Natural Science Lab GUR Elective | | 1 |
| STS 201 | Understanding Technological Society | 3 |
| CS 100 | Roadmap to Computing | 3 |

| | | |
|---|---|---|
| Transfer-NA Elective | | |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 105 | Elementary Probability and Statistics | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Natural Science GUR Elective | | 3 |
| ECON 201 | Economics | 3 |
| Free Elective (100 or 200 level or equivalent) | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| STS 308 | Technology and Global Development: Introduction to STS | 3 |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Free Elective (100 or 200 level or equivalent) | | 3 |
| Free Elective (100 or 200 level or equivalent) | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| STS 310 | Technology and Human Values | 3 |
| 300 Level STS Specialization | | 3 |
| Free Elective (100 or 200 level or equivalent) | | 3 |
| Free Elective (100 or 200 level or equivalent) | | 3 |
| Free Elective (100 or 200 level or equivalent) | | 3 |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| STS 304 | Writing about Science, Technology and Society | 3 |
| 300 Level STS Specialization | | 3 |
| 300 Level LIT/PHIL/HIST Course | | 3 |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| STS 307 | Fundamentals of Research in STS | 3 |
| 300 Level STS Specialization Course | | 3 |
| STS Independent Study Elective | | 1 |
| Open GUR 300-level LIT/PHIL/HIST/ENG Course | | 3 |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| STS 490 | Project and Seminar I | 3 |
| 300 level STS Elective | | 3 |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| MGMT 390 | Principles of Management | |
| ENTR 410 | New Venture Management | |
| HRM 301 | Organizational Behavior | |
| IE 492 | Engineering Management | |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| STS 491 | Project and Seminar II | 3 |
| 300 Level STS Elective | | 3 |
| 400 Level Senior Seminar | | 3 |
| Free Elective (300 or 400 level or equivalent) | | 3 |
| STS 300-level Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **124** |

## GUR Requirements

| | | |
|---|---|---|
| **Social Science (lower-level) GUR** | | |
| Select one of the following Economics courses: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| Approved courses at Rutgers-Newark | | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| Approved courses at Rutgers-Newark | | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select one of the following: | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |

| | | |
|---|---|---|
| HIST 213 | The Twentieth-Century World | |
| 2XX | 200-level history course at Rutgers-Newark | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| All students, except those enrolled in the honors college, take one of the following: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |
| Students enrolled in the honors college take one from: | | 3 |
| HSS 408H | | |
| HSS 491H | | |
| **Physical Education GUR** | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |

## Electives

| | |
|---|---|
| **Major Option** | |
| Select appropriate electives in consultation with an advisor [1] | 18 |
| **Free Electives** | |
| Students select appropriate electives in consultation with an advisor. | |

[1] Usually the Director of the STS Program. Courses may be selected from different disciplines but must comprise a coherent program of study within an option.

Refer to the **General University Requirements** for further information on electives.

## Specializations

- Mind, Behavior, and Society
- Environmental and Sustainability Studies
- Race and Gender in Science in Technology
- Politics, History, and Ethics in Science and Technology
- Music, Literature, and Culture in a Technological Society

## Co-op

Co-op courses replace electives with the approval of an advisor. In science, technology and society, STS 311 Co-op Work Experience I and STS 411 Co-op Work Experience II are taken for degree credit.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Communication Minor

Five courses in Language and Communication approved by the minor coordinator.

More information on this minor can be found on the Humanities website (http://humanities.njit.edu/academics/undergraduate/communication/pc-minor.php).

# Electronic Creative Writing Minor

| | | |
|---|---|---|
| Select five of the following: [1] | | 15 |
| COM 303 | Video Narrative | |
| COM 325 | Special Topics in Communication | |

| | | |
|---|---|---|
| COM 350 | Digital Video Production | |
| COM 351 | Documentary Studies | |
| COM 352 | Photojournalism | |
| COM 369 | Digital Poetry | |
| COM 390 | Electronic Writing Workshop | |
| ENG 333 | Cybertext | |
| ENG 336 | Advanced Composition | |
| ENG 351 | Online Journalism | |
| ENG 354 | Composing Documents for the Web | |
| HUM 401 | Independent Study | |
| STS 347 | Introduction to Music | |
| STS 349 | Advanced Music Technology | |
| **Total Credits** | | **15** |

[1] Appropriate Communications, Media, or Art courses at Rutgers-Newark may also be applied to the minor. Other upper-division humanities electives may be approved by faculty coordinator.

# Journalism Minor

(15 credits)

| | | |
|---|---|---|
| ENG 339 | Practical Journalism | 3 |
| Four courses in journalism or related fields chosen in consultation with the minor adviser | | 12 |
| Equivalent Rutgers-Newark courses may be taken with department approval | | |
| **Total Credits** | | **15** |

# Literature Minor

(15 credits)

Five upper division literature courses approved by the minor coordinator.

# Philosophy Applied Ethics Minor

(15 credits)

Five upper division courses in Philosophy and STS chosen with approval of minor coordinator.

# Science, Technology & Society Minor

(15 credits)

Five upper division STS courses or substitutes approved by the minor coordinator.

More **information on this minor** can be found on the Humanities (http://humanities.njit.edu/academics/undergraduate) website.

# Technology, Gender and Diversity Minor

(15 credits)

Five upper division courses in relevant fields chosen with approval of minor coordinator.

# Theatre Arts and Technology Minor

(15 credits)

Five upper division courses in drama approved by the minor coordinator.

# Mathematical Sciences

NJIT's nationally recognized Department of Mathematical Sciences (http://math.njit.edu) offers a B.S. degree in mathematical sciences with options in applied mathematics, applied statistics, mathematical biology, and mathematics of finance and actuarial science; an M.S. in applied mathematics; an M.S. in applied statistics; and a Ph.D. in mathematical sciences with tracks in applied mathematics and applied probability and statistics. A seven-year accelerated B.S./M.D. program in mathematical sciences is also offered. In addition to its own degree programs, the department serves the university by providing courses in mathematics required for programs in various technological and scientific disciplines. The diverse research interests of department faculty include mathematical biology, mathematical fluid dynamics, linear and nonlinear waves, electromagnetics, optics, acoustics, applied statistics, and numerical analysis. This work is supported by substantial funding from sources such as the NSF, NIH, ONR, AFOSR, NASA, DOE, Whitaker Foundation, and the Council for International Exchange of Scholars (Fulbright Foundation).

## NJIT Faculty

### A

Afkhami, Shahriar Zakerzadeh, Associate Professor

Ahluwalia, Daljit Singh, Professor

Andrushkiw, Roman, Professor Emeritis

### B

Batson II, William Richard, Post Doctoral Fellow

Bechtold, John K., Professor

Blackmore, Denis L., Professor

Booty, Michael R., Professor

Bose, Amitabha K., Professor

Boubendir, Yassine, Associate Professor

Brown, Ronald Robert, University Lecturer

Bukiet, Bruce G., Associate Professor

### C

Choi, Wooyoung, Professor

Cummings, Linda J., Professor

### D

Dhar, Sunil K., Professor

Diekman, Casey O., Assistant Professor

Dios, Rose, Associate Professor

### F

Fang, Yixin, Associate Professor

Froese, Brittany, Assistant Professor

### G

Garfield, Ralph, Associate Professor Emeritus

Goodman, Roy H., Associate Professor

Guo, Wenge, Associate Professor

## H

Hayes, Jimmy L., University Lecturer

Horntrop, David J., Associate Professor

Horwitz, Kenneth A., University Lecturer

Hunter, John, University Lecturer

## J

Jiang, Shidong, Associate Professor

## K

Kappraff, Jay M., Associate Professor

Kelly, Rudy, University Lecturer

Kondic, Lou, Professor

Kriegsmann, Gregory A., Distinguished Professor Emeritus

## L

Loh, Ji Meng, Associate Professor

Luke, Jonathan H. C., Professor

## M

Matveev, Victor V., Associate Professor

Michalopoulou, Zoi-Heleni, Professor

Milojevic, Petronije, Professor

Miura, Robert M., Distinguished Professor Emeritus

Mohebbi Forushani, Soroosh, University Lecturer

Moore, Richard O., Associate Professor

Muratov, Cyrill B., Professor

## N

Natarajan, Padma, University Lecturer

## P

Perez, Manuel, Professor

Petropoulos, Peter G., Associate Professor

Plastock, Roy A., Associate Professor

Pole, Andrew, MSMCF Coordinator

Porus, Jonathan J, Math Tutoring Center Director

Potocki-Dul, Magdallena M., University Lecturer

## R

Rappaport, Karen D., Senior University Lecturer

Ratnaswamy, Jeyakumaran, Senior University Lecturer

Rotstein, Horacio G., Professor

### S

Shirokoff, David, Assistant Professor

Siegel, Michael S., Professor

Stickler, David, Professor Emeritus

Subramanian, Sundarraman, Associate Professor

### T

Tavantzis, John, Professor Emeritus

Turc, Catalin C., Associate Professor

### V

Voronka, Roman W., Professor Emeritus

### W

Wang, Antai, Associate Professor

### Y

Young, Yuan-Nan, Associate Professor

### Z

Zaleski, Joseph, University Lecturer

## Programs

- Mathematical Sciences - B.S. (see Concentrations)

## Accelerated Programs (p. 92)

- Mathematical Sciences - B.S./M.D., D.M.D., D.D.S., O.D. (p. 399)
- Mathematics - B.S./M.D. (p. 398)

## Double Majors (p. 92)

- Applied Mathematics and Applied Physics - B.S. (p. 405)
- Biology and Mathematical Sciences - B.S. (p. 406)
- Computer Science and Applied Mathematics - B.S. (p. 209)

- Applied Mathematics Minor (p. 402)
- Applied Statistics Minor (p. 404)
- Computational Mathematics Minor (p. 409)
- Mathematical Biology Minor (p. 411)
- Mathematics of Finance and Actuarial Science Minor (p. 414)

- Applied Mathematics (p. 401)
- Applied Statistics and Data Analysis (p. 403)
- Computational Mathematics (p. 408)
- Mathematical Biology (p. 410)
- Mathematics of Finance and Actuarial Science (p. 412)

## Mathematical Sciences Courses

**MATH 101. Foundations of Mathematics for the Liberal Arts. 3 credits, 3 contact hours (3;0;0).**
Intended for students in degree programs offered by HSS and History. This course reviews principles of algebra and the foundations of mathematics. Degree credit awarded for degrees offered by HUM and HIST.

**MATH 102. Modern Pre-calculus. 6 credits, 6 contact hours (6;0;0).**
This course is an intensive non-traditional approach to pre-calculus employing curriculum innovations for the preparation of students for college calculus. The course infuses calculus techniques into the pre-calculus curriculum. The format includes both regular class and workshop environments with a focus on student problem solving. Course meets on Saturdays in the fall and spring terms and M, T, W, R in the summer, second session. This course is only available to high school students.

**MATH 105. Elementary Probability and Statistics. 3 credits, 3 contact hours (3;0;0).**
Consider notions of probability. Topics include the binomial and normal distributions, expected value, and variance. The notions of sampling, hypothesis testing, and confidence intervals are applied to elementary situations.

**MATH 107. University Mathematics BI. 3 credits, 3 contact hours (3;0;0).**
Linear functions, equations, inequalities, systems of linear equations, quadratic equations, elementary functions, graphing functions.

**MATH 108. University Mathematics I B. 4 credits, 5 contact hours (5;0;0).**
Intended for students whose major requires MATH 111. Linear functions, equations, inequalities, systems of linear equations, quadratic equations, polynomials, rational expressions, expressions involving radicals, partial fraction decomposition, conic sections, graphing functions.

**MATH 110. University Mathematics B II - Trigonometry. 4 credits, 5 contact hours (4;1;0).**
Intended for students whose major requires MATH 111. Prerequisite: MATH 108 or placement by performance on standardized entrance examinations. Trigonometric functions and identities, laws of sines and cosines, logarithmic equations, systems of nonlinear equations, polar coordinates.

**MATH 111. Calculus I. 4 credits, 5 contact hours (5;0;0).**
Prerequisite: MATH 110 with a grade of C or better or MATH 139 with a grade of B or better, or placement by performance on standardized entrance examinations. Topics include limits, differentiation, applications of differentiation, and integration.

**MATH 111H. Honors Mathematics I. 4 credits, 4 contact hours (4;0;0).**
Admission to this course is by invitation, based on standardized entrance exams. Topics enhance those of MATH 111 and concepts are studied in detail. Emphasizes science and engineering applications.

**MATH 112. Calculus II. 4 credits, 5 contact hours (5;0;0).**
Prerequisite: MATH 111 with a grade of C or better or MATH 132 with a grade of C or better. Topics include integration, applications of integration, series, exponential and logarithmic functions, transcendental functions, polar coordinates, and conic sections.

**MATH 113. Finite Mathematics and Calculus I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: (Intended for Architecture students.) MATH 107 with a grade of C or better, or MATH 110 with a grade of C or better, or NJIT placement. An introduction to differential and integral calculus. Applications include area, volumes, curve lengths, surface area, centroids, and moments. Focus is on application throughout the course.

**MATH 114. Finite Mathematics and Calculus II. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: (Intended for Architecture students.) MATH 113 with a grade of C or better. Topics include numerical methods, set theory and counting, series, descriptive statistics and basic probability, matrices, and optimization.

**MATH 115. Elements of Geometry. 3 credits, 3 contact hours (3;0;0).**
A modern approach to the elements of geometry grounded in real-world applications. Topics included basic axiomatic, Euclidean geometry, non-Euclidean geometry, and transformational geometry. Applications and examples in architecture, engineering and science are integrated throughout the course.

**MATH 116. Mathematics of Design. 3 credits, 3 contact hours (3;0;0).**
The course is project oriented, covering theories of proportion; tiling, symmetry, symmetry groups, and informal geometry; fractals; theory of graphs and knots; three-dimensional design and polyhedra. The mathematics is oriented towards carrying out designs rather than a systematic development of mathematical theory.

**MATH 120. Basic Concepts in Statistics. 1 credit, 1 contact hour (1;0;0).**
The course offers an introduction to the basic concepts in statistics. Topics include the role of statistics, data summary, normal distribution, elements of probability, and computation of mean and variance. This course will also include an introduction to statistical estimation and inference.

**MATH 131. Calculus A. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: MATH 139 with a grade of B or higher and permission of the major advisor or placement. The course covers limits, continuity, differentiation, and related rates, also reviewing the foundations of algebra, precalculus, and trigonometry. MATH 131, MATH 132, and MATH 133 are equivalent to MATH 111 and MATH 112.

**MATH 132. Calculus B. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: MATH 131 with a grade of C or higher or MATH 111 with a grade of C or higher. The course covers optimization, integration, calculation of arc length, area, volume, and hyperbolic functions (4-1-4) MATH 131, MATH 132, and MATH 133 are equivalent to MATH 111 and MATH 112.

**MATH 133. Calculus C. 4 credits, 5 contact hours (5;0;0).**
Prerequisites: MATH 132 with a grade of C or higher. The course covers integration, applications of integration, numerical integration, series, and polar coordinates. MATH 131, MATH 132 and MATH 133 are equivalent to MATH 111 and MATH 112.

**MATH 135. Calculus for Business. 3 credits, 3 contact hours (3;0;0).**
Intended for students with major offered by SOM. Prerequisite: MATH 107 with a grade of C or better or MATH 110 with a grade of C or better or NJIT placement. An introduction to mathematics of business, principles of differential and integral calculus, and optimization.

**MATH 138. General Calculus I. 3 credits, 3 contact hours (3;0;0).**
Intended for students who are not in Science or in Engineering. Prerequisite: MATH 107 with a grade of C or better, or MATH 110 with a grade of C or better or NJIT placement. An introduction to differential and integral calculus of a single variable.

**MATH 139. Trigonometry and Principles of Differential Calculus. 4 credits, 5 contact hours (4;0;1).**
Prerequisites: Grade A in MATH 108 or NJIT placement. Comprehensive review of trigonometry and pre-calculus topics integrated into an introduction to differential calculus. Topics covered include: Exponential, logarithmic and trigonometric functions, analytics trigonometry, conic sections, limits, derivatives, applications of differentiation.

**MATH 211. Calculus III A. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include vectors, curvature, partial derivatives, multiple integrals, line integrals, and Green's theorem. Students who are considering a major in Mathematical Sciences or who are undecided about their major should take MATH 213.

**MATH 213. Calculus III B. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include vectors, curvature, partial derivatives, multiple integrals, line integrals, and Green's, divergence, and Stokes' theorems.

**MATH 222. Differential Equations. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Methods for solving ordinary differential equations are studied together with physical applications, Laplace transforms, numerical solutions, and series solutions.

**MATH 225. Survey of Probability and Statistics. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include descriptive statistics, elements of probability, random variables and distributions; mean and variance; introduction to estimation and inference. This course satisfies the Mathematics GUR in probability and statistics. However, degree credit will not be granted for both MATH 225 and any other upper level course in probability and/or statistics.

**MATH 225A. Survey of Probability and Statistics. 1 credit, 1 contact hour (1;0;0).**
For Chemical Engineering students only. Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include descriptive statistics, elements of probability, random variables and distributions; mean and variance; introduction to estimation and inference. This course satisfies the Mathematics GUR in probability and statistics. However, degree credit will not be granted for both MATH 225 and any other upper level course in probability and/or statistics.

**MATH 226. Discrete Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. An introduction to discrete mathematics. An introduction to discrete mathematics. Topics include elementary set theory, logic, combinatorics, relations, and selections from graphs and trees and algebraic systems.

**MATH 227. Mathematical Modeling. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better and CS 115 with a grade of C or better or CS 113 with a grade of C or better or CS 100 with a grade of C or better or CS 101 with a grade of C or better. An introduction to the theory and practice of mathematical modeling. Techniques include scaling and dimension, fitting of data, linear and exponential models, elementary dynamical systems, probability, optimization, Markov chain modeling. Models are drawn from applications including biology, physics, economics, finance, and chemistry.

**MATH 238. General Calculus II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 138 with a grade of C or better or MATH 139 with a grade of C or better or MATH 111 with a grade of C or better or placement. A continuation of MATH 138. Topics include applications of integral calculus and an introduction to ordinary differential equations.

**MATH 240. Numerical Mathematics Laboratory. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better, and CS 113 or knowledge of FORTRAN, C, or C++. Introduction to basic concepts and processes of numerical mathematics with emphasis on practical issues of implementation, use of numerical algorithms and software, and interpretation of numerical data. Weekly projects involving writing computer programs, presenting numerical results in tables and graphs, evaluation and approximation of standard numerical functions, round-off errors and loss of significance, basic iterative processes, matrix arithmetic, random number generation, and Monte Carlo methods. Students gain experience using a programming language, such as C, and mathematical software, such as MATLAB.

**MATH 244. Introduction to Probability Theory. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Topics include basic probability theory in discrete and continuous sample space, conditional probability and independence, Bayes' theorem and event trees, random variables and their distributions, joint distribution and notion of dependence, expected values and variance, moment generating functions, useful parametric families of distributions including binomial, geometric, hypergeometric, negative binomial, exponential, gamma, normal and their applications, simple case of central limit theorem and its uses.

**MATH 245. Multivariate Probability and Stochastic Processes. 3 credits, 0 contact hours (0;0;0).**
Prerequisite: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Topics include discrete and continuous multivariate distributions and their moments, multivariate normal distributions, order statistics, discrete and continuous Markov chains, Poisson processes, and Brownian motion processes.

**MATH 246. Introduction to Financial Mathematics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 135 with a grade of C or better or MATH 138 with a grade of C or better or MATH 111 with a grade of C or better. An introduction to the basics of simple interest and discount, compound interest and discount, and simple annuities. This course is primarily intended for students whose major only requires Calculus I. It cannot be used for credit towards major or minor degrees offered by the Department of Mathematical Sciences.

**MATH 279. Statistics and Probability for Engineers. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. This course introduces methods of summarizing and analyzing engineering data and the importance of observing processes over time such as control charts. Descriptive statistics, plots and diagrams are then used to summarize the data. Elements of probability and random variables with their distributions along with mean and variance are taught. All this knowledge is then used as a platform towards covering how to do basic estimation and inference, including confidence intervals and hypothesis testing based on a single sample. Students taking this course cannot receive degree credit for MATH 225, MATH 244, or MATH 333.

**MATH 305. Statistics for Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: (Intended for students in Engineering Technology.) MATH 111 with a grade of C or better, or MATH 132 with a grade of C or better, or MATH 138 with a grade of C or better. An introduction to the modern concepts of statistics needed by engineering technologists. Topics include organization of data, descriptive statistics, discrete and continuous probability distributions, sampling distribution and designs, estimation -- one and two populations, tests of hypotheses.

**MATH 309. Mathematical Analysis for Technology. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: MATH 112 with a grade of C or better, or MATH 133 with a grade of C or better or MATH 238 with a grade of C or better. Emphasis on partial derivatives; vector calculus, and multiple integrals.

**MATH 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of the sophomore year, departmental approval, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**MATH 321. Introduction to the Finite Element Method. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 with a grade of C or better. An elementary introduction to the theory and practice of the finite element method (FEM) is given. The mathematical underpinnings covered in this course include the basics of Sobolev spaces, Galerkin's method and various other weak formulations. Mathematical modeling of different physical problems and their solution techniques are also discussed. Existing finite element programs will be introduced through a course project.

**MATH 322. Differential Equations for Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better or MATH 238 with a grade C or better. An applied science study using differential equations as the vehicle for comprehension of the unknown. Introduction to first-order differential equations and their applications to motion, cooling and electromechanical systems followed by higher order differential equations and their solutions. Study of methods of undetermined coefficients, variation of parameters, and many series and numerical methods. Includes Laplace transforms, matrix methods, and eigenvalue problems.

**MATH 326. Discrete Analysis for Computer Engineers. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. An introduction to mathematical logic, Boolean algebra, and Karnaugh maps. Other topics include functions, equivalence relations and partially ordered sets, counting, graph theory and finite state machines. The emphasis is on computation but proofs will be addressed. Students cannot receive credit for both MATH 226 and MATH 326.

**MATH 328. Mathematical Methods for Scientists and Engineers. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211 with a grade of C or better, or MATH 213 with a grade of C or better. Corequisite: MATH 222. The course exposes students to concepts of mathematics encountered throughout the physical science and engineering disciplines. Topics include matrix algebra, vector analysis, complex numbers, and boundary value problems in partial differential equations.

**MATH 331. Introduction to Partial Differential Equations. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 or MATH 213 and MATH 222 all with a grade of C or better. Partial differential equations in science and engineering. Topics include initial- and boundary-value problems for parabolic, hyperbolic, and elliptic second-order equations. Emphasis is placed on separation of variables, special functions, transform methods, and numerical techniques.

**MATH 332. Introduction to Functions of a Complex Variable. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 or MATH 213 and MATH 222 all with a grade of C or better. Functions of a complex variable: Cauchy-Riemann equations, Cauchy-Goursat theorem, integration, series, residues, poles, geometrical aspects. Emphasis on techniques.

**MATH 333. Probability and Statistics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Descriptive statistics and statistical inference. Topics include discrete and continuous distributions of random variables, statistical inference for the mean and variance of populations, and graphical analysis of data.

**MATH 334. Operations Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Considers mathematical methods found especially in contemporary fields such as operations research and reliability engineering. Topics include linear programming, graph theory, finite mathematics, differential equations, matrices, and determinants.

**MATH 335. Vector Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better. Algebra and calculus of vectors. Topics include the theorems of Gauss, Green, and Stokes, and curvilinear coordinates.

**MATH 336. Applied Abstract Algebra. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Classical algebra from a modern and constructive viewpoint. Emphasis is on the development of algorithmic and computational skills. Topics include rings, fields, and groups and their applications to science and engineering.

**MATH 337. Linear Algebra. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. Matrices, determinants, systems of linear equations, vector spaces, linear transformations, eigenvalues, eigenvectors, and related topics.

**MATH 340. Applied Numerical Methods. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better, and CS 100 with a grade of C or better or CS 101 with a grade of C or better oror CS 113 with a grade of C or better or CS 115 with a grade of C or better or MATH 240 with a grade of C or better. Introduction to numerical methods with emphasis on mathematical models. Implements and investigates numerical techniques for the solution of linear and nonlinear systems of equations, eigenvalue problems, interpolation and approximation, techniques of optimization, Monte Carlo methods, and applications to ordinary differential equations and integration.

**MATH 341. Statistical Methods II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Covers applications of classical statistical inference. Topics include transformation of variables, moment generating technique for distribution of variables, introduction to sampling distributions, point and interval estimation, maximum likelihood estimators, basic statistical hypotheses and tests of parametric hypotheses about means of normal populations, chi-square tests of homogeneity, independence, goodness-of-fit.

**MATH 344. Regression Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333 with a grade of C or better or MATH 341 with a grade of C or better. An introduction to statistical data analysis using regression techniques. Topics include least squares estimation, hypothesis testing, prediction, regression diagnostics, residual analysis, variance stabilizing transformations, regression using indicator variables, variable selection, and model building.

**MATH 345. Multivariate Distributions. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better. Topics include discrete and continuous multivariate distributions and their moments, multivariate distributions including multivariate normal and multinominal distributions, order statistics, conditional probability and the use of conditioning, discrete time Markov chains and their examples, discrete time branching processes, homogeneous and nonhomogeneous Poisson processes.

**MATH 346. Mathematics of Finance I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112 with a grade of C or better or MATH 133 with a grade of C or better. The main topics include basic problems in interest, annuities, certain amortization and sinking funds, bonds and related securities.

**MATH 347. Mathematics of Finance II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 346 and MATH 244 or MATH 333 all with a grade of C or better. This course introduces mathematical models of bond and stock prices, which lead to arbitrage pricing of options and other derivative securities, and portfolio management. These areas of mathematical finance have a great impact on the way financial markets function. Topics include risk-free, and risky assets, portfolio management, futures, and options.

**MATH 371. Physiology and Medicine. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 with a grade of C or better. Mathematical models of organs and organ systems: the heart and circulation, gas exchange in the lungs, electrical properties of excitable membranes, neuro-biological clocks, the renal countercurrent mechanism, muscle mechanics. The biology is introduced with each topic. Emphasis is on quantitative problem solving, model building, and numerical simulation.

**MATH 372. Population Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 with a grade of C or better. Introduction to the mathematics of populations: Malthus' model of geometric population growth, Euler's renewal equations, age structure in human populations, predator satiation, chaos, mathematical models of inheritance, and the theory of epidemics. The ability to weave back and forth between physical concepts and mathematical notation is emphasized as well as the relationships between random and non-random models of similar phenomena.

**MATH 373. Introduction to Mathematical Biology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better and MATH 337 with a grade of C or better. This course provides an introduction to the use of mathematical techniques applied to problems in biology. Discrete and continuous models of biological phenomena will be discussed. Biological topics discussed range from the subcellular molecular systems and cellular behavior to physiological problems, population biology and developmental biology. Techniques of phase plane analysis for differential equations are introduced in the course. No prior background in biology is necessary.

**MATH 388. Introduction to Chaos Theory. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better. An elementary treatment of chaos theory and its applications concentrating on discrete dynamical systems. Uses theory and applications illustrated by computer experiments to develop such topics as bifurcation, attractors, the logistic map, period-doubling routes to chaos, symbolic dynamics, Sarkovskii's theorem, fractals, and Julia and Mandelbrot sets for complex dynamics.

**MATH 391. Numerical Linear Algebra. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 337 with a grade of C or better and CS 113 with a grade of C or better or CS 115 with a grade of C or better or CS 101 with a grade of C or better or CS 100 with a grade of C or better. This course provides an introduction to computational linear algebra. Topics include direct solution of linear systems, iterative methods for linear systems, fast Fourier transforms, least squares problems, singular value decomposition and eigenvalue/eigenvector problems.

**MATH 401. Undergraduate Research Seminar. 1 credit, 1 contact hour (0;0;1).**
Research seminar intended for students who participate in year-long research projects. Methodologies and techniques needed for summer research projects are discussed. Presentations of current research topics are made by various faculty.

**MATH 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MATH 310 with a grade of C or better, departmental approval, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience.

**MATH 426. Advanced Discrete Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 226 with a grade of C or better or MATH 326 with a grade of C or better. Topics include graphs, trees and their applications, grammars, finite state machines, Turing machines and Petri nets, applied combinatorics -- Stirling, Catalan, and Ramsey numbers, Polya-Burnside counting methods, finite Markov chains and coding theory.

**MATH 430. Analytical and Computational Neuroscience. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better, and MATH 222 with a grade of C or better, and CS 100 with a grade of C or better or CS 113 with a grade of C or better or CS 115 with a grade of C or better or MATH 340 with a grade of C or better. A mathematical and computational introduction to the biophysical mechanisms that underlie physiological functions of single neurons and synapses. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, nerve impulse propagation in axons and dendrites, single- and multi-compartmental modeling, synaptic transmission, calcium handling dynamics and calcium dependent currents and processes.

**MATH 431. Systems Computational Neuroscience. 3 credits, 0 contact hours (0;0;0).**
Prerequisites: MATH 430 with a grade of C or better or departmental approval. This course provides a mathematical and computational introduction to operations of neuronal systems and networks. Topics covered include central pattern generators, neuroethology of sensory systems, sensory-motor transformations, models of various brain regions, models of visual processes, large networks modeling, models of learning and memory, neural coding and mathematics of neural networks.

**MATH 432. Mathematics of Financial Derivatives I (Capstone I). 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222 with a grade of C or better and MATH 346 with a grade of C or better. Mathematical analysis of models encountered in the area of financial derivatives. Topics include modeling and analysis of futures markets, determination of future prices, hedging strategies, swaps, option markets, stock options and their trading strategies.

**MATH 433. Mathematics of Financial Derivatives II (Capstone II). 3 credits, 3 contact hours (3;0;0).**
Corequisite: MATH 340 with a grade of C or better. MATH 432 with a grade of C or better. Mathematical analysis of models encountered in the area of financial derivatives with emphasis on numerical methods. Topics include: Binomial Trees, Black Scholes Models, Finite Difference Methods.

**MATH 440. Advanced Applied Numerical Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 331 with a grade of C or better and MATH 340 with a grade of C or better. A survey of numerical methods for solving ordinary and partial differential equations. Includes initial-value and boundary-value problems for ordinary differential equations and for elliptic, hyperbolic, and parabolic partial differential equations.

**MATH 441. Actuarial Mathematics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 346 with a grade of C or better. Topics include the economics of insurance, individual risk models for a short term, survival distributions and life tables, life insurance per year, life annuities, and net premiums.

**MATH 442. Actuarial Mathematics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 441 with a grade of C or better. Topics include net premium reserves, insurance models including expenses, nonforfeiture benefits, and dividends.

**MATH 444. Applied Sampling Methods and Quality Control. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333 with a grade of C or better, or MATH 244 with a grade of C or better and MATH 341 with a grade of C or better. An introduction to sample survey and statistical quality control. Topics include sampling from a finite population and different sampling techniques, more detailed study of random sampling and stratification, control charts and acceptance sampling plans in statistical quality control.

**MATH 445. Introduction to Experimental Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 333 with a grade of C or better, or MATH 244 with a grade of C or better and MATH 341 with a grade of C or better. Basic concepts and principles of designs are covered. Topics include randomized blocks, Latin squares, factorial designs.

**MATH 446. Topics in Applied Statistics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 341 with a grade of C or better or MATH 333 with a grade of C or better. Topics may include biostatistics, environmental statistics, statistical consulting.

**MATH 447. Applied Time Series Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 341 with a grade of C or better or MATH 333 with a grade of C or better. An introduction to applied univariate time series analysis. Topics include regression techniques for modeling trends, smoothing techniques (moving average smoothing, exponential smoothing), autocorrelation, partial auto-correlation, moving average, and autoregressive representation of series, Box-Jenkins models, forecasting, model selection, estimation, and diagnostic checking, Fourier analysis, and spectral theory for stationary processes.

**MATH 448. Stochastic Simulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 340 and either MATH 244 or MATH 333 with a grade of C or better. An introduction in the use of computer simulation to study stochastic models. Topics include the generation of samples of continuous and discrete random variables and processes with applications to stochastic models, statistical analysis of the results, and variance reduction techniques.

**MATH 450. Methods Of Applied Math. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 331 with a grade of C or better, Math 337 with a grade of C or better, and MATH 340 with a grade of C or better. Combines mathematical modeling with physical and computational experiments conducted in the Undergraduate Mathematics Computing Laboratory.

**MATH 451. Methods Appl Math II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Math 450 H with a grade of C or better. Small teams of students conduct research projects under the guidance of faculty members who perform applied research.

**MATH 453. High-Performance Numerical Computing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 391 with a grade of C or better and MATH 440 with a grade of C or better. The course covers state-of-the-art numerical algorithms for solving large-scale problems accurately and efficiently. Topics include iterative methods for linear systems and eigenvalue computations, introduction to parallel program and parallel numerical algorithms and spectral methods. An instructor-selected advanced topic will be included in the course.

**MATH 460. Differential Geometry of Curves and Surfaces. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222 with a grade of C or better. Curves in the plane and Euclidean space, moving frames, surfaces in Euclidean space, orientability of surfaces, Gaussian and mean curvatures, surfaces of revolution, ruled surfaces, minimal surfaces, special curves on surfaces, Theorema Egregium, the intrinsic geometry of surfaces.

**MATH 473. Intermediate Differential Equations. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222 with a grade of C or better and MATH 337 with a grade of C or better. Topics in the qualitative behavior of solutions of ordinary differential equations with applications to engineering problems. Includes phase plane analysis, stability, dynamical systems, and chaos.

**MATH 477. Stochastic Processes. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 244 with a grade of C or better or MATH 333 with a grade of C or better and MATH 337 with a grade of C or better. This course introduces the theory and applications of random processes needed in various disciplines such as mathematical biology, finance, and engineering. Topics include discrete and continuous Markov chains, Poisson processes, as well as topics selected from Brownian motion, renewal theory, and simulation.

**MATH 478. Intro Stat Methods in Data Sci. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Math 333 with a grade of C or better or Math 341 with a grade of C or better. This course introduces to students concepts in statistical methods used in data science, including data collection, data visualization and data analysis. Emphasis is on model building and statistical concepts related to data analysis methods. The course provides the basic foundational tools on which to pursue statistics, data analysis and data science in greater depth. Topics include sampling and experimental design, understanding the aims of a study, principles of data analysis, linear and logistic regression, resampling methods, and statistical learning methods. Students will use the R statistical software.

**MATH 480. Introductory Mathematical Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better. Builds on principles taught in basic calculus courses. Topics discussed include continuity, differentiation, integration, and the limit process of sequences and series.

**MATH 481. Advanced Calculus. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 480 with a grade of C or better. Systematic development of partial differentiation, multiple and improper integrals, transformations, inverse and implicit function theorems, and integrals over curves and surfaces.

**MATH 491. Independent Study in Mathematics. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Senior standing and departmental approval. Each student works under the direct supervision of a member of the Department of Mathematical Sciences. The work consists primarily of a project applying the student's mathematical skills to an engineering- or science-oriented project.

**MATH 492. Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Senior standing and departmental approval. Each student works under the direct supervision of a member of the Department of Mathematical Sciences. The work consists primarily of a project applying the student's mathematical skills to an engineering- or science-oriented project.

**MATH 495. Topics in Applied Mathematics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 331 with a grade of C or better, MATH 332 with a grade of C or better, and MATH 340 with a grade of C or better, or departmental approval. A survey of selected areas of applied mathematics. Case histories of problems in applied mathematics from an industrial background.

**MATH E. Math Stack Engineers. 3 credits, 3 contact hours (3;0;0).**

**MATH NE. Math Stack For Non-Engineers. 3 credits, 3 contact hours (3;0;0).**

## Rutgers-Newark Courses

**R960 211. Statistics I. 3 credits, 3 contact hours (3;0;0).**

**R960 212. Statistics II. 3 credits, 3 contact hours (3;0;0).**

**R960 238. Found Modern Math. 3 credits, 3 contact hours (3;0;0).**

**R960 463. Regression Methods. 3 credits, 3 contact hours (3;0;0).**

**R960 563. Data Models. 3 credits, 0 contact hours.**

**R960 567. Appld M-Var Analysis. 3 credits, 3 contact hours.**

**R960 575. Data Analysis & Decision Makin. 3 credits, 3 contact hours.**

**R960 576. Financial Time Series. 3 credits, 0 contact hours.**

**R960 577. Intro Stats Linear Models. 3 credits, 3 contact hours.**

**R960 580. Stochastic Process. 3 credits, 0 contact hours.**

**R960 583. Meth Stat Inf. 3 credits, 3 contact hours.**

**R960 586. Interpretation of Data. 3 credits, 3 contact hours.**

**R960 641. Analytics for Business Intel. 3 credits, 3 contact hours.**

# Accelerated Bachelor of Science in Mathematical Sciences for M.D.

## Accelerated Bachelor of Science in Mathematical Sciences for MD (7 years)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| R120 101 | General Biology | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education | | 1 |
| | **Term Credits** | **19** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| R120 102 | General Biology | 4 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| | **Term Credits** | **19** |
| **Summer** | | |
| CS 115 | Intro. to CS I in C++ | 3 |
| MATH 213 | Calculus III B | 4 |
| | **Term Credits** | **7** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 222 | Differential Equations | 4 |

| | | |
|---|---|---|
| MATH 337 | Linear Algebra | 3 |
| R120 201 | Foundations Of Biology | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 333 | Probability and Statistics | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| English Composition and Cultural History (lower-level) GUR | | 3 |
| | **Term Credits** | **17** |
| **Summer** | | |
| Humanities and Social Sciences (upper-level) GUR | | 3 |
| ECON 201 | Economics | 3 |
| | **Term Credits** | **6** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| MATH 430 | Analytical and Computational Neuroscience | 3 |
| MATH 450H | 3 | |
| CHEM 473 | Biochemistry | 3 |
| Open Elective in Humanities and Social Sciences (upper-level) GUR | | 3 |
| Engineering Technology GUR | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MATH 371 | Physiology and Medicine | 3 |
| MATH 451H | 3 | |
| Math 300+ | | 3 |
| Management GUR | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level) GUR | | 3 |
| Engineering Technology GUR | | 3 |
| | **Term Credits** | **18** |
| | **Total Credits** | **121** |

# Accelerated Bachelor of Science in Mathematical Sciences for M.D., D.M.D., D.D.S., O.D

## 7 Year Accelerated B.S. in Mathematical Sciences for M.D., D.D.S., D.M.D., or O.D.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| R120 101 | General Biology | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |

| | | |
|---|---|---|
| Physical Education:GUR | | 1 |
| | **Term Credits** | **19** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| R120 102 | General Biology | 4 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| | **Term Credits** | **19** |
| **Summer** | | |
| CS 115 | Intro. to CS I in C++ | 3 |
| MATH 213 | Calculus III B | 4 |
| | **Term Credits** | **7** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 337 | Linear Algebra | 3 |
| R120 201 | Foundations Of Biology | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 333 | Probability and Statistics | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| English Composition and Cultural History (lower-level) GUR | | 3 |
| | **Term Credits** | **17** |
| **Summer** | | |
| Humanities and Social Sciences (upper-level) GUR | | 3 |
| ECON 201 | Economics | 3 |
| | **Term Credits** | **6** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| MATH 430 | Analytical and Computational Neuroscience | 3 |
| MATH 450H | 3 | |
| CHEM 473 | Biochemistry | 3 |
| Open Elective in Humanities and Social Sciences (upper-level) GUR | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 371 | Physiology and Medicine | 3 |
| MATH 451H | 3 | |
| Math 300+ | | 3 |
| Management GUR | | 3 |
| Capstone Seminar-Humanities and Social Sciences (upper-level) GUR | | 3 |
| | **Term Credits** | **15** |

| | | |
|---|---|---|
| | **Total Credits** | **115** |

# Applied Mathematics Concentration

## B.S. in Mathematical Sciences, Applied Mathematics Concentration

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| Physical Education | | 1 |
| EPS 202 | Society, Technology, and the Environment [1] | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 213 | Calculus III B | 4 |
| MATH 227 | Mathematical Modeling | 4 |
| Select one of the following: | | 3 |
| MATH 244 | Introduction to Probability Theory | |
| MATH 333 | Probability and Statistics | |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| Cultural History:GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 337 | Linear Algebra | 3 |
| ECON 201 | Economics | 3 |
| Technical Elective | | 3 |
| Lit/Hist/Phil/STS:GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 473 | Intermediate Differential Equations | 3 |
| MATH 480 | Introductory Mathematical Analysis | 3 |
| Management:GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |

| | | |
|---|---|---|
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| MATH 481 | Advanced Calculus | 3 |
| Humanities & Social Science Upper Level Elective | | 3 |
| Free Elective | | 3 |
| Select one of the following: | | 3 |
| MATH 391 | Numerical Linear Algebra | |
| MATH 440 | Advanced Applied Numerical Methods | |
| MATH 448 | Stochastic Simulation | |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Mathematics 300+ Elective | | 3 |
| Senior Seminar-Humanities and Social Science:GURI Elective | | 3 |
| Technical Elective | | 3 |
| Free Elective | | 3 |
| MATH 450 | Methods Of Applied Math | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Mathematics 400+ Elective | | 3 |
| MATH 451 | Methods Appl Math II | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

[1] or approved course at Rutgers-Newark.

## General University Requirements and Electives

All students are required to satisfy the General University Requirements (GUR). All GUR courses and additional mathematics, technical, and free electives are to be selected in consultation with a faculty advisor in the Department of Mathematical Sciences. Refer to the General University Requirements (http://catalog.njit.edu/undergraduate/academic-policies-procedures/general-university-requirements) section of this catalog for further information on electives.

## Co-op Courses

In Mathematical Sciences, the co-op courses, MATH 310 Co-op Work Experience I and MATH 410 Co-op Work Experience II, bear degree credit and count as technical or free electives, subject to approval by a faculty advisor in the Department of Mathematical Sciences.

## Electives

All electives should be selected after consultation with a Mathematical Sciences faculty advisor. Any mathematics course numbered 331 or above may be used as a mathematics, technical, or free elective. Any NJIT course at or above the 100 level may be used as a technical or free elective; except a technical elective is a course that has a significant mathematical and/or scientific content. All elective courses are to be chosen in consultation with a faculty advisor in the Department of Mathematical Sciences.

# Applied Mathematics Minor

| | | |
|---|---|---|
| MATH 222 | Differential Equations | 4 |
| MATH 244 | Introduction to Probability Theory | 3 |
| or MATH 333 | Probability and Statistics | |
| MATH 337 | Linear Algebra | 3 |
| Two courses approved by the minor coordinator | | 6-8 |
| **Total Credits** | | **16-18** |

More **information on this minor** can be found on the Mathematical Sciences website.

# Applied Statistics and Data Analysis Concentration

## B.S. in Mathematical Sciences, Applied Statistics and Data Analysis Concentration

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| Physical Education:GUR | | 1 |
| CS 113 | Introduction to Computer Science | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 213 | Calculus III B | 4 |
| MATH 227 | Mathematical Modeling | 4 |
| MATH 244 | Introduction to Probability Theory | 3 |
| CS 114 | Introduction to Computer Science II | 3 |
| Cultural History (lower level): GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 341 | Statistical Methods II | 3 |
| MATH 337 | Linear Algebra | 3 |
| CS 280<br>or CS 288 | Programming Language Concepts<br>or Intensive Programming in Linux | 3 |
| Social Science (lower level): GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 334 | Operations Research | 3 |
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 344 | Regression Analysis | 3 |
| CS 431 | Database System Design and Management | 3 |
| Social Science (lower level): GUR Elective | | 3 |
| Management:GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MATH 345 | Multivariate Distributions | 3 |
| MATH 478 | Intro Stat Methods in Data Sci | 3 |
| Humanities and Social Sciences (upper level) Elective:GUR | | 3 |
| Technical Elective | | 3 |

| | | |
|---|---|---|
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MATH 448 | Stochastic Simulation | 3 |
| MATH 480 | Introductory Mathematical Analysis | 3 |
| 400+ level elective with advisor's approval | | 3 |
| Humanities and Social Sciences (upper level) Elective:GUR | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 477 | Stochastic Processes | 3 |
| Select one of the following: | | 3 |
| MATH 440 | Advanced Applied Numerical Methods | |
| MATH 477 | Stochastic Processes | |
| any other 400+ level elective with advisor's approval | | |
| Senior Seminar-Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Free Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **126** |

## General University Requirements and Electives

All students are required to satisfy the General University Requirements (GUR). All GUR courses and additional mathematics, technical, and free electives are to be selected in consultation with a faculty advisor in the Department of Mathematical Sciences. Refer to the General University Requirements (p. 93) section of this catalog for further information on electives.

## Co-op Courses

In Mathematical Sciences, the co-op courses, MATH 310 Co-op Work Experience I and MATH 410 Co-op Work Experience II, bear degree credit and count as technical or free electives, subject to approval by a faculty advisor in the Department of Mathematical Sciences.

## Electives

All electives should be selected after consultation with a Mathematical Sciences faculty advisor. Any NJIT course at or above the 100 level may be used as a technical or free elective; except a technical elective is a course that has a significant mathematical and/or scientific content. All elective courses are to be chosen in consultation with a faculty advisor in the Department of Mathematical Sciences.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Applied Statistics Minor

(16 - 17 credits)

| | | |
|---|---|---|
| MATH 222 | Differential Equations | 3-4 |
| or MATH 226 | Discrete Analysis | |
| MATH 333 | Probability and Statistics | 3 |
| MATH 337 | Linear Algebra | 3 |
| MATH 344 | Regression Analysis | 3 |
| Statistics course approved by the minor coordinator | | 4 |
| **Total Credits** | | **16-17** |

More **information on this minor** can be found on the Mathematical Sciences website (http://math.njit.edu/academics/undergraduate/minorinappliedstat.php).

# B.S. in Applied Mathematics and B.S. in Applied Physics

(130 Credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| CS 100<br>or CS 115 | Roadmap to Computing<br>or Intro. to CS I in C++ | 3 |
| CHEM 125 | General Chemistry I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| CHEM 126 | General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 213 | Calculus III B | 4 |
| MATH 244 | Introduction to Probability Theory | 3 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Social Science (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 335 | Vector Analysis | 3 |
| PHYS 335 | Introductory Thermodynamics | 3 |
| English Composition and Cultural History (lower-level): GUR | | 3 |
| Social Science (lower-level):GUR Elective | | 3 |
| Physical Education Elective | | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 337 | Linear Algebra | 3 |
| PHYS 430 | Classical Mechanics I | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| Select one of the following: | | 3-4 |
| MATH 227 | Mathematical Modeling | |
| Math 300+ Elective | | |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| Eng/Hist/Lit/Phil/STS:GUR Elective | | 3 |
| | **Term Credits** | **18-19** |
| **2nd Semester** | | |

| | | | |
|---|---|---|---|
| MATH 340 | Applied Numerical Methods | | 3 |
| MATH 331 | Introduction to Partial Differential Equations | | 3 |
| Physics/OPSE Elective | | | 3 |
| Physics/OPSE Elective | | | 3 |
| PHYS 433 | Electromagnetism II | | 3 |
| | **Term Credits** | | **15** |
| **Fourth Year** | | | |
| **1st Semester** | | | |
| MATH 480 | Introductory Mathematical Analysis | | 3 |
| PHYS 442 | Introduction to Quantum Mechanics | | 3 |
| MATH 473 | Intermediate Differential Equations | | 3 |
| Eng/Hist/Lit/Phil/STS/SS/THTR:GUR Elective | | | 3 |
| MATH 450H | | 3 | |
| | **Term Credits** | | **15** |
| **2nd Semester** | | | |
| Management:GUR Elective | | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR | | | 3 |
| PHYS 450 | Advanced Physics Laboratory | | 3 |
| MATH 451H | | 3 | |
| Phys/OPSE Elective [1] | | | 3 |
| | **Term Credits** | | **15** |
| | **Total Credits** | | **130-131** |

[1] This Phys/OPSE course must satisfy the Engineering Technology GUR requirement. Courses that meet this requirement are all OPSE courses, PHYS 443 Modern Optics, PHYS 444 Fluid and Plasma Dynamics, PHYS 481 Applied Solid State Physics: Microelectronics I, PHYS 482 Applied Solid State Physics: Microelectronics II and PHYS 485 Computer Modeling of Applied Physics Problems.

## General University Requirements and Electives

All students are required to satisfy the General University Requirements (GUR). All GUR courses and additional mathematics, technical, and free electives are to be selected in consultation with a faculty advisor in the Department of Mathematical Sciences. Refer to the General University Requirements (http://catalog.njit.edu/undergraduate/academic-policies-procedures/general-university-requirements) section of this catalog for further information on electives.

## Co-op Courses

In Mathematical Sciences, the co-op courses, MATH 310 Co-op Work Experience I and MATH 410 Co-op Work Experience II, bear degree credit and count as technical or free electives, subject to approval by a faculty advisor in the Department of Mathematical Sciences.

## Electives

All electives should be selected after consultation with a Mathematical Sciences faculty advisor. Any mathematics course numbered 331 or above may be used as a mathematics, technical, or free elective. Any NJIT course at or above the 100 level may be used as a technical or free elective; except a technical elective is a course that has a significant mathematical and/or scientific content. All elective courses are to be chosen in consultation with a faculty advisor in the Department of Mathematical Sciences.

# B.S. in Biology and B.S. in Mathematical Sciences

## Double Major in Biology and Mathematical Sciences

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| BIOL 200 | Concepts in Biology | 4 |
| CHEM 125 | General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| BNFO 135 | Programming for Bioinformatics | 3 |

| | | |
|---|---|---|
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| BIOL 205 | Foundations of Biology: Ecology and Evolution Lecture | 3 |
| BIOL 206 | Foundations of Biology: Ecology and Evolution Lab | 1 |
| BNFO 236 | Programming For Bioinfo II | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 211 | Calculus III A | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 337 | Linear Algebra | 3 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| Physical Education GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 340 | Applied Numerical Methods | 3 |
| Biology Elective - Functional Organism Lab | | 4 |
| Biology Elective - Ecology and Evolution | | 3 |
| English Composition and Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| MATH 373 | Introduction to Mathematical Biology | 3 |
| Laboratory Experience Elective | | 4 |
| Social Sciences (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MATH 333 | Probability and Statistics | 3 |
| MATH 450 | Methods Of Applied Math | 3 |
| MATH 480 | Introductory Mathematical Analysis | 3 |
| Biol Elective - Molecular and Cellular | | 3 |
| Biol Elective - Laboratory Experience | | 3 |

| | | |
|---|---|---|
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MATH 451 | Methods Appl Math II | 3 |
| MGMT 390 | Principles of Management | 3 |
| Math Biology Elective | | 3 |
| HSS Upper Level Elective | | 3 |
| Humanities and Social Sciences (upper-level) Capstone Seminar:GUR Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **132** |

# Computational Mathematics Concentration

## B.S. in Mathematical Sciences, Computational Mathematics Concentration

(125 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CS 100 | Roadmap to Computing | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 213 | Calculus III B | 4 |
| MATH 333 | Probability and Statistics [1] | 3 |
| MATH 337 | Linear Algebra | 3 |
| Select one of the following: | | 3-4 |
| PHYS 234 | Physics III | |
| CHEM 125 | General Chemistry I | |
| BIOL 200 | Concepts in Biology | |
| FIN 402 | Financial Risk Measurement and Management | |
| English Composition and Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **16-17** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 340 | Applied Numerical Methods | 3 |
| Social Science (lower-level) GUR Elective | | 3 |
| Application Elective | | 3 |

| | | |
|---|---|---|
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |
| MATH 391 | Numerical Linear Algebra | 3 |
| MATH 480 | Introductory Mathematical Analysis | 3 |
| Application Elective | | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| MATH 440 | Advanced Applied Numerical Methods | 3 |
| Select one of the following: | | 3 |
| MATH 341 | Statistical Methods II | |
| MATH 344 | Regression Analysis | |
| MATH 447 | Applied Time Series Analysis | |
| Application Elective | | 3 |
| Open Elective in Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MATH 448 | Stochastic Simulation | 3 |
| MATH 450H | 3 | |
| Technical Elective | | 3 |
| Management Elective | | 3 |
| Humanities and Social Sciences (upper-level) Capstone Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 451H | 3 | |
| MATH 453 | High-Performance Numerical Computing | 3 |
| Math 300+ Elective | | 3 |
| Technical Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **125-126** |

[1] Students may substitute MATH 244 Introduction to Probability Theory, with advisor approval; However, MATH 244 Introduction to Probability Theory does not satisfy the prerequisite requirements for either MATH 344 Regression Analysis or MATH 447 Applied Time Series Analysis.

Notes: Students are required to take 9 credits of application elective courses in a single area of specialization. Possible areas of specialization for application elective courses include: Biology, Chemistry, Computer Science, Economics/Finance, Physics, Statistics. Students interested in computer science and physics are encouraged to consider the double major programs. Technical electives are courses in any discipline with substantial mathematical content.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Computational Mathematics Minor

(16 hours)

| | | |
|---|---|---|
| MATH 222 | Differential Equations | 4 |

| | | |
|---|---|---|
| MATH 337 | Linear Algebra | 3 |
| MATH 340 | Applied Numerical Methods | 3 |
| Select two approved electives such as: | | 6 |
| MATH 321 | Introduction to the Finite Element Method | |
| MATH 391 | Numerical Linear Algebra | |
| MATH 440 | Advanced Applied Numerical Methods | |
| MATH 448 | Stochastic Simulation | |
| **Total Credits** | | **16** |

More information on this minor can be found on the Mathematical Sciences website (http://math.njit.edu/academics/undergraduate/minorincompumath.php).

# Mathematical Biology Concentration

## B.S. in Mathematical Sciences, Mathematical Biology Concentration

(125 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| Physical Education: GUR | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 213 | Calculus III B | 4 |
| MATH 227 | Mathematical Modeling | 4 |
| MATH 337 | Linear Algebra | 3 |
| R120 101 | General Biology | 4 |
| CHEM 125 | General Chemistry I | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 333 | Probability and Statistics | 3 |
| R120 102 | General Biology | 4 |
| ECON 201 | Economics | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |

| | | |
|---|---|---|
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 373 | Introduction to Mathematical Biology | 3 |
| R120 201 | Foundations Of Biology | 3 |
| English Composition and Cultural History (lower-level): GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 332 | Introduction to Functions of a Complex Variable | 3 |
| MATH 371 | Physiology and Medicine | 3 |
| Humanities and Social Sciences (upper-level) Elective:GUR | | 3 |
| Free Elective | | 3 |
| Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MATH 430 | Analytical and Computational Neuroscience | 3 |
| MATH 450H | 3 | |
| MATH 480 | Introductory Mathematical Analysis | 3 |
| Free Elective | | 3 |
| Management: GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 451H | 3 | |
| MATH 481 | Advanced Calculus | 3 |
| Technical Elective | | 3 |
| Senior Seminar-Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **125** |

## General University Requirements and Electives

All students are required to satisfy the General University Requirements (GUR). All GUR courses and additional mathematics, technical, and free electives are to be selected in consultation with a faculty advisor in the Department of Mathematical Sciences. Refer to the General University Requirements (p. 93) section of this catalog for further information on electives.

## Co-op Courses

In Mathematical Sciences, the co-op courses, MATH 310 Co-op Work Experience I and MATH 410 Co-op Work Experience II, bear degree credit and count as technical or free electives, subject to approval by a faculty advisor in the Department of Mathematical Sciences.

## Electives

All electives should be selected after consultation with a Mathematical Sciences faculty advisor.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Mathematical Biology Minor

(16 hours)

| | | |
|---|---|---|
| MATH 222 | Differential Equations | 4 |
| MATH 337 | Linear Algebra | 3 |
| MATH 373 | Introduction to Mathematical Biology | 3 |
| Select two approved electives such as: | | 6 |
| MATH 371 | Physiology and Medicine | |
| MATH 372 | Population Biology | |

| | | |
|---|---|---|
| MATH 430 | Analytical and Computational Neuroscience | |
| MATH 431 | Systems Computational Neuroscience | |
| **Total Credits** | | **16** |

More **information on this minor** can be found on the Mathematical Sciences website (http://math.njit.edu/academics/undergraduate/minorinmathbiology.php).

# Mathematics of Finance and Actuarial Science Concentration

## B.S. in Mathematical Sciences, Mathematics of Finance and Actuarial Science Concentration

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 111 | Calculus I | 4 |
| CS 100 | Roadmap to Computing | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 112 | Calculus II | 4 |
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **17** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 213 | Calculus III B | 4 |
| MATH 227 | Mathematical Modeling | 4 |
| MATH 244 | Introduction to Probability Theory | 3 |
| ECON 265 | Microeconomics | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 337 | Linear Algebra | 3 |
| MATH 341 | Statistical Methods II | 3 |
| ECON 266 | Macroeconomics | 3 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 447 | Applied Time Series Analysis | 3 |
| MATH 346 | Mathematics of Finance I | 3 |
| MATH 345 | Multivariate Distributions | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| Humanities and Social Sciences (upper-level) Elective:GUR | | 3 |

| | | |
|---|---|---|
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MATH 331 | Introduction to Partial Differential Equations | 3 |
| MATH 344 | Regression Analysis | 3 |
| MATH 347 | Mathematics of Finance II | 3 |
| Senior Seminar-Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Management:GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Mathematics 400+ Elective | | 3 |
| MATH 432 | Mathematics of Financial Derivatives I (Capstone I) | 3 |
| FIN 416<br>or R390 330 | Advanced Corporate Finance<br>or Corporate Finance | 3 |
| Select one of the following electives: | | 3 |
| MATH 440 | Advanced Applied Numerical Methods | |
| MATH 441 | Actuarial Mathematics I | |
| MATH 442 | Actuarial Mathematics II | |
| MATH 480 | Introductory Mathematical Analysis | |
| MATH 481 | Advanced Calculus | |
| FIN 401 | Securities in Financial Markets | |
| FIN 402 | Financial Risk Measurement and Management | |
| FIN 422 | International Finance | |
| FIN 423 | Risk Analysis | |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 477 | Stochastic Processes | 3 |
| MATH 448 | Stochastic Simulation | 3 |
| MATH 433 | Mathematics of Financial Derivatives II (Capstone II) | 3 |
| Select one of the following electives: | | 3 |
| MATH 440 | Advanced Applied Numerical Methods | |
| MATH 441 | Actuarial Mathematics I | |
| MATH 442 | Actuarial Mathematics II | |
| MATH 480 | Introductory Mathematical Analysis | |
| MATH 481 | Advanced Calculus | |
| FIN 401 | Securities in Financial Markets | |
| FIN 402 | Financial Risk Measurement and Management | |
| FIN 422 | International Finance | |
| FIN 423 | Risk Analysis | |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **129** |

## General University Requirements and Electives

All students are required to satisfy the General University Requirements (GUR). All GUR courses and additional mathematics, technical, and free electives are to be selected in consultation with a faculty advisor in the Department of Mathematical Sciences. Refer to the General University Requirements (p. 93) section of this catalog for further information on electives.

### Co-op Courses

In Mathematical Sciences, the co-op courses, MATH 310 Co-op Work Experience I and MATH 410 Co-op Work Experience II, bear degree credit and count as technical or free electives, subject to approval by a faculty advisor in the Department of Mathematical Sciences.

### Electives

All electives should be selected after consultation with a Mathematical Sciences faculty advisor. Any mathematics course numbered 331 or above may be used as a mathematics, technical, or free elective. Any NJIT course at or above the 100 level may be used as a technical or free elective; except a technical elective is a course that has a significant mathematical and/or scientific content. All elective courses are to be chosen in consultation with a faculty advisor in the Department of Mathematical Sciences.

# Mathematics of Finance and Actuarial Science Minor

(16 hours)

| | | |
|---|---|---|
| MATH 222 | Differential Equations | 4 |
| MATH 340 | Applied Numerical Methods | 3 |
| MATH 346 | Mathematics of Finance I | 3 |
| Select two approved electives such as: | | 6 |
| MATH 334 | Operations Research | |
| MATH 347 | Mathematics of Finance II | |
| MATH 432 | Mathematics of Financial Derivatives I (Capstone I) | |
| MATH 433 | Mathematics of Financial Derivatives II (Capstone II) | |
| MATH 441 | Actuarial Mathematics I | |
| MATH 448 | Stochastic Simulation | |
| MATH 477 | Stochastic Processes | |
| **Total Credits** | | **16** |

More **information on this minor** can be found on the Mathematical Sciences website (http://math.njit.edu/academics/undergraduate/minorinmathfacts.php).

# Physics

With a primary focus on applied physics, the department offers research-intensive programs at the undergraduate and graduate levels to prepare students for professional careers and to foster the scientific literacy that informed citizens need in the 21stare at the forefront of research areas that include solar physics, photonics, imaging and optical science, biophysics, material science, and microelectronics. In solar physics, NJIT's Big Bear Observatory in California is the most powerful ground-based optical telescope dedicated to the study of the Sun and the terrestrial impact of phenomena such as solar flares. Members of the Physics Department (http://physics.njit.edu) are also at the leading-edge of solar radio astronomy, at the Owens Valley Expanded Solar Array in California.

## NJIT Faculty

### A

Ahn, Keun Hyuk, Associate Professor

Ahn, Kwangsu, Assistant Research Professor

### C

Cao, Wenda, Associate Professor

Chin, Ken K., Professor

Chen, Bin, Assistant Professor

### D

Delahoy, Alan E., Research Professor

Deng, Na, Research Professor

Dias, Cristiano Luis, Assistant Professor

## F

Farrow, Reginald C., Research Professor

Federici, John F., Distinguished Professor

Fleishman, Gregory David, Distinguished Research Professor

## G

Gary, Dale E., Distinguished Professor

Gatley, Ian, Distinguished Professor

Georgiou, George E., University Lecturer

Gerrard, Andrew J., Professor

Gokce, Oktay Huseyin, Senior University Lecturer

Goode, Philip R., Distinguished Research Professor

## J

Janow, Richard H., University Lecturer

Jerez, Andres, University Lecturer

Jing, Ju, Research Professor

## K

Kosovichev, Alexander G., Professor

## L

Lanzerotti, Louis J., Distinguished Research Professor

Levy, Roland A., Distinguished Professor

Liu, Chang, Research Professor

## M

Maljian, Libarid A., University Lecturer

## N

Nita, Gelu M., Research Professor

## O

Opyrchal, Halina, Senior University Lecturer

## P

Piatek, Slawomir, Senior University Lecturer

Prodan, Camelia, Associate Professor

## R

Ravindra, N. M., Professor

Russo, Onofrio L., Associate Professor

## S

Shneidman, Vitaly A., Senior University Lecturer

Sirenko, Andrei, Professor

### T

Thomas, Benjamin, Assistant Professor

Thomas, Gordon A., Professor

Towfik, Nissim M., Associate Professor

Tyson, Trevor A., Distinguished Professor

### V

Varsik, John R., Research Professor

### W

Wang, Haimin, Distinguished Professor

### X

Xu, Yan, Research Professor

### Y

Yurchyshyn, Vasyl, Research Professor

### Z

Zhou, Tao, Associate Professor

## Programs

- Applied Physics - B.S. (p. 422)
- Biophysics - B.S. (p. 425)

## Accelerated Programs (p. 92)

- Applied Physics - B.S./M.D. (p. 420)

## Double Majors (p. 92)

- Applied Mathematics and Applied Physics - B.S. (p. 405)
- Computer Science and Applied Physics - B.S. (p. 207)

## Physics Courses

**PHYS 102. General Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. Intended for students in architecture, computer science (B.A. only), STS and other disciplines requiring laboratory science electives. Elementary statics and dynamics. Subjects discussed are kinematics, Newton's laws of motion, energy, momentum, conservation principles, and mechanical properties of matter. Lab must be taken concurrently.

**PHYS 102A. General Physics Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: None. This course is the laboratory component of PHYS 102 and must be taken concurrently.

**PHYS 103. General Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 102 with grade of C or better. A continuation of PHYS 102 for students in architecture, computer science (B.A. only), STS and other disciplines requiring laboratory science electives. Topics discussed are heat, thermodynamics, sound, wave motion, illumination, geometric and physical optics, and color. Lab must be taken concurrently.

**PHYS 103A. General Physics Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: PHYS 102 with grade of C or better. This course is the laboratory component of PHYS 103 and must be taken concurrently.

**PHYS 111. Physics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 131; Corequisite: MATH 111 or MATH 132. Elementary mechanics with an emphasis on the fundamental concepts and laws of mechanics, especially the conservation laws. Topics are scalar and vector quantities of mechanics; rectilinear and circular motion; equilibrium and Newton's laws of motion; work, energy, momentum; the conservation laws. Lab must be taken concurrently. See PHYS 111A.

**PHYS 111A. Physics I Laboratory. 1 credit, 2 contact hours (0;2;0).**
Corequisite: MATH 111. Laboratory component of PHYS 111. Lab must be taken concurrently with PHYS 111.

**PHYS 114. Introduction to Data Reduction with Applications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 131; Corequisite: MATH 111 or MATH 132. Physics majors only. An introduction to both the theory and application of error analysis and data reduction methodology. Topics include the binomial distribution and its simplification to Gaussian and Poisson probability distribution functions, estimation of moments, and propagation of uncertainty. Forward modeling, including least-squares fitting of linear and polynomial functions are discussed. The course enables students to apply the concepts of the data reduction and error analysis using data analysis software to real data sets found in the physical sciences.

**PHYS 121. Physics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 111 with a grade of C or better. MATH 111 or 132. Co-requisite: MATH 112 or MATH 133. This course deals with an introduction to electricity and magnetism. Topics include simple dc circuits, the electric field, the magnetic field, electric potential, capacitance relationships between electric and magnetic fields, inductance, and simple ac circuits. Lab must be taken concurrently. See PHYS 121A.

**PHYS 121A. Physics II Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisites: PHYS 111 and MATH 111 all with grade of C or better. Corequisite: MATH 112.

**PHYS 202. Introductory Astronomy and Cosmology. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. A non-mathematical presentation of contemporary views of the origin, evolution, and structure of the solar system, stars, galaxies, and the universe. Special topics include neutron stars, black holes, gravitationally strange objects, and the ?big bang.?.

**PHYS 202A. Astronomy and Cosmology Laboratory. 1 credit, 2 contact hours (0;2;0).**
Corequisite: PHYS 202. Includes demonstration of physical principles applicable to astronomy. Use of telescope for lunar, solar and planetary observations.

**PHYS 203. The Earth in Space. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: None. Introduces fundamental phenomena, such as plate tectonics, erosion, volcanism, and glaciation. Studies the interaction between the Earth's four major reservoirs?atmosphere, hydrosphere, biosphere and solid earth; investigates the dependence of the Earth on the Sun; the effect of the Moon on the Earth. Extends knowledge gained from studying the Earth to other planets in this solar system.

**PHYS 203A. The Earth in Space Laboratory. 1 credit, 2 contact hours (0;2;0).**
Corequisite: PHYS 203. Optional laboratory course associated with PHYS 203.

**PHYS 204. Biophysics of Life. 3 credits, 3 contact hours (3;0;0).**
A non-mathematical view of how living entities work in terms of the basic concepts of physics. The course will discuss how these concepts underline topics ranging from birth to death, from touch to pleasure, from vision to beauty, and from a thought to a heartbeat.

**PHYS 231A. Physics III Laboratory. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: PHYS 121 and MATH 112, all with grade of C or better.

**PHYS 231H. Physics III Honors. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: PHYS 121 or PHYS 121H and MATH 112 or MATH 112H, all with grade of C or better. Third semester of a three-semester program in Honors Physics. Physical optics is treated in greater detail. Modern physics includes a greater number of topics, with special emphasis on the wave-particle duality in nature. Lab must be taken concurrently. See PHYS 231A.

**PHYS 234. Physics III. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 112. Elements of simple harmonic motion, wave motion, geometric and physical optics are considered. The wave and particle duality of nature is emphasized and made plausible by an examination of the important experiments and theories which lead to the modern concepts of matter and radiation. The conservation laws are broadened to include the equivalence of mass and energy.

**PHYS 310. Introduction to Atomic and Nuclear Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234; MATH 222, all with grade of C or better. Selected topics in atomic physics including the Pauli Exclusion Principle and the Atomic Shell Model. In nuclear physics, the two-body problem, nuclear models, alpha, beta, and gamma radiation, acclerators, and nuclear detectors are studied. R750 403 may be substituted for this course.

**PHYS 311. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Acceptance into the co-op program. Students gain major-related experience and reinforcement of the academic program. Work assignments are facilitated and approved by the Office of Cooperative Education and Internships. Participation in seminars and a final report/project is mandatory. Note: Normal grading applies to this COOP Experience.

**PHYS 320. Astronomy and Astrophysics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121, with grade of C or better. A quantitative introduction to the astronomy of the sun, earth, and solar system, with an emphasis on the physical principles involved. Includes celestial mechanics, planetary atmospheres and the physics of comets, asteroids and meteorites.

**PHYS 321. Astronomy and Astrophysics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 320, with grade of C or better. A quantitative introduction to the astronomy of the stars, the galaxy, and cosmology, with an emphasis on the physical principles involved. Includes stellar interiors, stellar evolution, galactic dynamics, large-scale structure and early history of the universe.

**PHYS 322. Observational Astronomy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 320, with grade of C or better. Most class time is spent in an observatory performing observations of celestial objects such as the Sun, Moon, planets, stars, stellar clusters, and galaxies. Experimental projects include charting the skies, asterophotography (film and CCD), measuring masses of planets, rotational period of the Sun, topography of the Moon, H-R diagrams of stellar clusters, etc.

**PHYS 335. Introductory Thermodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 211 or MATH 213, all with grade of C or better. Corequisites: MATH 222, MATH 238 or MATH 335. Introductory thermodynamics, kinetic theory, statistical physics. Topics include equations of state, the three laws of thermodynamics, reversible and irreversible processes. R750 315 may be substituted for this course.

**PHYS 350. Biophysics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 121 with a grade of C or better. This course presents an introduction to general biophysics and a preparation for medical school and biotechnology careers. It features molecules, viruses and cells racing to form enormous electric fields, succumbing to diseases and creating life. It explains how key medical devices preserve life. It asses students? progress using questions just like those on the medical school entrance exams and seeks an understanding of a few, simple principles of life science.

**PHYS 390. Selected Topics of Current Interest in Physics. 1 credit, 1 contact hour (1;0;0).**
Prerequisite: PHYS 234 with grade of C or better. Seminar covering topics that are currently in the forefront of physics. The lecture series offers exposure to such topics as nuclear physics, solid state physics, plasma physics, the special and general theories of relativity, and the history and philosophy of science.

**PHYS 411. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: PHYS 311, with grade of C or better, and acceptance into the co-op program. Provides for co-op work assignments which must be approved by the Office of Cooperative Education and Internships. Participation in seminars and a final -report/project are mandatory. Note: Normal grading applies to this COOP Experience.

**PHYS 418. Fundamentals of Optical Imaging. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: PHYS 234 or PHYS 231, with grade of C or better. This is a course with both lectures and experiments and the emphasis is on the hands-on experiences. Upon completion of the course, students should not only grasp the basic concepts involved in imaging science, but also be able to work on simple real world imaging systems. The main content of the lecture part of this course can be summarized as the following: Optical sources, detectors and their working mechanism; Image formation and transmission; Optical imaging system and their characteristics; Imaging processing and algorithms. This course is developed in close collaboration with Edmund Optics Inc.

**PHYS 420. Special Relativity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 and MATH 222, all with grade of C or better. An introduction to Einstein's Special Theory of Relativity at the advanced undergraduate level. Topics include invariance of the speed of light, relativity of time and space, the Lorentz transformations, space-time diagrams, the twin paradox and time travel, relativistic mechanics, rotating reference frames, laser gyroscopes, superluminal motion, phase and group velocities, and applications in high-energy physics, relativistic engineering, nuclear physics, astrophysics, and cosmology.

**PHYS 421. General Relativity. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 and MATH 222, all with grade of C or better. An introduction to Einstein's General Theory of Relativity at the advanced undergraduate level. Topics include review of Newton's Theory of Gravitation, review of Einstein's Special Theory of Relativity, tensor calculus on both flat and curved manifolds, the covariant derivative, curvature, Einstein's Gravitational Field Equations, the weak-field limit, gravitational radiation, the black hole solution, Hawking radiation, the No-Hair Theorem, cosmology, and a history of the Universe.

**PHYS 430. Classical Mechanics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 and MATH 222 and MATH 328 or MATH 335, all with grade of C or better. Newtonian mechanics of particles and systems. Lagrange's and Hamilton's approaches. Continuous systems. R750 361 may be substituted for this course.

**PHYS 431. Classical Mechanics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 430, with grade of C or better. Theory of small oscillations and mechanical waves. Rigid bodies. Topics include stability, linearization methods, forced vibrators and perturbation theory, fluids and mechanics of continuous media. 21&62 750 362 may be substituted for this course.

**PHYS 432. Electromagnetism I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H and Math 328 or Math 335, all with grade of C or better. Electrostatics and magnetostatics, Maxwell's equations with applications, and electrodynamics.

**PHYS 433. Electromagnetism II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 432, with grade of C or better. Maxwell's equations with applications and electrodynamics.

**PHYS 441. Modern Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222 , all with grade of C or better. Topics include wave-particle duality, wave mechanics, two-state quantum systems, the motion of an electron in a periodic lattice, band theory of solids, electrical, thermal and magnetic properties of solids, and plasmas and super fluid systems. R750 316 may be substituted for this course.

**PHYS 442. Introduction to Quantum Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 430, with grade of C or better. Wave-particle duality, the Schrodinger and Heisenberg formulations of quantum mechanics. The hydrogen atom, perturbation theory, and concepts of degeneracy, composite states and general properties of eigenfunctions. R750 404 may be substituted for this course.

**PHYS 443. Modern Optics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with a grade of C or better. Electromagnetic theory of light, interference, diffraction, polarization, absorption, double refraction, scattering, dispersion, aberration, and an introduction to quantum optics. Other topics include holography, lasers, information retrieval, spatial filtering, and character recognition.

**PHYS 444. Fluid and Plasma Dynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222 , all with grade of C or better. Introduces the basics of plasma physics. Covers the following plasma parameters, single particle motions, plasma as fluid, waves, diffusion and resistivity, equilibrium and instability, kinetic theory, nonlinear effects. Applications in three areas: controlled fusion, astrophysics, and interaction between light and plasma.

**PHYS 446. Solid State Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222, with grade of C or better. Corequisite: PHYS 442. An introduction to modern concepts of the solid state. Topics include crystal structure and diffraction, crystal binding and elastic properties, thermal properties, dielectric phenomena, band theory of solids and Fermi surfaces, electrical conductors, semiconductors, magnetism, and super-conductivity. R750 406 may be substituted for this course.

**PHYS 450. Advanced Physics Laboratory. 3 credits, 5 contact hours (1;4;0).**
Prerequisites: PHYS 335, PHYS 430, PHYS 432, all with grade of C or better. Introduction to electrical measurements; instrumentation; theoretical and applied electronics, solid state electronic devices, digital circuitry; computer design; experiments in modern physics.

**PHYS 451. Biophysics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121 with a grade of C or better. An introduction to electrical aspects of biophysics and a preparation for medical school and biotechnology careers. Covering how medical devices work and using active learning with reports on new research.

**PHYS 452. Atomic and Nuclear Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with grade of C or better. Topics include atomic spectra, atomic structure, and nuclear physics.

**PHYS 456. Introduction to Solid State Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with grade of C or better. Treats the same topics as PHYS 446 while introducing the necessary modern physics. Designed for students choosing a minor in applied physics. Students majoring in applied physics are ineligible.

**PHYS 461. Mathematical Methods of Theoretical Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 430, PHYS 432, PHYS 433, all with grade of C or better. Topics include vector and tensor analysis, matrix methods, complex variables, Sturm-Liouville theory, special functions, Fourier series and integrals, integral equations, and numerical solutions of differential equations.

**PHYS 480. Topics in Applied Physics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Permission of instructor. Current topics and interests in applied physics and physics. Emphasis is on research and scientific development in microelectornics, optoelectronics, optical physics, materials science, surface science, solar physics, and modern physics.

**PHYS 481. Applied Solid State Physics: Microelectronics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 446, with grade of C or better. Topics include physics of bipolar and field effect devices, Phonon and optical spectra, unipolar devices, and thermal and high field properties of semiconductor devices.

**PHYS 482. Applied Solid State Physics: Microelectronics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 446, with grade of C or better. Topics include large-scale integrated circuits, device characteristics, charge-coupled devices, LED and semiconductor lasers, photodetectors, and electrical and optical properties of materials.

**PHYS 483. Applied Solid State Physics. 3 credits, 6 contact hours (0;6;0).**
Prerequisite: PHYS 446, with grade of C or better. Introduction to digital concepts; binary circuits and microprocessor architecture. Applications of discrete solid-state devices and integrated circuits are explored both in theory and practice. The laboratory also serves as an introduction to hardware and software components of a typical microcomputer.

**PHYS 485. Computer Modeling of Applied Physics Problems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 234 or PHYS 231 and MATH 222, all with grade of C or better. General computer programming modeling methods and techniques. Numerical solutions to integro-differential equations. Eigenvalues problems. Application of computer-aided-design and other packages. R750 461 may be substituted for this course.

**PHYS 490. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Departmental approval. Undertake individual research or a project under the supervision of a member of the physics department. 21&62 750 485, 486 may be substituted for this course.

**PHYS 491. Independent Study II. 3 credits, 3 contact hours (0;0;3).**

## Rutgers-Newark Courses

**R750 109. Astronomy & Cosmology. 3 credits, 3 contact hours (3;0;0).**

**R750 110. Astronomy & Cosmology. 3 credits, 3 contact hours (3;0;0).**

**R750 131. Elements Of Physics. 3 credits, 0 contact hours (0;0;0).**

**R750 133. Elements Of Physics Lab. 1 credit, 1 contact hour (0;1;0).**

**R750 202. Physics As Librl Art. 3 credits, 0 contact hours (0;0;0).**

**R750 203. General Physics I. 4 credits, 3 contact hours (3;0;0).**

**R750 204. General Physics II. 4 credits, 4 contact hours (4;0;0).**

**R750 205. Intro Physics Lab. 1 credit, 1 contact hour (0;1;0).**

**R750 206. Intro To Physics Lab. 1 credit, 1 contact hour (0;1;0).**

**R750 213. Univ Physics. 4 credits, 4 contact hours (4;0;0).**

**R750 214. Elements Of Physics. 4 credits, 4 contact hours (4;0;0).**

**R750 222. Dynamics. 3 credits, 3 contact hours (3;0;0).**

**R750 307. Computer Electronics. 4 credits, 4 contact hours (4;0;0).**

**R750 308. Computer Electronics. 3 credits, 0 contact hours (0;0;0).**

**R750 315. Intro Thermodynamics. 3 credits, 3 contact hours (3;0;0).**

**R750 316. Modern Physics. 3 credits, 3 contact hours (3;0;0).**

**R750 333. App Math To Physics. 3 credits, 3 contact hours (3;0;0).**

**R750 361. Mechanics I. 3 credits, 3 contact hours (3;0;0).**

**R750 362. Mechanics. 3 credits, 3 contact hours (3;0;0).**

**R750 364. Applied Math To Physics. 3 credits, 3 contact hours (3;0;0).**

**R750 385. Elec-Magn Fields & Waves. 3 credits, 3 contact hours (3;0;0).**

**R750 386. Elec-Magn Flds & Waves. 3 credits, 3 contact hours (3;0;0).**

**R750 396. Trumpet. 1 credit, 0 contact hours (0;0;0).**

**R750 403. Intro Atom & Nucl Phys. 3 credits, 3 contact hours (3;0;0).**

**R750 404. Quantum Mechanics. 3 credits, 3 contact hours (3;0;0).**

**R750 406. Solid State Physics. 3 credits, 3 contact hours (3;0;0).**

**R750 407. Advancd Phys Lab I. 1 credit, 0 contact hours (0;0;0).**

**R750 408. Adv Physics Lab II. 1 credit, 1 contact hour (0;1;0).**

**R750 410. Physical Electronics. 2 credits, 2 contact hours (2;0;0).**

**R750 411. Physical Optics. 3 credits, 3 contact hours (3;0;0).**

**R750 446. Solid State Physics. 3 credits, 0 contact hours (0;0;0).**

**R750 461. Computation Physics. 3 credits, 3 contact hours (3;0;0).**

**R750 462. Adv Math Meth In Phy. 0 credits, 0 contact hours (0;0;0).**

**R750 485. Individual Research. 1-3 credits, 3 contact hours (3;0;0).**

**R750 486. Individual Research. 3 credits, 0 contact hours (0;0;0).**

**R750 492. Physics Seminar. 1 credit, 1 contact hour (1;0;0).**

**R750 493. Readings In Physics. 3 credits, 3 contact hours (3;0;0).**

**R750 494. Reading In Physics. 3 credits, 3 contact hours (3;0;0).**

# Accelerated B.S. in Applied Physics/M.D.

(115 credits)

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| R120 101 | General Biology | 4 |
| CHEM 125 | General Chemistry I | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| R120 102 | General Biology | 4 |
| Social Science (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **19** |
| **Summer** | | |
| CS 113 or CS 115 | Introduction to Computer Science or Intro. to CS I in C++ | 3 |
| MATH 211 | Calculus III A | 3 |
| | **Term Credits** | **6** |
| **Second Year** | | |
| **1st Semester** | | |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| R120 201 | Foundations Of Biology | 3 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| CHEM 243 | Organic Chemistry I | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MATH 328 | Mathematical Methods for Scientists and Engineers | 3 |
| MATH 222 | Differential Equations | 4 |
| Social Science (lower-level):GUR Elective | | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| PHYS 335 | Introductory Thermodynamics | 3 |
| | **Term Credits** | **17** |
| **Summer** | | |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Management:GUR Elective | | 3 |
| | **Term Credits** | **6** |
| **Third Year** | | |
| **1st Semester** | | |
| Physical Education:GUR Elective | | 1 |
| PHYS 430 | Classical Mechanics I | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| OPSE 301 | Introduction to Optical Science and Engineering | 3 |

| | | |
|---|---|---|
| PHYS 350 | Biophysics I | 3 |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| PHYS 451 | Biophysics II | 3 |
| OPSE 410 | Biophotonics | 3 |
| Capstone Semina Humanities and Social Sciences (upper-level)r:GUR Elective | | 3 |
| PHYS 433 | Electromagnetism II | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **114** |

Refer to the **General University Requirements** for further information on GUR electives

## Co-op

Co-op courses bearing degree credit replace a technical elective or another course approved by the faculty advisor in the students major department. In applied physics, both PHYS 311 Co-op Work Experience I and PHYS 411 Co-op Work Experience II are taken for degree Credit with permission.

# B.S. in Applied Physics

## Bachelor of Science in Applied Physics - Astronomy Option

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| CS 113<br>or CS 115 | Introduction to Computer Science<br>or Intro. to CS I in C++ | 3 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 211 | Calculus III A | 3 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| Social Science (lower-level):GUR Elective | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **15** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 328 | Mathematical Methods for Scientists and Engineers | 3 |
| PHYS 335 | Introductory Thermodynamics | 3 |
| Social Science (lower-level):GUR Elective | | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| PHYS 418 | Fundamentals of Optical Imaging | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| PHYS 320 | Astronomy and Astrophysics I | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| PHYS 430 | Classical Mechanics I | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| PHYS 433 | Electromagnetism II | 3 |
| PHYS 321 | Astronomy and Astrophysics II | 3 |
| Math Elective | | 3 |
| Capstone Seminar:GUR Elective | | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Math/Phys/CS Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| PHYS 420 | Special Relativity | 3 |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| Math/Phys/CS Elective | | 3 |
| Technical Elective | | 3 |
| Management:GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| PHYS 322 | Observational Astronomy | 3 |
| PHYS 421 | General Relativity | 3 |
| PHYS 450 | Advanced Physics Laboratory | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

# Electives

## Math/Phys/CS

Consult the physics department for information about qualifying courses.

## Technical

Consult the physics department for information about qualifying courses.

Refer to the **General University Requirements** for further information on GUR electives.

# Co-op Courses

Co-op courses bearing degree credit replace a technical elective or another course approved by the faculty advisor in the students major department. In applied physics, both PHYS 311 Co-op Work Experience I and PHYS 411 Co-op Work Experience II are taken for degree Credit with permission.

# Bachelor of Science in Applied Physics - Optical Science and Engineering Option

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| CS 113<br>or CS 115 | Introduction to Computer Science<br>or Intro. to CS I in C++ | 3 |
| CHEM 125 | General Chemistry I | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| CHEM 126 | General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 211 | Calculus III A | 3 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| Social Science (lower-level):GUR Elective | | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 328 | Mathematical Methods for Scientists and Engineers | 3 |
| MATH 335 | Vector Analysis | 3 |
| Social Sciences (lower-level):GUR Elective | | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| OPSE 301 | Introduction to Optical Science and Engineering | 3 |
| PHYS 418 | Fundamentals of Optical Imaging | 3 |
| PHYS 430 | Classical Mechanics I | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| PHYS 433 | Electromagnetism II | 3 |
| PHYS 446 | Solid State Physics | 3 |
| OPSE 402 | High Power Laser and Photonics Applications | 3 |
| Free Elective | | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |

| | | |
|---|---|---|
| Phys/OPSE Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| Technical Elective | | 3 |
| Management Elective | | 3 |
| Technical Elective | | 3 |
| Phys/OPSE/EE Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| OPSE 310 | Virtual Instrumentation | 3 |
| PHYS 450 | Advanced Physics Laboratory | 3 |
| Phys/EE Elective | | 3 |
| Technical Elective | | 3 |
| Capstone Seminar Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

## Electives

### Phys/OPSE

Consult the physics department for information about qualifying courses.

### Math/Phys/CS

Consult the physics department for information about qualifying courses.

### Math/Phys/EE/CS

Consult the physics department for information about qualifying courses.

### Technical

Consult the physics department for information about qualifying courses.

Refer to the **General University Requirements** for further information on GUR electives.

## Co-op Courses

Co-op courses bearing degree credit replace a technical elective or another course approved by the faculty advisor in the students major department. In applied physics, both PHYS 311 Co-op Work Experience I and PHYS 411 Co-op Work Experience II are taken for degree Credit with permission.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Biophysics

(127 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| MATH 111 | Calculus I | 4 |
| CS 113<br>or CS 115 | Introduction to Computer Science<br>or Intro. to CS I in C++ | 3 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |

| | | |
|---|---|---|
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| PHYS 114 | Introduction to Data Reduction with Applications | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MATH 112 | Calculus II | 4 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| R120 101 | General Biology | 4 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| PHYS 234 | Physics III | 3 |
| PHYS 231A | Physics III Laboratory | 1 |
| CHEM 243 | Organic Chemistry I | 3 |
| MATH 211 | Calculus III A | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 328 | Mathematical Methods for Scientists and Engineers | 3 |
| PHYS 335 | Introductory Thermodynamics | 3 |
| R120 201 | Foundations Of Biology | 3 |
| R120 202 | Foundations Of Biology Lab | 1 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| R120 102 | General Biology | 4 |
| PHYS 430 | Classical Mechanics I | 3 |
| PHYS 432 | Electromagnetism I | 3 |
| Social Sciences (lower-level):GUR Elective | | 3 |
| Social Sciences (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| OPSE 310 | Virtual Instrumentation | 3 |
| PHYS 433 | Electromagnetism II | 3 |
| R120 360 | Biochemistry | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| English Composition and Cultural History (lower-level):GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Open Elective in Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| PHYS 442 | Introduction to Quantum Mechanics | 3 |
| PHYS 418 | Fundamentals of Optical Imaging | 3 |
| 300 or 400 level Physics Elective | | 3 |

| | | |
|---|---|---|
| PHYS 350 | Biophysics I | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Management:GUR Elective | | 3 |
| PHYS 451 | Biophysics II | 3 |
| PHYS 450 | Advanced Physics Laboratory | 3 |
| OPSE 410 | Biophotonics | 3 |
| Humanities and Social Sciences (upper-level) Capstone Seminar:GUR Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

## GUR Electives

Refer to the **General University Requirement** section of this catalog for further information on GUR electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Interdisciplinary Programs



# Environmental Studies and Sustainability Minor

(15 credits)

Five courses in environmental studies and sustainability approved by the minor coordinator

More **information on this minor** can be found on the College of Science and Liberal Arts website (http://csla.njit.edu/cslaprograms/ess).

# Newark College of Engineering

One of the oldest and largest professional engineering schools in the United States, Newark College of Engineering offers 13 undergraduate degree programs, 16 master’s and 10 doctoral degree programs. Undergraduate enrollment is more than 2,500, and more than 1,100 are enrolled in graduate study. The 150-member faculty includes engineers and scholars who are widely recognized in their fields.

## Programs

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- Engineering Technology, Mechanical Engineering Technology (MET) - B.S. (p. 528)
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- Biomedical Engineering Minor (p. 469) (for Engineering Science students)
- Chemistry Minor (p. 476) (for Chemical Engineering majors)
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## Programs



## Newark College of Engineering Courses

**BME 101. Introduction to Biomedical Engineering. 0 credits, 3 contact hours (3;0;0).**
This course is open only to freshmen and new transfer students. Faculty members describe their research in biomedical engineering.

**BME 102. Biomedical Engr Research. 1 credit, 1 contact hour (1;0;0).**
Corequisite: FED 101 OR BME 111 Students at our prehealth program aim to be in medical practice. This course offers them to critically read medical engineering articles, understand it, research it and present engineering design principles to our faculty. This will enhance their ability to both succeed professionally and to contextualize their chosen vocations.

**BME 105. Introduction to Human Physiology I. 2 credits, 2 contact hours (2;0;0).**

**BME 106. Introduction to Human Physiology II. 1 credit, 1 contact hour (1;0;0).**

**BME 111. Introduction to Physiology. 3 credits, 3 contact hours (3;0;0).**
This course is open only to freshmen and transfer students. An overview of human physiology is presented as an introduction to subsequent core courses in the Biomedical Engineering curriculum. Not intended to be an exhaustive review of physiology, the course will instead emphasize key examples that highlight understanding of the interaction between the biomedical and engineering worlds.

**BME 301. Electrical Fundamentals of Biomedical Engineering. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: Grade of C or higher in PHYS 121 and MATH 112. Course lectures and laboratories will address important issues for biomedical engineers at the introductory level; covering the origins of bio-electric signals and the instrumentation involved in collection of biopotentials from the electrodes to processing of the signals on the computer. Some other topics included are the transducers/sensors and modern engineering software used in bio-instrumentation. Laboratory work will provide hands-on experience in all of these areas. The course will also address practical issues in design of medical devices such as noise, resolution, linearity, and saturation. This course is offered in Studio format that involves the integration of lectures and labs into one highly participatory structure.

**BME 302. Mechanical Fundamentals of Biomedical Engineering. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: Grade of C or higher in PHYS 121 and MATH 112. BME 301 is not a prerequisite. The format is identical to that of BME 301. Course lectures and laboratories will address important issues covering the mechanical fundamentals that are important bases for later learning experiences. This course introduces the students to to engineering mechanics and how those principles are relevant to biomechanical issues. This course is offered in Studio format that involves the integration of lectures and labs into one highly participatory structure.

**BME 303. Biological and Chemical Foundations of Biomedical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Grade of C or higher in (CHEM 126 or CHEM 122) and PHYS 121. This course covers organic chemistry, biochemistry and cellular mechanics in sufficient depth to give biomedical engineering students a strong enough background for them to understand the introductory aspects of the discipline, which focus on the application of engineering principles to medicine and surgery.

**BME 304. Material fundamentals of Biomedical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: A Grade of C or higher in (CHEM 126 or CHEM 122) and BME 111.This course is an introduction to the field of biomaterials with an emphasis on the wound healing process and interactions between the human body and implanted devices fabricated from various types of biomaterials. The thrust of this course will be to illuminate the processes occurring at the tissue-biomaterial interface. Attention will be given to the biological events occurring at the molecular level on the surface of an implanted device. The nature of these surfaces and the physiological consequences of these processes will be examined in terms of how the body and functioning of the device are impacted.

**BME 310. Biomedical Computing. 3 credits, 4 contact hours (3;1;0).**
Prerequisite: Grade of C or higher in BME 111 and BME 301 and CS 101. This course covers the application of digtal signal processing to biomedical problems. Application of programming language common in engineering, for signal acquisition and processing. Applications include analysis of the electrocardiogram and other electrical signals generated by the body.

**BME 311. Co-op Work Experience. 3 credits, 3 contact hours (0;0;3).**
Restriction: sophomore standing or above, approval of department, and permission of Career Development Services. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**BME 321. Adv Mechanics for Biomed Engr. 3 credits, 3 contact hours (3;0;0).**
Prerequisite:BME 302 with a grade of C or better This course provides an understanding of engineering mechanics, especially as applied to biomechanical systems. Students should be familiar with static equilibrium analysis and concepts of stress and strain. Course topics include method of sections, area moment of inertia, mechanical properties of materials, torsion, bending, stress transformation, Mohr's circle, and deflection of beams.

**BME 333. Biomedical Signals and Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 310 and MATH 222. BME Tools such as the Laplace and Fourier Transforms, time-frequency analysis are introduced. Applications include signals and noise, processing of the ECG, mathematics of imaging and derivation of useful physiological parameters from input signals.

**BME 351. Introduction to Biofluid Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 111, BME 302, MECH 236 and MECH 320 all with a C or bettter. Introduction to the principles of fluid flow. Basic fluid principles, such as fluid properties, fluid statics, conservation of mass, momentum, and energy will be discussed and presented in BME context. Special attention will be given to the non-Newtonian nature of blood, viscous flow in arteries, unsteady flows, and to the fluidic output of the heart. The textbook material will be supplemented throughout the course to emphasize examples relative to BME.

**BME 372. Biomedical Electronics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite:BME 111 and BME 301 with a C or better. The first of a two-semester sequence that covers the design of electronic circuits for Biomedical applications. This course covers basic operational amplifier circuits as well as the operation of semiconductor diodes and transistors. An introduction to digital logic circuits is also provided. Computer simulation as well as hands-on breadboarding of electronic circuits are used throughout the course to supplement the lectures.

**BME 373. Biomedical Electronics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BME 372. This is a continuation of BME 372 emphasizing biomedical applications of oscillators, active filters, and wave-shaping circuits.

**BME 382. Engineering Models of Physiological Systems. 3 credits, 5 contact hours (5;0;0).**
Prerequisites: BME 111, BME 301, BME 302 and Math 222 all with a C or better. Students learn to develop quantitative models of organs and organ systems from an engineering viewpoint. Students translate their understanding of physiological systems into models that evolve dynamically based on engineering block diagrams. Additional topics include: hierarchical structure, sensitivity analysis, parameter estimation, negative feedback control, and characteristic traits of models. Students will use models to gain insight into how a physiological system functions and to design a biomedical engineering device or procedure that interacts with the physiological system. Systems studied include the cardiovascular system, gas exchange in the lungs, nerve and muscle action potentials, and musculo-skeletal spinal reflex.

**BME 383. Measurement Lab for Physiological Systems and Tissue. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: BME 302, BME 310, and (MATH 279 or MATH 333). Through laboratory experiences, students will apply engineering methods for measuring and interpretating the properties of physiological systems and biological tissues. Topics include measurements relevant to cardio-pulmonary, nerve and muscular systems.

**BME 384. Biomechanics Laboratory. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: BME 111, BME 302, MECH 236, MECH 320, CS 101 and MATH 279 all wtih a C or better. This course is an introduction to the experimental analysis of the biomechanics of human motion. Laboratory experiments include the application and integration of anatomical and mechanical concepts to a wide variety of activities. Students will develop basic competence in a systematic approach to the observation, analysis and evaluation of human movement in clinical, educational, and industrial environments.

**BME 385. Cell and Biomaterial Engineering Laborarory. 3 credits, 4 contact hours (1;3;0).**
Prerequisite: MATH 112, PHYS 121 BME 304 and (MATH 279 or MATH 333) all with a C or better. This laboratory course is designed to provide students with valuable hands-on experience in the field of cellular and biomaterial engineering. Experiments include biomaterial fabrication and characterization, mechanical testing of biomaterials, colorimetric protein assay, cell-based assay, the basics of cell culture techniques, the basics of light and electron microscopy, and image capture and analysis. A lecture on the principles of a given technique will be followed by laboratory activity.

**BME 386. Bioinstrumentation Laboratory. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: ECE 251, BME 372 and (MATH 279 or MATH 333). Laboratory exercises involve projects at all levels of a bioinstrumentation system from sensors to data acquisition and data processing. Analog and digital circuits are constructed to condition the signals from sensors and convert them into a format that can be displayed or acquired into a computer. The final projects help to develope the skills to integrate various parts of a bioinstrumentation system, collect and analyze data and troubleshoot a circuit.

**BME 411. Co-op Work Experience. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: BME 311 and completion of sophomore year, approval of department, and permission of Career Development Services. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report. May count as BME or approved elective. Grade will now be issued as a letter grade.

**BME 420. Advanced Biomaterials Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 302, BME 304, MATH 222 and MTSE 301. The goal of this course is to understand material selection, important properties of materials for use in the body and failure modes of applied biomaterials. The course will cover the structure and properties of materials used as biomaterials including metals, ceramics, synthetic polymers, and biopolymers. The structure of these materials will be explored to understand how it defines the behavior of a material. The bulk behavior of materials will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced (including thermal strain, surface properties, and viscoelasticity). Students will be presented with problems of property characterization, failure analysis and performance testing. Students will work in teams to analyze a marketed implant or device using biomaterial(s) using the tool and concepts learned in the course.

**BME 422. Biomaterials Characterization. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Math 112, Phys 121, BME 304 and MTSE 301 all with a C or better. The quantum mechanical origins of spectroscopy, the relationship of spectroscopic behavior to thermal characteristics of a material, and the differences in approach to the chemical and physical characterization of synthetic and biological polymers are discussed.

**BME 427. Biotransport. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222, (BME 303 or R120 102), and CHE 230. This course provided an introduction to basic concepts in thermodynamics and transport phenomena as applied to biological systems. The structure and composition of the body will be covered followed by an exploration of the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Design of artificial kidneys and heart-lung machines is also explored.

**BME 430. Fundamentals of Tissue Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BME 302, (BME 303 or R120 102), BME 304, MATH 222 and MTSE 301. This course is an introduction to the field of tissue engineering as a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated by delivering cells, scaffolds, DNA, proteins, and/or protein fragments at surgery. This course will cover the advances in the fields of cell biology, molecular biology, material science and their relationship towards developing novel "tissue engineered" therapies.

**BME 451. Biomechanics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 302, MECH 236 and MECH 320. Tensor analysis. Kinematics of continuous media. Stress. The elastic solid. Newtonian fluid. Conservation principles of mass, momentum and energy. Viscometric flows. Formulation of constitutive equations. Applications to the modeling of bone and other living tissues.

**BME 452. Mechanical Behavior and Performance of Biomaterials. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BME 302, BME 304, MATH 222, MATH 337, MATH 279, and MECH 320. Biomaterial selection and performance is essential to the design and implementation of most any biomedical application. Students will learn about important properties of materials for use in the body and failure modes of applied biomaterials. Material behavior will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced including thermal strain, surface properties, and viscoelasticity. Material biocompatibility will be introduced in regards to body responses including cell and tissue interaction, toxicity and safety.

**BME 471. Principles of Medical Imaging. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 301 and BME 310 This is an introductory undergraduate course in biomedical imaging. This course will cover medical physics, instrumentation, data aquisition and processing to generate structural and functional images. A number of modalities including X-ray, Computer Tomography, Ultrasound, and magnetic resonance imaging systems are included. This course is an elective in te Bioinstrumentation track.

**BME 478. Introduction to CAD for Biomechanics. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: BME 302 and MECH 320. Introduction to Computer Aided Designing and analysis as applied to biomedical engineering design programs. Topics include theoretical insight into the process of design and geometrical modeling and design using industry standard CAD (Computer Aided Design) software packages. The course will also include several projects involving the applicaiton of design principles to standard problems in biomedical design.

**BME 479. BioMicroElectroMechanical Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 301, BME 302, and BME 304. This course focuses on the study of the broad body of knowledge required to design, fabricate, and test BioMEMS. We define BioMEMS as any type of biomedical devices for the fabrication of which miniaturization techniques (at least in part) are required. BioMEMS are used in advanced analytical techniques (microfluidic devices), implantable chips, biomedical sensors and actuators, and in-vitro tissue modeling. BioMEMS for diagnosis as well as for cell biology and tissue engineering are studied. This course provides a hands-on approach to BioMEMS and microfluidic devices and allows students to design, fabricate, and characterize their own BioMEMS.

**BME 489. Medical Instrumentation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 372, BME 310. This course covers the hardware and instrumentation needed to measure variables from different physiological systems. The following topics will be taught: electrodes, sensors and transducers. Bioelectric amplifiers, electrical safety and computing. Applications include the study and design of instrumentation for measurement of the ECG, EEG, EMG, respiratory system, nervous system in general.

**BME 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
In depth research experience taught under the guidance of a professor typically within a laboratory. Approved requirements are needed for engineering credit. Research thesis required. Needs permission of professor.

**BME 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: BME 491. Approved requirements are needed for engineering credit. Research thesis required. Needs permission of professor.

**BME 493. Honors Research Thesis I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: GPA 3.5, an appropriate research methods course and ENG 352 Part of a two semester undergraduate research thesis. Students will learn how to formulate a hypothesis, design a scientific based experiment, analyze data using statistics, interprete data, and describe work within oral defense and written thesis.

**BME 494. Honors Research Thesis II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: BME 393 Part of a two semester undergraduate research thesis. Students will learn how to formulate a hypothesis, design a scientific based experiment, analyze data using statistics, interprete data, and describe work within oral defense and written thesis.

**BME 495. Capstone Design I. 3 credits, 4 contact hours (1;3;0).**
Restriction: Senior standing. Prerequisite: BME 372 or MTSE 301 or (MECH 236 and MECH 320). The goal of this course is to provide students with the guidance to choose a capstone design topic and advisor conduct library/search engine background research and to prepare the design proposal for their chosen project. The course introduces the student to the definition of design as well as introducing issues of intellectual property, bioethics and safety, and professional societies.

**BME 496. Capstone Design 2. 3 credits, 4 contact hours (1;3;0).**
Prerequisite: BME 495. Implementation of the project approved in BME 495. This portion of the project includes library research, time and cost planning, oral and written reports, as well as construction, troubleshooting and demonstration of a working prototype.

**BME 498. ST:. 3 credits, 3 contact hours (3;0;0).**

**CE 101. CE Computer Aided Design. 1 credit, 2 contact hours (0;2;0).**
Co-requisite or Pre-requisite: FED 101 Introduce students to the basics of Civil Engineering computer aided design and the application of practical engineering ideas with the linking of technology. CE CAD teaches students the use of basic tools, such as Autocad software, used in the preparation of Civil Engineering contract documents. Autocad is a widely used computer program for generating engineering drawings.

**CE 200. Surveying. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 111 or ENGR 101. Angle and distance measurement; leveling; topographic mapping; traverse and area computations; horizontal and vertical curves; cross sections; triangulation; state plane coordinates; global positioning system. Emphasis on the use of the computer for solving typical field and office problems. Lab should be taken concurrently.

**CE 200A. Surveying Laboratory. 1 credit, 3 contact hours (0;3;0).**
Corequisite: CE 200. Field exercises in conjunction with the classroom exercises in CE 200 utilizing classical and electronic instruments and COGO/CAD software.

**CE 210. Construction Materials and Procedures. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HSS 101. Introduction to construction management organization, contracts, construction safety, engineering economics, and engineering ethics. Studies current practices of heavy construction including soil and rock excavation productivity, and building construction materials and procedures. Field trips to construction sites provide opportunities to directly view many of the practices.

**CE 260. Civil Engineering Methods. 3 credits, 3 contact hours (2;1;0).**
Prerequisite: HUM 101, CE 101, CE 200, CE 200A. Provides students with in-depth experience in computer applications in civil engineering and with written and oral communication.

**CE 307. Geometric Design for Highways. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A. Highway design based on a study of traffic distribution, volume, and speed with consideration for the predictable future. Analysis of elements of at-grade intersections and interchanges and the geometrics of highway design and intersection layout with advanced curve work including compound and transition curves.

**CE 311. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a -report.

**CE 320. Fluid Mechanics. 4 credits, 4 contact hours (4;0;0).**
Prerequisite or Co-requisite: MECH 236 with a grade of C or better. Prerequiste: Mech 235 with a grade of C or better, Math 112 and Phys 111/111A This course is designed to present the fundamental laws relating to the static and dynamic behavior of fluids. The emphasis is placed on applications dealing with the flow of water and other incompressible fluids. These include flow in pipe systems and natural channels.

**CE 320A. Hydraulics Laboratory. 1 credit, 3 contact hours (0;3;0).**
Prerequisite or corequisite: CE 320. Explores the principles of fluid mechanics through laboratory experiments. Investigates various hydraulic phenomena with both physical and computer models. Demonstrates basic civil engineering design principles for pipe networks, open channel systems, and ground water regimes.

**CE 321. Water Resources Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A, MATH 225 or MATH 279. Training in methods of developing water supplies and the means to treat supplies for consumptive use. Covers hydrologic techniques such as surface and ground water yield, hydrograph and routing analyses, and probabilistic methods related to hydrologic studies.

**CE 322. Hydraulic Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 320, CE 321. The objective is to provide the tools required to design water distribution systems, storm drains, and sanitary sewers. Examines related hydrologic and hydraulic techniques.

**CE 332. Structural Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 237 with a grade of C or better. A working knowledge of free body diagrams, equilibrium conditions for force systems and moments. The primary objective is an understanding of the various methods of analyzing determinate and indeterminate beams, frames, and trusses encountered in practice.

**CE 333. Reinforced Concrete Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 332. The student must have a working knowledge of structural analysis including determinate and indeterminate beams and frames. Primary objectives include the following: to acquaint the student with the properties of concrete and steel and with the behavior of reinforced concrete as a structural material; also, to develop methods for the design of reinforced concrete structural members such as beams, slabs, footings, and columns. Both ultimate strength design and working stress method will be studied.

**CE 341. Soil Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MECH 237 with a grade of C or better or equivalent. Corequisite: CE 341A. A study of soil types and properties is made with the objective of developing a basic understanding of soil behavior. The methods of subsurface investigation and compaction are presented. Fundamentals pertaining to permeability, seepage, consolidation, and shear strength are introduced. Settlement analysis is also presented. Lab must be taken concurrently.

**CE 341A. Soil Mechanics Laboratory. 1 credit, 3 contact hours (0;3;0).**
Corequisite: CE 341. Students perform basic experiments in soil mechanics.

**CE 342. Geology. 3 credits, 3 contact hours (3;0;0).**
Restriction: Sophomore status. Studies science of geology with emphasis on physical geological processes. Stresses the principle of uniformity of process in the context of rock and soil formation, transformation, deformation, and mass movement. Includes aspects of historical geology and geomorphology.

**CE 350. Transportation Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A. A study of the principal modes of transportation, with emphasis on the planning, design and construction of facilities for modern transportation systems.

**CE 351. Intro To Transportation System. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A, CE 350 A study of the principal modes of transportation, with emphasis on the planning, design and construction of facilities for modern transportation systems.

**CE 360. Sustainable Civil Engr Mat. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: CHEM 121 or 125 and MECH 237 (with a grade of C or better) This course will provide instruction on engineering materials used in the construction of civil engineering projects. Additionally, the fundamentals of sustainability and sustainable design within the context of civil engineering will be discussed. The engineering properties of aggregates, wood, metal, portland cement concrete and asphaltic concrete and design of these materials will be covered. These materials will be used to discuss sustainability concepts and design within civil engineering.

**CE 381. Geomorphology. 3 credits, 3 contact hours (3;0;0).**
This is a course in geomorphology, the study of landforms and the contemporary processes that create and modify them. The course will emphasize earth surface processes and quantitative analysis of landform change. Lectures will stress geomorphic principles and two field-based problems will enable students to apply these principles to contemporary geomorphic problems in engineering and management with a focus on the natural environment.

**CE 406. Remote Sensing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 234. Principles of remote sensing are covered including general concepts, data acquisition procedures, data analysis and role of remote sensing in terrain investigations for civil engineering practices.

**CE 410. Construction Scheduling and Estimating. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 210. Quantity take off, cost estimate and CPM computer analysis of typical building or highway projects. A study is made of construction project organization, contract requirements and management control techniques with an introduction to computer applications.

**CE 412. Construction Codes and Specifications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 210. Code and specification aspects of engineered construction. Topics include professional ethics, contracts, specifications, bidding procedures, building codes such as B.O.C.A. and New Jersey Uniform Construction Code, Energy Code Provisions, construction safety, and the impact of the EPA on construction.

**CE 413. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CE 311 or equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements including a report and/or project.Note: Normal grading applies to this COOP Experience.

**CE 414. Engineered Construction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 210, CE 332, CE 341. Design, erection, and maintenance of temporary structures and procedures used to construct an engineering project. Business practices, codes, design philosophies, construction methods, hardware, inspection, safety, and cost as they pertain to engineered construction projects.

**CE 431. Construction Materials Lab. 1 credit, 3 contact hours (0;3;0).**
Prerequisites: CE 210, MECH 237 with a grade of C or better, CE 210. This course provides an understanding of the basic properties of construction materials, and presents current field and laboratory standards and testing requirements for these materials. Students select a material or component assembly for testing, design a testing procedure, and present their results.

**CE 432. Steel Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 332. A working knowledge of structural analysis including determinate and indeterminate beams and frames is essential. The development of current design procedures for structural steel elements and their use in multistory buildings, bridges, and industrial buildings.

**CE 443. Foundation Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 341, CE 341A. Site investigation, selection of foundation types and basis for design, allowable loads, and permissible settlements of shallow and deep foundations. Computations of earth pressure and design of retaining walls.

**CE 450. Urban Planning. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: junior engineering standing. Introduction to urban planning, its principles, techniques, and use. Topics include development of cities, planning of new towns, redevelopment of central cities, and land use and transportation planning.

**CE 461. Professional Practice in CEE. 3 credits, 3 contact hours (3;0;0).**
Develop an understanding of the process to become a licensed professional engineer and familiarize the students with the professional practice of engineering including codes of ethics and professional business practices and to provide an adequate background for the Fundamentals of Engineering.

**CE 465. Green and Sustainable Civil Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 210 and Junior standing. Designed to teach students currently available approaches that incorporate renewable energy and sustainable development concepts in civil engineering projects. This will include various methods of planning, design, and evaluation which promote increased energy efficiency and sustainable use of materials. Cost estimating and life cycle planning will also be included. The course will encourage students to look beyond the information in the course, to come up with additional methodologies which may not currently be in use.

**CE 485. Special Topics in Civil Engineering. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of civil engineering not regularly covered in any other CE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**CE 490. Civil Engineering Projects. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in civil engineering and approval of the department. Work on an individually selected project, guided by the department faculty advisor. The project may include planning, research (library or laboratory), engineering reports, statistical or analytical investigations, and designs. Any of these may follow class-inspired direction or the student may select his or her own topic. The project must be completed and professionally presented by assigned due dates for appropriate review and recording of accomplishment.

**CE 491. Research Exper-Civil Engr. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Junior standing, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. This course provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion. Open to students with a GPA of 3.0 or higher.

**CE 494. Civil Engineering Design I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 210, CE 260, CE 320, CE 321, CE 350, CE 341 , CE 341A and senior standing in civil engineering. Simulates the submission and acceptance process normally associated with the initial design phases for a civil engineering project. Familiarizes students with the preparation of sketch plats, preliminary engineering design, and a related environmental assessment. Requirements include written submittals and oral presentations in defense of the project.

**CE 495. Civil Engineering Design II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 333, CE 432, CE 443 and CE 494. Provides students with the type of design experience they would receive if engaged in civil and environmental engineering design practice. Course will focus on one or more of these design areas: structural, geotechnical, transportation and planning, and sanitary and environmental engineering.

**CET 225. Soil Mechanics. 3 credits, 0 contact hours (0;0;0).**

**CET 233. Structural Analysis in Construction. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MET 237. This course will cover the aspects of the design and construction of structural steel and reinforced concrete for construction engineering technology students. This will include the design of beams, slabs and columns as well review of the connection of these structural members as encountered in practice.

**CET 313. Construction Procedures I. 3 credits, 3 contact hours (3;0;0).**
Corequisite: CET 317. An introduction to heavy construction practices. Emphasis is on construction equipment, site preparation, earthmoving, compaction, dewatering, piles, drilling and blasting, and tunnelling. Case studies in heavy construction are used.

**CET 314. Construction Procedures II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313, CET 317. An introduction to building construction practices and building materials. Emphasis is on structural systems, construction materials and detailed finishing operations required to make a serviceable structure. Case studies in building construction are used.

**CET 317. Construction Computing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 106 Application of available software to construction-related computing problems, including: strength of materials, structural analysis, fluids/ hydraulics, surveying, scheduling, cost estimating, and computerized drafting (CAD).

**CET 322. Construction Codes and Regulations. 3 credits, 3 contact hours (3;0;0).**
An introduction to the New Jersey Uniform Construction Code, the BOCA National Building Code, NJ DOT Standard Specifications and the CSI specification format. A code analysis of a typical construction project is undertaken.

**CET 323. Construction Safety. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313 and CET 314 This course will address the safety issues encountered in construction as mandated by the Occupational Safety and Health Act (OSHA)and other similar regulations.

**CET 331. Structural Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CET 233. Study of types and behavior of modern structures using both analytical and intuitive techniques. Examples include beam and column, one- and two-way slab systems, wood and masonry systems, and wind and seismic analysis.

**CET 341. Soils and Earthworks. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MET 237 A study of the significant soil types and tests. Problems are investigated relating to soil mechanics, soil supported foundations for engineering structures. Appropriate field trips are made.

**CET 411. Cost Estimating. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313, CET 314, CET 317. Take off of quantities of materials from typical building and highway projects. Pricing for labor, materials, and equipment. Crew sizes, productivity and manpower leveling. Computerized cost estimating and take off methods. Prepare a complete bid estimate for a construction project.

**CET 413. Environmental Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313, CET 314, CET 431. An introduction to construction-related environmental science topics, including basic environmental chemistry, geology, ground water hydrology, basic air quality, surface water run-off, erosion and sedimentation control, indoor air quality, and vibration analysis. Case studies cover various construction activities with respect to their effect on the environment and the manner in which they can be controlled.

**CET 415. Construction Project Management. 3 credits, 3 contact hours (3;0;0).**
Restriction: Senior standing in construction enginerring technology or contruction management technology. An introduction to construction management and administration methods and procedures including the design and construction process, project organizational structure, construction planning, contract administration, records and reports, financial management, risk analysis, manual and computerized GANTT and CPM scheduling, change orders and extra work, claims and disputes, cost accounting and document tracking.

**CET 416. Senior Construction Project. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: CET 415; second semester senior standing in construction engineering technology or construction management technology. Simulates the methods and procedures used to successfully manage a construction project. Provides familiarization with constructability analysis, value engineering, productivity improvement, quality control, advanced field and office administration techniques, problem solving, and construction auto-mation. Extensive use of construction-related computer software. Written submittals and oral presentations required.

**CET 421. Construction Contracts. 3 credits, 3 contact hours (3;0;0).**
Legal aspects of the various types of construction contracts and specifications. Scope, format, and use of various types of contracts such as owner-contractor and contractor-sub-contractor.

**CET 431. Construction Testing. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET237 Exposure to a variety of construction-related field tests and field testing equipment. Includes concrete mix design, concrete testing, soil density and compaction, asphalt tests, load testing of wood, mortar analysis and testing, brick and CMU testing, and quality control methods and procedures for finishes.

**CET 435. Design of Temporary Structures. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CET 331. Analysis of loadings on, and design of, temporary structures required in construction. Formwork, shoring and scaffolding systems, temporary bridges, trenching, and temporary retaining walls are among the subjects covered. Construction safety associated with temporary structures is stressed.

**CET 460. Forensics in Construction. 3 credits, 3 contact hours (3;0;0).**
Restriction: Senior standing in construction engineering technology. Construction failure, in its many forms, are both interesting and instructive and in the context of this course students will study construction failures in their many forms.

**CET 490. Special Project. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Senior standing in construction engineering technology. The student works on one or more individually selected projects guided by the department staff. The project must be construction related and may include planning, research (library or lab), engineering report, and statistical, analytical, or field investigation. Any of these may follow class-inspired direction, or the students may branch out on their own. The project(s) of each student must be completed and professionally presented by assigned due date for appropriate review and recording of accomplishments.

**CET 491. Special Project. 1 credit, 1 contact hour (1;0;0).**
Restriction: Senior standing in construction engineering technology. The student works on an individually selected project guided by the department staff. The project may be design- or construction-related and may include research, engineering design, technical report, or field investigation. Requirements will include a written submittal.

**CET 492. Special Project. 2 credits, 2 contact hours (0;0;2).**
Restriction: Senior standing in construction engineering technology. The student works on a selected project guided by the department staff. The project may be design or construction related and may include research, engineering design, technical report or field investigation. Requirements will include a written submittal.

**CET 493. Special Projects. 3 credits, 3 contact hours (3;0;0).**

**CET 497. Co-op Work Experience. 3 credits, 3 contact hours (0;0;3).**
Restriction: Approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.Note: Normal grading applies to this COOP Experience.

**CHE 101. Introduction to Chemical Engineering. 0 credits, 1 contact hour (1;0;0).**
Prerequisites: None. An introduction to the field of chemical engineering and to the Otto H. York Department of Chemical Engineering. Topics include the curriculum, tours of department teaching laboratories and computing facilities, undergraduate research opportunities, cooperative employment, and student professional societies. Also included are visits by alumni who discuss their careers after graduation from the department.

**CHE 210. Chemical Process Calculations I. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126 or CHEM 122. Corequisites: MATH 112 and CS 115. Analysis of chemical processes is introduced, emphasizing steady and unsteady-state mass and species balances. This course uses primarily chemistry and algebra to determine, for a wide variety of processes and applications, the flow and concentrations of different chemical species.

**CHE 210W. Chemical Process Calculations I. 0 credits, 1 contact hour (1;0;0).**
Workshop.

**CHE 230. Chemical Engineering Thermodynamics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126, (or CHEM 122), MATH 112, PHYS 111. Corequisite MATH 211 (or MATH 213). The Fundamentals of thermodynamics are applied to chemical engineering processes. Thermophysical properties and their engineering correlations are covered. Applications include chemical engineering and related fields such as environmental and biomedical engineering.

**CHE 230W. Chemical Engineering Thermodynamics I Workshop. 0 credits, 1 contact hour (1;0;0).**
Workshop.

**CHE 240. Chemical Process Calculations II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 210 and CHE 230 This course covers the basic principles of energy balances for a variety of engineering systems. Combined with material from other sophomore courses, simple designs of chemical processes are considered. The course also introduces chemical process simulation software.

**CHE 240W. Chemical Process Calculations II. 0 credits, 1 contact hour (1;0;0).**
Workshop.

**CHE 260. Fluid Flow. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHE 230. Corequisite: CHE 240, MATH 222. This course considers the principles of molecular and turbulent transport of momentum, particularly as they apply to pressure drop calculations in piping systems, packed columns, and other flow devices. Flow around submerged objects is also considered.

**CHE 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**CHE 311. Co-op Work Experience II. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: CHE 310. Restriction: permission of undergraduate advisor. Cannot be used for degree credit.

**CHE 312. Chemical Process Safety. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior standing. A study of the technical fundamentals of chemical process safety: includes impact of chemical plant accidents and concepts of societal and individual risk; hazards associated with chemicals and other agents used in chemical plants, including toxic, flammable and reactive hazards: concepts of inherently safer design; control and mitigation of hazards to prevent accidents, including plant procedures and designs; major regulations that impact safety of chemical plants; consequences of chemical plant incidents due to acute and chronic chemical release and exposures; hazard identification procedures; introduction to risk assessment.

**CHE 342. Chemical Engineering Thermodynamics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 230, MATH 211 (or MATH 213), CHEM 236. The principles and methods developed in Chemical Engineering Thermodynamics I are extended to multicomponent systems, and used to treat phase and chemical equilibrium as well as such applications as chemical reactors and refrigeration systems.

**CHE 349. Kinetics and Reactor Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 342, CHE 370, MATH 222, CHEM 236. Derive and solve species and energy balances for single chemical reactors; introduces heterogeneous catalysis, non-ideal reactors as ideal reactor combinations, and special topics such as polymeric or biochemical reactions.

**CHE 360. Separation Processes I. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 342, CHE 370. This is the first course in separations, examines traditional methods and technologies by which chemical engineers separate and purify mixtures. Emphasis here is on strippers, absorbers, distillations, and extractions.

**CHE 365. Techniques for Process Simulation. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 370. Corequisite: CHE 360 Course Description: Introduction to basic concepts of computational methods for solving chemical engineering problems and performing process simulations. Topics include various numerical techniques for the solution of linear and non-linear algebraic equations and ordinary differential equations, differentiation/integration, and interpolation/regression of data. Students will be exposed to various computational software and commercial process simulators for simulating chemical processes.

**CHE 370. Heat and Mass Transfer. 4 credits, 4 contact hours (4;0;0).**
Prerequisites: CHE 240, CHE 260, MATH 222. The principles of heat and mass transfer in chemical engineering systems are covered. Steady and unsteady heat transfer is examined, with emphasis on the heat exchanger design. Mass transfer by steady and unsteady molecular diffusion, and turbulent convective mass transfer is studied.

**CHE 375. Structure, Properties and Processing of Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 236 or CHEM 235 Tailoring materials properties by engineering their microscopic/macroscopic structures via processing is central to product design and development in the chemical industry. This course introduces the principles of materials engineering from the perspective of structure-property-processing relationships. Instead of covering different types of materials separately, this course will use the principles common to engineering of all important materials as an underlying theme. These are atomic/molecular structure, nanoscale, morphology, principles of phase transformation, structure development during processing, and property dependence on structure. All these topics will be introduced through the paradigm of comparing metals, ceramics and polymers. Besides single component systems, advanced materials such as multiphase and/or multicomponent systems (e.g. composites and gels) and nanomaterials will be discussed based on these principles. An integral part of this course will be the criteria for selection of materials for the chemical process industry.

**CHE 380. Introduction to Biotechnology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 122 or CHEM 126. Basic principles of molecular biotechnology with selected examples of applications.

**CHE 396. Chemical Engineering Laboratory I. 3 credits, 5 contact hours (0;5;0).**
Prerequisites: CHE 370, ENG 352. Corequisite: MATH 225A. In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

**CHE 402. Applied Optics in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Junior or senior standing in chemical engineering. Combined laboratory and lecture course emphasizing photonics and laser applications in chemical engineering.

**CHE 411. Work Experience III. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: CHE 311. Continuation of CHE 311. Cannot be used for degree credit.

**CHE 427. Biotransport. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 230 and MATH 222. Introduction to basic concepts of transport phenomena as applied to biological systems. Topics include the structure and composition of the human body, the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Students learn to analyze solute transport in biological systems and apply it to the design of biomedical devices.

**CHE 444. Introduction to Polymer Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 370. Introduction to the basic concepts of polymer engineering. Topics covered include rheology, heat transfer, and kinetics of polymerization reactors.

**CHE 460. Separation Processes II. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 360. This second course in separations examines non-traditional methods and technologies such as fixed-bed processes, membranes, crystallization, and mechanical separations.

**CHE 472. Process and Plant Design. 4 credits, 4 contact hours (4;0;0).**
Prerequisites: CHE 349, CHE 365, CHE 375, CHE 380, IE 492. Corequisite CHE 460. A capstone course in the chemical engineering program. This class is divided into three- or four-person groups. Each group must complete an open-ended process design problem, including equipment specification and economics.

**CHE 473. Mathematical Methods in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, CHE 349, CHE 360, and CHE 370. An introduction to the use of differential equations to solve chemical engineering problems.

**CHE 476. Introduction to Biochemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 245, CHE 349. Corequisite: CHE 349. The application of chemical engineering to biochemical processes. Topics include enzyme reactions, dynamics of microbial populations, fermentation equipment, bioreactor design, and sterilization.

**CHE 489. Process Dynamics and Control. 3 credits, 4 contact hours (4;0;0).**
Prerequisites: CHE 349, CHE 365. This course is an introduction to chemical process dynamics and control. Topics include analysis of the dynamics of open-loop systems, the design of control systems, and the dynamics of closed-loop systems. Control techniques and methodologies, used by practicing chemical engineers, are emphasized.

**CHE 490. Special Topics in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 349, CHE 360. Topics of current interest in chemical engineering, such as supercritical fluid extraction, combustion research, environmental problems, biotechnology, technologies in hazardous and toxic substance management, etc. AS interests develop, other topics will be considered.

**CHE 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in chemical engineering, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. Normally a GPA greater than 3.0 is required to participate in the course. Provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion.

**CHE 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: CHE 491. A continuation of CHE 491.

**CHE 492H. Research and Independent Study II Honors. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: CHE 491. Same as CHE 492, with special projects for Honors students.

**CHE 495. Chemical Engineering Lab I. 3 credits, 5 contact hours (0;5;0).**
Prerequisites: CHE 370, ENG 352, MATH 225A Course Description: In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

**CHE 496. Chemical Engineering Laboratory II. 3 credits, 6 contact hours (0;6;0).**
Prerequisites: CHE 349, CHE 360, CHE 380, CHE 396, CHEM 339, MATH 225A. Corequisites: CHE 460, CHE 489. In this second course in chemical engineering capstone laboratory, experiments are conducted in the areas of mass transfer, separations, reaction engineering, and process dynamics and control. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

**CIMT 101. Introduction to Concrete. 3 credits, 3 contact hours (3;0;0).**
This course is an overview of the concrete industry including historical aspects, the chemistry, properties and uses of concrete, production and delivery, and management of production facilities. Students will also be introduced to concrete construction and contracting, environmental concerns, professionalism, and career opportunities in the concrete industry.

**CIMT 205. Concrete Properties and Testing. 3 credits, 4 contact hours (2;2;0).**
The effects of concrete-making materials (aggregates, cements, admixtures, etc.) on the properties of fresh and hardened concrete will be studied and analyzed from an applications point of view. Concrete mixture proportioning calculations, statistical analysis of strength tests, and the economics of various concrete mixes will also be discussed.

**CIMT 210. Concrete Applications I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CIMT 101 and CIMT 205. This course is the first of two courses designed to provide a detailed study of the many applications of concrete in the construction of buildings, pavements, and other facilities as they relate directly to the concrete industry. Emphasis will be placed on the advantages, disadvantages and unique problems facing the concrete industry and suppliers of materials used in the manufacture of concrete products.

**CIMT 305. Concrete Applications II. 3 credits, 3 contact hours (3;0;0).**
This course is a continuation of CIMT 210 and focuses on codes, specifications and industry standards as well as the production and delivery issues related to traditional and unique concrete applications.

**CIMT 310. Concrete Products and Delivery. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CIMT 210 Concrete Applications I. This course will provide the student with a basic understanding of managing the order and delivery process common to all concrete products. An emphasis will be given to planning, organizing and controlling at both the management level as well as the supervisory level.

**CIMT 315. Concrete Construction Methods. 3 credits, 3 contact hours (3;0;0).**

**CIMT 405. Advanced Concrete Testing and Quality Assurance. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CIMT 205. This course will focus on advanced concrete testing techniques and quality assurance procedures currently used in the industry for traditional and specialty applications.

**CIMT 410. Senior Project in CIM. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Senior standing in Concrete Industry Management. The student works on one or more individually selected projects guided by the department staff. The project must be concrete industry related and may include planning, research (library or lab), engineering report and statistical, analytical, or field investigation. Any of these may follow class-inspired direction, or the students may branch out on their own. The project(s) of each student must be completed and professionally presented by assigned due date for appropriate review and recording of accomplishments.

**CIMT 491. Special Project in CIM. 1 credit, 1 contact hour (1;0;0).**

**CIMT 492. Special Project in CIM. 2 credits, 2 contact hours (2;0;0).**

**CIMT 493. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**CIMT 497. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.Note: Normal grading applies to this COOP Experience.

**CIMT 498. Coop Work Experience II. 3 credits, 3 contact hours (0;0;3).**

**CMT 332. Structural Systems for Construction Management. 3 credits, 3 contact hours (3;0;0).**
Study of the types and behavior of building structural systems using qualitative analysis techniques. Systems to be covered will include those involving structural steel, reinforced concrete, wood and timber, and plain and reinforced masonry. The effect of wind and seismic events on these systems is reviewed.

**CMT 414. Environmental Science for Construction Management. 3 credits, 3 contact hours (3;0;0).**
An introduction to construction-related environmental topics, including environmental chemistry, geology, ground water hydrology, outdoor air quality, surface water run-off, erosion and sedimentation control, indoor air quality, asbestos abatement, radon remediation, and noise and vibration.

**CMT 436. Temporary Structures for Construction Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CMT 332. Study of the types of the various temporary systems and structures used in field construction activities, including concrete forming and falsework, sheeting and shoring for excavations, scaffolding, barricades, ladders, and temporary bridges and ramps. Construction safety with respect to the systems is covered.

**CMT 452. Mechanical and Electrical Systems for Construction. 3 credits, 3 contact hours (3;0;0).**
Study of the different types of water supply, plumbing, fire protection, heating, ventilation, air conditioning and electrical systems commonly employed in residential and commercial buildings. Case studies include an overview of the design of these systems and their installation in the field.

**CPT 310. Computer Design Fundamentals for Computer Technology. 3 credits, 4 contact hours (2;2;0).**
Restriction: enrolled in the computer technology option. Boolean algebra, gates, combinational and sequential logic. Memory, microprocessor, and I/O control IC's. Sequential bus architecture.

**CPT 315. Computer Architecture for Computer Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 310. Computer design fundamentals for computer technology, Von Neumann computer architecture: processor, memory and I/O. Processor organization: registers, ALU, and control. Memory organization and memory bus, I/O organization: I/O bus, memory mapped I/O. Number representations and ALU designs. Fundamentals of assembly language, lab exercises in assembly language are used throughout to illustrate concepts.

**CPT 325. Medical Informatics Technology. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior standing. Medical Informatics (MI) professionals use information technology to benefit the health and human services industry. One of the main challenges is to develop an integrated medical record/information system that links doctors, pharmacists, medical imaging facilities and hospitals. In addition, MI professionals will also develop skills to design and develop suport technology for seniors to maintain independent life styles. This includes remote monitoring systems linked to medical professionals, software for support services, and home automation technology.

**CPT 330. Software Web Applications for Engineering Technology I. 3 credits, 4 contact hours (2;2;0).**
Common software applications using software objects. The use of software objects in the management of programming projects. Projects illustrate concepts.

**CPT 335. Networks Applications for Computer Technology I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: C++, Visual Basic, UNIX utilities. Covers common gateway interface (CGI), servers, network protocols, network administration, server and network per-formance.

**CPT 341. Visual Basic.NET for Engineering Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Previous programming experience. Creation of windows with text, controls, menus and graphics, events detection, files and objects management, object oriented techniques.

**CPT 373. Web App Development for Mobile. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: A basic programming course, in addition is recommended an introductory web programming course. Mobile platforms are becoming ubiquitous and software development for these devices is becoming an essential skill for technical professionals. This software/App development course integrates software and web skills with cross platform open source tools that allow developers to write apps for multiple platforms. Course topics will include PhoneGap and open course development software, App layout, CSS (styling) and navigation (transition animations), JavaScript and native functions, geolocation listeners and Asynchronous JavaScript and XML (AJAX) skills. A class project will incorporate skills introduced in this course. Medical informatics majors will design and build an Electronic Medical records Apps. Other projects will be tailored to the interest of other majors.

**CPT 395. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: Approval of the department and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**CPT 401. Senior Project. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: MIS 345. Restriction: senior standing in computer technology. Project management and development, scheduling, proposal writing, documentation of software projects, technical presentations. The successful completion of the project consists of research on a recent computer software and/or hardware product, and the application of the findings to the development of a project, which must include a software component. The senior project may be replaced by a cooperative education experience course, subject to advisor's approval.

**CPT 425. Medical Informatics Technology II. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 325. Restriction: Senior standing. Advanced topics, builds on the core competencies introduced in Medical Informatics I. This course focuses on: Management of Information in Healthcare Organizations/Cost Benefit Analysis, Health and Financing, Consumer Health and Telehealth and Wireless Patient-Monitoring Systems. Cutting edge technologies that will impact on future healthcare delivery.

**CPT 430. Software Web Applications for Engineering Technology II. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 330. Common applications using software objects. The use of software objects in the management of programming projects. Projects are used to illustrate concepts.

**CPT 435. Networks Applications for Computer Technology II. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 335. Network security. Database implementations. Scaling.

**CPT 440. Visual Basic Applications for Engineering Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 340. PC-based control techniques, embedded systems. Database control. Real-time control. Network data acquisition. Man-machine interface and ergonomics considerations.

**CPT 450. Computer Graphics for Computer Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: Calculus II, knowledge of the programming language used in the course, check with the instructor. Drawing shapes, curves and text. Colors and areas, point of light, shading. Masking, 2-D drawings and transformations, 3-D drawings and transformations. Animation. Introduction of a popular graphics package. Lab exercises are used throughout to illustrate concepts.

**CPT 491. Special Projects in Computer Technology. 1 credit, 1 contact hour (1;0;0).**
Restriction: Senior standing in computer technology. The student works on selected projects guided by the department staff.

**CPT 492. Special Projects in Computer Technology. 2 credits, 2 contact hours (2;0;0).**
See CPT 491.

**CPT 493. Special Projects in Computer Technology. 3 credits, 3 contact hours (3;0;0).**
See CPT 492.

**ECE 101. Introduction to Electrical and Computer Engineering. 0 credits, 1 contact hour (1;0;0).**
Familiarize students with various disciplines, career opportunities and curricula in electrical and computer enginneering. Invited speakers include faculty and industrial representatives.

**ECE 231. Circuits and Systems I. 3 credits, 4 contact hours (4;0;0).**
Prerequisites: PHYS 121 and MATH 112 or MATH 133. The basic concepts of electric circuit theory and system analysis. Topics include basic circuit elements, loop and node analysis, network theorems, sinusoidal steady-state analysis, power, resonance, mutual inductance, and ideal transformers.

**ECE 232. Circuits and Systems II. 3 credits, 4 contact hours (4;0;0).**
Prerequisite: ECE 231. Corequisite: MATH 222. A continuation of circuits and systems with special emphasis on transient response. Topics include Laplace transform analysis, transfer functions, convolution, Bode diagrams, and Fourier series.

**ECE 251. Digital Design. 3 credits, 4 contact hours (4;0;0).**
Prerequisites: PHYS 121. The design of combinational and sequential logic circuits used in digital processing systems and computers. Basic register transfer operations are covered. Topics include Boolean algebra, minimization techniques and the design of logic circuits such as adders, comparators, decoders, multiplexers, counters, arithmetic logic units, and memory systems.

**ECE 252. Microprocessors. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 251. An introduction to microprocessor system organization and assembly language programming. The course covers the architecture, instruction set and assembly language of a specific microprocessor. Other topics included are memory organization, input/output interfacing, interrupt processing as well as exception processing. The problems associated with the design of a single board computer are also covered. Students receiving degree credit for CIS 453 cannot receive degree credit for ECE 352. Co-listed as COE 252.

**ECE 271. Electronic Circuits I. 3 credits, 4 contact hours (4;0;0).**
Prerequisite: ECE 231. The electronic devices, junction diodes, bipolar transistors and field-effect transistors, are introduced and studied based on semiconductor physics models. The study then continues with analysis and design of main digital electronic circuits (NMOS and CMOS) inverters and logic gates, MOS memory and storage circuits) and with introduction to analog electronic circuits such as simple one transistor amplifiers.

**ECE 291. Electrical Engineering Laboratory I. 1 credit, 3 contact hours (0;3;0).**
Prerequisites: ECE 231, HUM 101. Corequisites: ECE 232. Laboratory work in the areas covered in ECE 231, ECE 232. Assembling, testing and analysis of basic analog circuits. Emphasis electronic measurement techniques, instrumentation and data analysis. Simulations of dc, ac, and transient circuit response on the personal computer.

**ECE 310. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.

**ECE 321. Random Signals and Noise. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 232 and ECE 333. Random processes occurring in electrical engineering. An introduction to probability and random variables is followed by stochastic processes and noise. Topics include auto- and cross-correlation functions, power spectral density, response of linear systems to random signals, and noise figure calculations.

**ECE 333. Signals and Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, MATH 222. A continuation of circuits and systems. Topics include signal models, system representations and properties, convolution, Fourier transform, sampling, z-transform, and an introduction to IIR and FIR filter design.

**ECE 341. Energy Conversion. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 231. Magnetic materials and their applications including the design of singly- and multiply-excited magnetic circuits and transformers, and the steady-state performance of dc and ac electromechanical energy converters.

**ECE 353. Computer Organization and Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 252. Emphasizes the hardware design of computer systems. Topics include register transfer logic, central processing unit design, microprogramming, ALU design, pipelining, vector processing, micro-coded arithmetic algorithms, I/O organization, memory organization and multiprocessing.

**ECE 354. Digital Test. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: ECE 251 or equivalent, MATH 333 or equivalent. Covers theory and practice related to test technology. Topics include fault modeling, test generation, fault simulation, design for testability, fault diagnosis, built-in self-test, scan design, and many others. Surveys several industrial design for testability structures.

**ECE 361. Electromagnetic Fields I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 231, MATH 213 and MATH 222. Overview of vectors analysis. The study of static electric and magnetic fields, basic laws of electrostatics (Coulomb’s and Gauss’s laws), scalar electric potential, electrostatic force and energy; basic laws of magnetostatics (Biot–Savart and Ampere’s laws), magnetostatic force and energy, vector magnetic potential; fundamental meaning of capacitance, resistance and inductance in terms of electric and magnetic fields; Poisson’s and Laplace’s equation; characterization of materials (conductors, dielectrics, magnetic materials).

**ECE 362. Electromagnetic Fields II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 361. Maxwell's equations solutions, reflection and refraction of plane waves in dielectric and conducting media, transmission lines; transients and frequency domain solutions in lossy and lossless lines, Smith chart and its applications, parallel plate and rectangular waveguides.

**ECE 368. Signal Transmission. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, ECE 251. This course is not for EE majors. Signal transmission both within and between digital systems. Topics include the telegrapher's equations, wave propagation, lattice diagrams, transients in digital systems, crosstalk, proper termination for high-speed logic, and the transmission characteristics of various interconnecting geometries.

**ECE 372. Electronic Circuits II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, ECE 271. Principles of MOSFET and BJT small signal amplifiers: Q point design, input and output impedance, gain, and signal range limitations for different single stage configurations. Design of analog integrated circuits including differential amplifiers, current sources, active loads. Transistor high frequency models, Miller effect, and frequency response of multistage amplifiers. Feedback in multistage amplifiers. Design and analysis of nonlinear circuits based on comparators. Design and analysis of signal generators.

**ECE 374. Electronic Device I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 271. This course addresses electronic devices on a fundamental level. Topics include semiconductors, structure and properties of p/n junction, Schottky barrier, BJT, MOS, MOS FET, semiconductor optoelectronics.

**ECE 392. Electrical Engineering Laboratory II. 2 credits, 3 contact hours (0;3;0).**
Prerequisite: ECE 271, and ECE 291. Co-requisite ECE 372. Laboratory work in the areas covered in ECE 232, ECE 271 and ECE 372. Design, computer simulation, testing and performance analysis of analog and digital electronic circuits.

**ECE 394. Digital Systems Lab. 1 credit, 3 contact hours (0;3;0).**
Prerequisites: ECE 251, ECE 271 and ECE 291. Experiments emphasize digital design from basic electronic circuits to complex logic. Topics include switching speed, basic sequential circuits, the arithmetic/logic unit, and computer memories.

**ECE 395. Microprocessor Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 291, ECE 252. In this laboratory the students are expected to learn to apply their theoretical knowledge of both the hardware and software aspects of microprocessors. To attain this objective the students are required to construct a microprocessor based single board computer (SBC), with adequate interfacing capabilities to be able to perform some useful control tasks. Programming of the device is done in assembly language. Some of the experiments that follow the construction project deal with software while others deal with the problems of interfacing of microprocessors.

**ECE 405. Electrical Engineering Principles. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121. (No credit for ECE students.) For non-electrical engineering majors. Topics include basic dc and ac circuits, basic electronics, an introduction to electromechanical energy conversion and control theory.

**ECE 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ECE 310, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. May count as EE or approved elective. Note: Normal grading applies to this COOP Experience.

**ECE 414. Electrical and Computer Engineering Project I. 1 credit, 1 contact hour (1;0;0).**
Prerequistes:In EE program:ECE 321, ECE 341, ECE 372, ECE 392, and ECE 395. In COE: ECE 353, ECE 368, ECE 395 and ECE 394. Student teams prepare and submit technical proposals for the senior design ("capstone") project to be completed the following semester in ECE 416 or ECE 417. Discussion of issues related to the engineering profession, including such topics as: intellectual property, sources of technical information, engineering codes and standards, professional organizations, professional registration. Required of all ECE students.

**ECE 416. Electrical and Computer Engineering Project II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 414. Continuation and completion of the project based on the proposal approved in ECE 414. Progress of the project is monitored by the instructor with demonstrations and presentations at given due dates of the regularly scheduled course. An oral presentation and demonstration of the project by the student team must be given and a written report submitted at the end of the course. Successful projects are approved for the presentation at the Senior Design Project Workshop in the presence of students, faculty and industry representatives.

**ECE 417. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ECE 414. Faculty adviser approval required. Continuation and completion of the project based on the proposal approved in ECE 414 guided by a faculty or a faculty and industrial mentors with meetings scheduled as needed. A formal written report is presented to the faculty advisor at the end of the course. An oral presentation of a successful project is made at the Senior Design Project Showcase attended by students, faculty, and industry representatives.

**ECE 418. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Requirements: senior standing or approval of the associate chairperson for undergraduate studies, a GPA greater than 3.0, and agreement of a faculty advisor. Provides the student with an opportunity to work on a research project under individual guidance of a faculty. The required work and intellectual challenge correspond to at least those of other senior ECE courses. A written report is required for the course completion.

**ECE 421. Digital Data Communications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, MATH 333, or ECE 321. This course is not for EE majors. Covers communications basics and some topics in digital communications most germane to data communication. Topics include signal classification, correlation, spectral analysis, energy and power spectral density, white noise, signal transmission through linear systems, sampling and quantization, and principles of digital data transmission.

**ECE 422. Computer Communications Networks. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 321 or MATH 333. Introduction to the fundamental concepts of computer communication networks. Topics include the OSI reference model, the physical, data link, network, and transport layers, TCP/IP, LANs (including token ring, token bus, and ethernet), ALOHA, routing and flow control.

**ECE 423. Data Communications Networking Devices. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 421 or ECE 481. Provides a working knowledge of data communication networking devices, including modems, routers, multiplexers, switches, and concentrators and are used as building blocks in the implementation, modification, or optimization of data communications networks. Emphasizes device design, functionality and physical layer protocols.

**ECE 424. Optical Communication Network. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232 and either ECE 321 or MATH 333. Focuses on digital optical networks, architecture, modulation techniques, and detection noise. Related topics are wireless communication, infrared link, and CATV. Computer simulations of network systems are done with commercial software packages.

**ECE 425. Wireless Communication Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 481 or ECE 421. Introduction to wireless system design and engineering. Develops an understanding and appreciation of the wireless engineering problems such as cellular layout design, resource allocation, mobility management, capacity and performance and signaling load calculations. Introduces physical layer building blockssuch as modulation, synchronization, coding, diversity, equalization, and spreading.

**ECE 429. Computer Communications Lab. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 422. Experiments with different protocols and standards used in the TCP/IP computer communications, including Ethernet/802.3 standard, Address Resolution Protocol (ARP), Internet Protocol (IP), Transport Control Protocol (TCP), User Datagram Protocol (UDP), and others. Exercises with network measurements and virtualization tools, and configurations of some commercial routers are included.

**ECE 431. Introduction to Feedback Control Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 333. Concept of feedback control. Typical feedback control systems. System dynamics by Laplace transform and state space methods. Stability definition and assessment: Routh-Hurwitx criteria. Graphical stability methods: Root locus, Nyquist and Bode plots. Performance evaluation and simulation. Matlab/Simulink used extensively. A good background in Laplace transform and linear (matrix) algebra highly desirable.

**ECE 432. Control Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 431. A continuation of the study of automatic control systems with emphasis on computer-aided design and problem solving. Topics covered include state feedback control, observers, industrial regulators, linear quadratic regulators, and the analysis of various common system nonlinearities. Implementation techniques on both analog and digital platforms will be addressed.

**ECE 435. Medical Imaging Instrumentation and Data Acquisition Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 231, ECE 252 and ECE 333. Three-Dimensional medical imaging modalities including X-ray Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, and Ultrasound utilizes advanced highly integrated electronic sensors, fast processor-based computers, and advanced signal proessing and reconstruction methods.

**ECE 436. Bio Control Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 431. This course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Real time signal acquisition and processing are also adressed.

**ECE 439. Control Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 431. Laboratory work in the design and synthesis of control systems, closely coordinated with the control systems elective.

**ECE 441. Power Electronics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 373. Electronic devices and circuits used to energize various apparatus and systems. Topics include circuits, freewheeling diodes, thyristors, firing and commutation of silicon-controlled rectifiers, converters, dc choppers, and power supplies.

**ECE 442. Power Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 341. Introduction to power plants and power networks. Topics include transmission line parameters, system modeling, economic operations of power systems, load flow studies, short circuit analysis, and power system stability.

**ECE 443. Renewable Energy Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 231 and ECE 271. This course presents the various sources of renewable energy including wind, solar, and biomass as potential sources of energy and investigates the contribution they can make to the energy profile of the nation. The technology used to harness these resources will be presented. Discussions of economic,environment, politics and social policy are integral components of the course.

**ECE 449. Power Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 494. Corequisite: ECE 442. Laboratory work in the design and synthesis of power systems, closely coordinated with the power systems elective.

**ECE 451. Advanced Computer Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 353. Focues on dvanced concepts in computer systems design, and the interaction between hardware and software components at various levels (i.e., hardware/_software codesign). Introduces common performance measures used by hardware and software designers to facilitate comparative analysis. Main topics are: advanced pipelining, good instruction sets, CISC and RISC microprocessors, introduction to parallel computing, and a brief historical survey of computer designs.

**ECE 452. Advanced Computer Architecture II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 451 Overview of recent advances and topics of current active research in the field of Computer Architecture. Includes: new computing paradigms such as brain inspired non-von Neumann architectures, stochastic computing, hybrid memory systems and other architectures leveraging emerging memory technologies. Systolic array systems; new interconnect architectures including NoCs; GPU-accelerated computing etc. are also discussed.

**ECE 453. Introduction to Discrete Event Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 251 or CS 251 or equivalent, and MATH 333 or ECE 321 or equivalent. Introduces logical models, timed models, and stochastic timed models of discrete event systems. Applies petri net methodology to the modeling of computer systems, flexible manufacturing systems, communication networks, and robotics. Contrasts the approaches of _simulation, elementary queueing theory, and Markov processes.

**ECE 457. Digital Image Processing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 333. An introduction to the fundamental techniques for digital image processing. Covers human visual sstems, image sensing and acquisition, image sampling and quantization, 1-D and 2-D systems, image enhancement, image restoration, image degradation, features extraction, and image segmentation.

**ECE 459. Advanced Computer Systems Design Lab. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 451, ECE 495. Corequisite: ECE 452. Design laboratory component of the advanced computer systems technical track offered to COE majors in the senior year. Experiments emphasize advanced CPU design concepts, such as RISC approaches and exception handling, multiprocessor and systolic array computers, and FPGAs. Develop software programs to test the capabilities of these hardware designs.

**ECE 461. Microwave and Integrated Optics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 362. The analysis and design of microwave transistor amplifiers and oscillators using scattering parameter techniques. Topics include transmission line theory, scattering parameters, matching networks, signal flow graphs, amplifier design considerations (power gain stability, noise and band width), and negative resistance oscillator design.

**ECE 462. RF/Fiber Optics Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 362. Topics include dielectric waveguides and optical fibers, semiconductor optical sources and detectors; rf/microwave modulation and demodulation of an optical carrier; design concepts in optical transmitters and receivers; and usage of CAD software tools for rf/microwave simulations.

**ECE 463. Optoelectronics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 374. The course addresses electronic and optoelectronics device concepts. Topics include optical materials, semiconductor materials,light propagination in waveguide, solar cell, LED and modulation of light.

**ECE 469. RF/Microwave and Fiber Optics Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Corequisite: ECE 462. Laboratory work in characterization of RF/microwave transmission structures and optical fibers, sources and detectors, spectral and time domain (OTDR) measurements in micro-waves and optics. Experiments in microwave and fiber optic links. Usage of CAD software tools for RF/microwave simulations.

**ECE 472. Pulse Techniques. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 373. Topics in electronics including linear and non-linear operational-amplifier circuits, the frequency compensation of operational-amplifiers, higher-order active filters including switched-capacitor designs, waveform generators, multi-vibrators, timers, waveshapers, converters, and other selected topics.

**ECE 475. VLSI Circuits. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 372. Topics include MOSFETs, their characteristics and use in analog and digital circuit design, static and dynamic circuits; memory cells; differential stages; symbolic layout of NMOS and CMOS circuits; fundamentals of silicon processing technology and associated design rules and methodology; calculation of chip performance including power, speed and area; logic arrays.

**ECE 481. Digital Communications Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 321. An introduction to digital communications systems and modulation and techniques, along with simulation experiments of communications systems and techniques in Matlab/Simulink. Description of AM and FM modulations, sampling and digitalization of signals, baseband and carrier-modulated digital transmission, signal detection in noise, inter-symbol interference and equalization, channel capacity, data compression techniques, error detection and correction methods.

**ECE 482. Communications Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 481. A continuation of the study of communications systems with selected topics from different areas of communications theory such as sampled-data communications, information theory and noise.

**ECE 489. Communications Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 481. The laboratory experiments are designed using Matlab/Simulink and Software Defined Radio (SDR). The major lab tasks include time and frequency domain analysis of AM and FM signals, generation and detection of digitally modulated waveforms such as BPSK, QPSK, 16QAM and 64QAM which are widely used in wireless communication networks. Through the experiments, students learn how to use Matlab/Simulink to control the SDR, to assess and combat the impairments due to noise and interference, and become familiar with instruments such as spectrum analyzers, audio analyzers and noise generators.

**ECE 494. Electrical Engineering Laboratory III. 2 credits, 3 contact hours (1;2;0).**
Prerequisites: ECE 341, ECE 374, ECE 392. A senior laboratory with experiments in two distinct areas: A) power and energy conversion, and B)semiconductor devices. Part A involves experiments with full size ac and dc electric motors, generators, and transformers. In part B characteristics of diodes, transistors and solar cells are measured using computer controlled instrumentation.

**ECE 495. Computer Engineering Design Lab. 3 credits, 5 contact hours (1;4;0).**
Prerequisites: ECE 353, ECE 394. Preparation for putting into practice the concepts learned in ECE 353. Emphasizes hardware design and debugging. Topics include combinational and sequential logic design using CAD tools, design based upon PLA/PLD devices, computer interface design using hardware and software, and an open-ended design project such as a central processing unit design.

**ECE 498. Special Topics in Electrical and Computer Engineering. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of electrical and computer engineering not regularly covered in any other ECE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**ECET 201. Circuits I. 3 credits, 4 contact hours (2;2;0).**
This first course in Electrical Circuits introduces the student to both DC and AC Circuit Theory. It includes Ohm's and Kirchoff's Laws for analysis of series and parallel circuits. Series-parallel, ladder and bridge networks are analyzed. Resonance and frequency response are included along with an introduction to AC circuits. Circuit simulations and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 202. Circuits II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 201 or ECE 231 and Math 138 or Math 111 This second course in Electrical Circuits expands on Circuit Theory introduced in ECET 201. It includes Ohm's and Kirchhoff's Laws for analysis of series and parallel AC circuits. Series-parallel, ladder and bridge networks are analyzed using AC signals. Resonance and frequency response are included. The basic theory and operation of diodes and transistors, including dc biasing are studied. Circuit simulation and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 205. Fundamentals of Analog Electronics. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 202 or ECE 232 This course introduces students to the active components used in electronics circuits. It covers the physics, the characteristics, and some applications of semiconductor diodes and transistors. The applications will include amplifiers, rectifiers, op amps, oscillators, and timers. Circuit simulation and laboratory experiments are designed to support the theory and provide measurement skills.

**ECET 210. Intro. to Microprocessors and Computer Architecture. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: None This is an introductory course in computer architecture and microprocessor applications for students who already have basic knowledge of digital circuit principles. Computer hardware architecture is analyzed, and assembly-language programs are written and run. Computer architecture concepts are applied through the use of assembly software programs for a popular microprocessor family. Theoretical ideas are reinforced by building and testing realistic experimental systems in the laboratory.

**ECET 214. Introduction to Communications. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 202 or ECE 232. Corequisite: ECET 205 A study of amplitude modulation, frequency modulation, and pulse modulation systems of transmission and reception, including applications of these systems in radio, television and telemetry. Introduces the latest digital communications theory and applications. Computer simulation and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 215. Introduction to Digital Electronics. 3 credits, 4 contact hours (2;2;0).**
The first course in digital electronics develops the fundamentals of the binary system, circuit implementation from Boolean functions and map minimization. Course includes study of combinational logic, sequential logic circuits, flip-flops, counters, and shift register. Computer simulation and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 300. Circuit Analysis: Transform Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECET 303 or ECE 232 and MATH 238 or Math 112. Corequisite: MATH 322 or MATH222. The principles, theorems and techniques of circuit analysis are reviewed. The technique of waveform and circuit transforms is introduced. Laplace transforms are studied and applied in the solution of circuit problems with a variety of input functions. Fourier analysis also is introduced. Extensive use of computer simulation software.

**ECET 303. Circuit Measurements. 2 credits, 4 contact hours (1;3;0).**
Prerequisite: ECET 205 or ECE 271 and MATH 238 or MATH 112. Lecture and laboratory sessions are designed to develop techniques for the measurement of various circuit parameters as well as the theoretical prediction of these parameters. Extensive use of computer simulation software.

**ECET 305. Integrated Circuit Applications. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 303 and MATH 238 or MATH 112. Corequisite: ECET 300. Provides a working knowledge of the characteristics and applications of integrated circuits. Topics include how linear ICs work, the most common circuit configurations in which ICs are used, and how to design the most commonly needed circuits with ICs, using manufacturers specification sheets.

**ECET 310. Microprocessors I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Courses in digital logic and introduction to microprocessors (AAS level). Develops a working knowledge of the characteristics and applications of microprocessors. Emphasis is put on the architecture and instruction set of an advanced microprocessor. Representative data handling problems are studied and tested in the laboratory.

**ECET 311. Embedded Systems I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CPT 315 or ECE 251 and ECET 215. Develops a working knowledge of the characteristics and applications of devices used in embedded systems such as microcontrollers. Emphasis is put on the architecture, instruction sets, and assemblers. Representative data handling problems and interfacing are studied and tested in the laboratory using state-of-the art hardware.

**ECET 314. Communication Systems. 3 credits, 4 contact hours (2;2;0).**
Corequisite: ECET 300. A study of amplitude modulation, frequency modulation, and pulse modulation systems of transmission and recep-tion, including applications of these systems in radio, television, and telemetry. Introduces the latest digital communications theory and applications. Perform appropriate laboratory exercises and projects.

**ECET 319. Electrical Systems and Power. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Physics I and Calculus (AAS level). Restriction: For non-ECET majors only. The fundamentals of ac and dc circuit theory are studied. Transistor and diode theory and their applications in amplifiers and filters are investigated. Electrical machines are also included in this course. Computer simulation as well as appropriate laboratories are required.

**ECET 329. Analog and Digital Electronics. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 201 or ECE 231. For MET majors only. Building on ECET 201, a study of more advanced topics in electronics including AC circuit analysis, op-amps, transistors, digital logic and microcontrollers. Computer simulation as well as laboratories are required.

**ECET 344. Numerical Computing for Engineering Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CS 101 or CS 100 or CS 106, or CS 115 and MATH 238 or MATH 112. Corequisite: MATH 309. An introduction to the use of a computer to analyze and solve problems common in engineering.Using computers and the application language students will confront a variety of tasks that will promote an object oriented programming structure. The goal of this course is to understand and program routines commonly used in the design of computer algorithms for computer-based problems. Practical applications as well as mathematical programming are stressed.

**ECET 350. Computerized Industrial Controls. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 315 and ECET 311. This course introduces students to the theory and application of computerized control systems and technologies used in industry today. The course focuses on the hands-on development and integration of programmable logic controllers (PLCs), motor controllers (drives), and supervisory software.

**ECET 365. Digital Logic and Circuit Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECET 215 or ECE 251 Develops the mathematics and minimization techniques together with the circuit implementation for the design of combinational and sequential digital solid-state logic circuits. Studies decoders, mulitplexers, counters, registers, and PLDs. Computer and communications circuits are used as examples. Projects employ computer simulation of digital circuits.

**ECET 395. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: Completion of Freshman year and Approval of the department and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**ECET 401. ECET Senior Project I. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: ECET 344, ECET 305, ECET 411 and ENG 352. The first course in a two-course sequence comprised of Senior Project 1 (ECET 401) and Senior Project 2 (ECET 402). Project management, concurrent engineering, proposal development, library research, and computer usage are stressed. Students develop a formal proposal, technical specifications, Gantt chart, and design specifications for the senior project to be implemented in ECET 402.

**ECET 402. ECET Senior Project II. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: ECET 401 (The previous semester) Apply technical knowledge to implement, build, and test the project approved in ECET 401.Complete library research, design specifications, computer analysis, simulation, and time and cost estimates. Purchase and build a working prototype of the design. Complete formal testing procedures to verify that the prototype meets design specifications. Submit formal written documentation and present the project during an oral presentation to a design review board and other students in the class.

**ECET 406. Control Systems and Transducers. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: ECET 305. Class and laboratory study of analog and digital automatic control. Using Laplace transforms, principles of analysis and design of control systems are introduced. Transducer characteristics and their application in instrumentation and control are investigated. Several experiments are implemented using Programmable Logic Controllers (PLCs).

**ECET 410. Microprocessors II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 310 and ECET 365. Covers the operations, bread boarding, and interfacing of devices peripheral to microcom-puters. Emphasizes embedded applications of microprocessers to systems requiring both hardware and software development. Advanced topics include programmable peripheral I/O controllers, interrupts and local ISA, PCI and USB buses.

**ECET 411. Embedded Systems II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 311 and ECET 365. This course is the second of two embedded systems courses. The primary objective is to prepare students in the ECET curriculum to design embedded systems as part of senior project and also in industry. The design of embedded systems is investigated at the hardware and software level with an emphasis on processor and system architecture. The C language is used for programming.

**ECET 412. Power Generation and Distribution. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 205 or ECE 271 Electrical generation, transmission, and distribution systems with an emphasis on 3 phase analysis, design, short circuit currents due to symmetrical faults, and reliability considerations of the electric power system. The laboratory portion includes hands on activities and experiments that align electric power theory with application. Design considerations for inside / outside plant, worker safety, system interconnection and protection, while focusing on reliability and cost considerations are covered.

**ECET 415. Fundamentals of Telecommunications. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 214. The focus of this course is on network data communication systems and related protocols. Main topics include transmission media including coax, twisted pair, fiber optics, wired, and wireless media. The Transmission Control Protocol/Internet Protocol (TCP/IP) model as well as the Open System Interface (OSI) model are discussed with emphasis on the details of the TCP/IP model. Additional topics such as wired and wireless LAN, backbone networks, wide area networks, The Internet, networking security, and networking design are covered.

**ECET 416. Networking Applications. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 344. Introduces students to the technology of networking with a particular focus on local area networks and the protocols associated with network communication. Comprised of two components: concept/theory and hands-on/applications in the laboratory. Topics include: an overview of network communication systems, networking concepts, network protocols, network standards, wide area networks, local area networks, enterprise networks, network topology, media access control, transport control protocol, internet protocol, and routing. Students learn to analze traffic flow on network links and how to write network based software applications.

**ECET 418. Transmission Systems. 3 credits, 4 contact hours (2;2;0).**
Prerequisites:ECET 214. A study of wireless and terrestrial transmission systems with an emphasis on fiber optics and the latest wireless techniques. The lectures examine the technologies as well as the advantages and disadvantages of the various transmission techniques. The laboratories are a mixture of fiber optic, microwave, and wireless experiments providing hands-on experience in these important areas.

**ECET 440. Clinical Internship. 3 credits, 3 contact hours (3;0;0).**
By Advisement". Consists of 200 hours of experience in the clinical engineering department of a hospital. The student is under the supervision, and is evaluated by, the director of clinical engineering at the hospital. A final report is submitted to and graded by the NJIT faculty advisor.

**ECET 444. Technology Applications of Object-Oriented Programming. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 344. Brings together prior software knowledge and applies it to develop modern software applications. Comprised of theory and hands-on applications in the lab. Concepts in modular/structured design and object-oriented design will be combined to develop modern internet and database connected applications. Examine several case studies during the last few weeks. Design, construct, and test a practical software project.

**ECET 491. Special Projects in ECET. 1 credit, 3 contact hours (3;0;0).**
By Advisement". Special projects course for ECET students with subject matter to be arranged by instructor and approved by program coordinator.

**ECET 492. Special Projects in ECET. 2 credits, 3 contact hours (3;0;0).**
By Advisement". See ECET 491.

**ECET 493. Special Projects in ECET. 3 credits, 3 contact hours (0;0;3).**
By Advisement". See ECET 491.

**ECET 495. Co-op Work Experience II. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: ECET 395. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.

**ENE 262. Introduction to Environmental Engineering. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: CHEM 126, MATH 112, and PHYS 121. To introduce students to the integrated science, engineering, design and management concepts of engineered environmental systems. The course will cover environmental regulations and standards, environmental parameters, mass balance and natural systems, water quality management, water and wastewater treatment, air pollution control, noise pollution, and solid and hazardous waste management. Background material and laboratories in the environmental sciences and management areas will be covered. Group term papers and presentations will be required.

**ENE 360. Water and Waste Water Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ENE 262 and junior standing. Training in the methods used for water pollution control. Topics include the chemical, physical, and biological processes that occur in waste treatment design and in receiving waters; modeling schemes to determine allowable loadings in various bodies of water; and waste treatment processes used for water pollution control.

**ENE 361. Solid and Hazardous Waste Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ENE 262 and junior standing. Exposure to the area of air pollution control, solid waste disposal, and radioactive waste disposal. Topics include the chemistry of contaminated atmospheres; the influence on meteorological conditions of dispersion of pollutants; abatement processes used in the control of emissions; classification and nature of solid waste, and solid waste disposal techniques; sources and methods for the disposal of radioactive contaminants; and related health effects.

**ENE 362. Pollution Prevention. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Chem 126, Math 111, and Junior Standing. This course presents pollution prevention concepts and principles, terminologies, life cycle impact approaches, and management strategies. It will also serve as a community based service learning course. The course introduces available improvement techniques for industrial pollution prevention and control and examines specific applications to industries biological, chemical, physical, and thermal techniques.

**ENE 485. Special Topics in Environmental Engineering. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of environmental engineering not regularly covered in any other ENEcourse. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**ENE 490. Senior Project. 3 credits, 3 contact hours (0;0;3).**

**ENE 491. Research Experience in ENE. 3 credits, 3 contact hours (3;0;0).**

**ESC 310. Work Experience I. 3 credits, 3 contact hours (0;0;3).**

**ESC 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in engineering science. Provides the student with an opportunity to work on a research project under the individual guidance of a program faculty member.

**ESC 491H. Honors Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in engineering science and enrolled in the Honors College. Same as ESC 491, but projects are more comprehensive and are of greater depth.

**ESC 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: ESC 491. A continuation of ESC 491.

**ET 101. Introduction to Engineering Technology. 0 credits, 2 contact hours (2;0;0).**
This course introduces the student to engineering technology. Also included is an introduction to the various engineering technology options: Construction, Electrical and Computer, and Mechanical Engineering Technologies as well as Concrete Industry Management.

**FED 101. Fundamentals of Engineering Design. 2 credits, 3 contact hours (2;1;0).**
Corequisite: HUM 101 and MATH 110 or MATH 131 or MATH 111. Teams of students work on open-ended engineering projects. Sections are offered to represent an introduction to real-world engineering design problems in a specific engineering discipline. Topics covered include introduction to basic engineering design elements, processes, measurements, product and project design and development, with hands-on experiments in a specific major area. Students also learn to use engineering tools for computer-aided design and simulation. Technical writing and oral presentation along with project management skills are emphasized. Students are required to take an FED section corresponding to their declared major. Undecided students will be placed in FED sections which best correspond to their interests according to space availability.

**IE 101. Introduction to Industrial Engineering. 1 credit, 2 contact hours (1;1;0).**
An Introduction to the field of Industrial Engineering, the functions performed by industrial engineers, career paths and opportunities in the field, introduction to the student and senior professional societies, and initiation of a mentoring program.

**IE 203. Applications of Computer Graphics in Industrial Engineering. 2 credits, 3 contact hours (1;2;0).**
Restriction: sophomore standing. Methods, tools and technologies of networked, graphical/visual communication systems with an industrial engineering focus. Lean and sustainable green enterprise, product, process, service and shop floor level visual factory management systems. Provides analytical and practical knowledge of computer graphics in IE, including graphical standards necessary to meet the requirements of today?s practice. Introduction of modern web-based software tools and systems.

**IE 224. Production Process Design. 3 credits, 4 contact hours (2;2;0).**
Restriction: sophomore standing. Introduction to the theory and practice of manufacturing processes. Study covers the fabrication of metallic, plastic, and electrical products, operation of NC and other automatic equipment, and economics of the design and production process.

**IE 310. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Restriction: junior standing, approval of co-op faculty advisor, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their aca-demic program. Work assignments facilitated by the co-op office and approved by the co-op faculty advisor. Mandatory participation in seminars and completion of a report.

**IE 331. Applied Statistical Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211. A presentation of statistical analysis techniques and their applications. Topics include the statistical measures describing data, frequency distributions, probability distributions, sampling parameter estimation, hypothesis testings, regression analyses, and analyses of variance. Special emphasis on their application to industrial fields.

**IE 334. Engineering Economy and Capital Investment. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing. Introduction to the principles of engineering economics for utilization and evaluation of capital investments, including time value of money, depreciation, cost of capital, life cycle cost, net present value, and payback. Consideration of decisions involving multiple choice replacement, uncertainty, and risk.

**IE 335. Engineering Cost Analysis and Control. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing. The tools and techniques applicable for cost analysis and control including standard costs, variance analysis, cost volume relationships, cost estimation, and utilization of accounting data for control of operations.

**IE 339. Work Measurement and Standards. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: IE 203, IE 224. Emphasizes the measurement and evaluation of existing work methods and how improvement can be achieved. Topics include visual and micro-motion study techniques, motion economy, time study, and work sampling. The development and use of standard data and computerized techniques. Also, hands-on experience through a series of laboratory experiments.

**IE 355. Human Factors. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing. Human-machine systems analysis including study of workplace layout, measurement of employee efficiency and productivity, criteria for tool and fixture design or selection, industrial fatigue, environmental influences on performance including the effects of illumination, noise, vibration, thermal, and other atmospheric factors. Basic ideas of industrial hygiene; the impact of OSHA; and special techniques for experimenting with human subjects, via demonstrations and supervised experiments.

**IE 411. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: IE 310. Restriction: approval of co-op faculty advisor and permission of the Office of Cooperative Education and Internships. Full-time work experience of approximately one semester's duration. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and an oral presentation to IE faculty. Note: Normal grading applies to this COOP Experience.

**IE 436. Cost Analysis and Engineering Economics. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. Not open to industrial engineering majors. Focuses on the economic factors of concern to manufacturing engineers. Major topics include justification of proposed capital expenditures, equipment retirement and replacement decisions, cost determination, profitability studies, and manufacturing budget construction and utilization for cost control.

**IE 439. Deterministic Models in Operations Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 or equivalent. The deterministic techniques of operations research. Topics include the applications of linear, nonlinear, integer, and dynamic programming methods and network flows analysis to solve industrial and systems engineering problems.

**IE 440. Stochastic Models in Operations Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IE 331, MATH 222 or their equivalent. Probabilistic techniques of operations research. Topics include the applications of Markov chains, queueing and inventory control models to analyze and evaluate systems performance.

**IE 441. Information and Knowledge Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. Introduction to recent advances in the application of computers in industrial engineering and database structures, both sequential and random. Description of methods for organizing data, database modeling, information storage and retrieval. Also, applications of expert systems concepts and techniques.

**IE 443. Senior Project I. 2 credits, 4 contact hours (1;3;0).**
Restriction: senior standing. Introduction to senior design project. Selection of specific system design for the project, establishment of initial contacts, preliminary collection and analysis of system data. Concepts of system design analysis emphasizing simulation modeling and analysis, model verification, and model validation.

**IE 444. Senior Project II. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: IE 443. Senior design project, in which the concepts of industrial engineering systems, principles, and procedures are integrated and applied in industrial projects or case studies.

**IE 445. Idustrial Simulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 101, IE 331 or equivalent. Introduction to the application of simulation modeling for the analysis of complex industrial and manufacturing service systems. Examples are chosen from real-life situations such as warehousing, material handling, robotics, transportation, and hospital emergency rooms. Verification/validation as well as statistical analysis of both input/output data are introduced.

**IE 447. Legal Aspects of Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. Familiarization with the U.S. system of case law, statutes and regulations applicable to professional relationships involving the engineer. Includes contracts, property, product liability and other torts, governmental regulatory bodies such as OSHA, EPA, and NRC, professional liability, and role of codes and standards.

**IE 449. Industrial Robotics. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CS 101, PHYS 121, junior or senior standing. Robotics in manufacturing systems. The field of robotics is studied with emphasis given to the role of programmable robots in manufacturing. Hands-on experience with hardware and software necessary for various industrial robot systems through laboratory experience.

**IE 450. Product Engineering Standards. 3 credits, 3 contact hours (3;0;0).**
Restriction: senior standing. Developing and using standards in the design, manufacturing, and use of products. Topics include economics of parts standardization, drawing and assembly techniques, and use of national and international standards. Review of the role of standards-setting bodies and methods for the development of product testing standards used in industry and commerce.

**IE 451. Industrial Measuring Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 331. Reviews contemporary measuring systems and provides a basic under-standing of the various methods, their accuracy, reliability, and relative costs to perform. Includes measuring methods needed for compliance evaluation in accordance with occupational and safety legislation, industrial processes, and product design.

**IE 453. Computer Integrated Manufacturing. 3 credits, 4 contact hours (2;2;0).**
Restriction: junior or senior standing. Examines the components of computer integrated manufacturing (CIM) including the design of information frameworks and network protocols required to orchestrate full manufacturing automation. Study of CAD, CAPP, robotics, NC, CNC, computer interfacing, and database systems in the context of a CIM environment. Exposure to state-of-the-art CIM software and hardware.

**IE 455. Robotics and Programmable Logic Controllers. 3 credits, 4 contact hours (2;2;0).**
Restriction: junior or senior standing. Introduction to the design and implementation of programmable logic controllers for use in industry in the areas of automotive assembly, pharmaceutical manufacturers, the chemical industry, and others. Includes ladder logic, input/output ports, continuous process control, timing and counting functions, chaining sequences, and digital gate logic.

**IE 456. Introduction to Industrial Hygiene. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 355. Analysis of the effects of various environmental stressors on people at work, including their interference with performance and the development of acute and chronic health problems. Study of how numerous airborne contaminants, noise, thermal extremes, ionizing and nonionizing radiation, etc., affect workers alone and in combination. Topics include measurement and evaluation techniques, TLVs, control methodologies, legal requirements for employers.

**IE 459. Production Planning and Control. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IE 221, IE 439, junior or senior standing. A study of the components and functioning of integrated production, planning, and control systems. Forecasting, aggregate planning, scheduling, and recent models of production and inventory control for optimizing continuous and intermittent manufacturing operations. MRP basics. Introduction to using a computer to apply scheduling models.

**IE 460. Measuring Techiniques and Quality Control. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: understanding of basic probability. Not open to industrial engineering majors; intended for other engineers, inspection supervisors, and management. Various types of control charts and acceptance sampling systems and procedures. These techniques are used widely in industry to improve product quality and reduce costs.

**IE 461. Product Quality Assurance. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 331. Methods used to achieve higher product quality, to prevent defects, to locate chronic sources of trouble, to measure process capability, and to use inspection data to regulate manufacturing processes are emphasized. Preparation of statistical control charts and selection of suitable sampling plans.

**IE 463. Invention and Entrepreneurship. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior or Senior standing or permission of instructor. This course will teach students the process of developing new products. It takes students from the art of creativity through product design and concludes with the formulation of a business plan for marking and production. If the new product satisfies the requirements of novelty, usefulness and nonobviousness, a patent application may be filed.

**IE 466. Material Handling and Facilities Layout. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 439. Analysis of organized human activities typified by industrial and office operations. Recent methods are applied to optimize location and layout of facilities. Introduction to modern material handling systems, expert systems in plant layout, logistics of motion of people and materials, flow analysis, plant layout, and material handling techniques.

**IE 469. Reliability in Engineering Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IE 331 or equivalent, senior standing. Emphasizes the determination of systems reliability from a knowledge of characteristics and reliability of individual system components. Topics include reliability concepts, failure rates, systems analysis, optimization, maintenance, etc. Covers techniques for the formulation and evaluation of reliability models.

**IE 472. Product Liability Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. The techniques available to the engineer to minimize the hazards of design and manufacturing that result in product liability cases. The effect of legal precedents on design, manufacturing, advertising, marketing, and using a product within developing technical disciplines such as: reliability prediction and analysis methods, assuring the quality of manufactured products, loss control systems, safety engineering precepts, human factors principles and design review. Review of government regulations for safety and protection.

**IE 473. Safety Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. The principles and practices of safety engineering in product and facilities design. Safe practices and hazard control, safety standards and codes, inspection procedures, the role of insurance, governmental regulations, and safety statistics. Participation in current safety engineering research studies. The Occupational Safety and Health Act and related legislation.

**IE 480. Special Studies in Industrial Engineering for Non-Majors. 3 credits, 3 contact hours (3;0;0).**
Restriction: permission of the IE faculty advisor. Not open to industrial engineering majors. Individual investigations under faculty guidance through consultation, readings, and visits with recognized authorities and institutions, dealing with specialized industrial engineering problems. Explore in depth an area of interest and give a report in a seminar setting, and submit a written project report.

**IE 481. Investigations in Industrial Engineering I. 3 credits, 3 contact hours (0;0;3).**
Restriction: junior or senior standing, per-mission of the IE faculty advisor. Individual investigation under faculty guidance through consultation, readings, and visits with recognized authorities and institutions, dealing with specialized industrial engineering design problems. Explore in depth an area of interest and give a report in a seminar setting, and submit a written project report.

**IE 482. Investigations in Industrial Engineering II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: IE 481, permission of the IE faculty advisor. Further individual investigations, a continuation of IE 481.

**IE 492. Engineering Management. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. An introduction for engineering majors to the fundamentals of engineering economics and the management process for engineering and development. Major topics include capital investment justification methods, project organization, scheduling and control techniques, legal, quality, and staffing issues.

**ME 215. Engineering Materials and Processes. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CHEM 126 or CHEM 122. Students also must register for the lab component. Combined lecture and laboratory relating to the study of engineering materials. Processes of formation from liquid and particle state, plastic forming, molding deformation, and metal removal. Effects of heat treatment on material properties. Laboratory exercises involve basic machine tools and computer-controlled equipment.

**ME 231. Kinematics of Machinery. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 101, MECH 234. Design, selection, and evaluation of mechanisms for various applications. Topics include displacement, velocity, and acceleration analysis of planar linkages, synthesis of function generators and motion generators, design of cams, gear-tooth geometry and analysis of gear trains.

**ME 304. Fluid Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 236, ME 311. Introduction to the basic principles of conservation of mass, momentum, and energy as they apply to engineering systems which utilize fluids. Some of the topics are dimensional analysis, theoretical and empirical analysis of one-dimensional compressible and incompressible flow, empirical analysis of external and internal flows, and elementary boundary layer theory.

**ME 305. Introduction to System Dynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, MECH 236, ME 231. Principles of dynamic system modeling and response with emphasis on mechanical, electrical, and fluid systems. Application of computer simulation techniques.

**ME 310. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: completion of freshman year, approval of department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report.

**ME 311. Thermodynamics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211, PHYS 111. Thermodynamic fundamentals. Topics are the first and second laws of thermodynamics, physical properties of pure substances, entropy, ideal and real gases, and gaseous mixtures.

**ME 312. Thermodynamics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ME 311. A continuation of ME 311 including studies of irreversibility and combustion. Thermodynamic principles are applied to the analysis of power generation, refrigeration, and air-conditioning systems. Introduction to solar energy thermal processes, nuclear power plants, and direct energy conversion.

**ME 315. Stress Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, MECH 237, ME 215. Problems related to mechanical design. Topics include two-dimensional elasticity, transformation of stress and strain, plane stress problems, axisymmetric members, buckling criteria, and failure theories.

**ME 316. Machine Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 231, ME 315. Aspects of the design process and design of machine elements. Mini-projects are used to introduce engineering design procedures.

**ME 339. Fundamentals of Mechanical Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MECH 234. For industrial engineering majors. Topics include kinematics of mechanisms, machine components, and a brief intro-duction to mechanical vibrations. Students gain the ability to deal with design problems from the viewpoint of a non-specialist.

**ME 343. Mechanical Laboratory I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: EE 405, MATH 279 or Math 333 and MECH 236. Students also must register for the lab component. Laboratory and lecture in instrumentation and measurement for mechanical engineering students. Applications for the sensing of such variables as pressure, tem-perature, mass flow, and displacement. Particular attention to the applicability and sensitivity of instruments.

**ME 403. Mechanical Systems Design I. 3 credits, 3 contact hours (2;1;0).**
Prerequisites: ME 304, ME 305, ME 312, ME 316. Lectures and projects covering problem solving methodology in the design, analysis, and synthesis of mechanical and thermal systems. The student's academic background combines with engineering principles and topics to serve as a foundation for broad engineering projects. Emphasis on creative thinking and the engineering design process in projects involving the optimal conversion of resources.

**ME 405. Mechanical Laboratory II. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: ME 343, ME 312. Laboratory emphasizing the use of fundamental principles and instrumentation systems for the analysis and evaluation of mechanical components within a system.

**ME 406. Mechanical Laboratory III. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: ME 405, ME 407. Laboratory covering the testing and evaluation of complete mechanical systems.

**ME 407. Heat Transfer. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, ME 304, ME 311. A study of the three fundamental modes of heat transfer: conduction, convection, and radiation. A physical interpretation of the many quantities and processes in heat transfer using numerical methods. Theory is applied to the analysis and design of heat exchangers and other applications. Where appropriate, computer simulation is used.

**ME 408. Mechanical Systems Design II. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: ME 403, ME 407. A continuation of ME 403 from a more integrated viewpoint, with lectures on special topics. Concepts in optimization and computer simulation are considered in the design and synthesis of mechanical engineering systems. The projects are more comprehensive, emphasizing creative design, and requiring design decisions of a more sophisticated nature.

**ME 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ME 310, approval of the department, and permission of the Office of Cooperative Education and Internships. Full-time work experience of approximately one semester's duration. Provides major related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and project. Note: Normal grading applies to this COOP Experience.

**ME 425. Finite Element Method in Mechanical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CIS 101, Math 222, and Mech 237. Introduction to central ideas underlying the finite element method in mechanical engineering and its computer implementation. Fundamental concepts such as interpolation functions for one- and two-dimensional elements, bar element method, Galerkin's method, discretization of a model, methods of assembling global matrices, and the final solution techniques for obtaining nodal values. Specific applications to mechanical engineering problems in trusses, beams, torsion, heat transfer, fluid flow, plane stress, and plane strain.

**ME 430. Introduction to Computer-Aided Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CS 101, FED 101 and Math 222. Introduction to basic concepts of computer-aided design as applied to mechanical engineering design problems. Topics include numerical techniques, computer graphics, geometric modeling, design optimization, and databases for design. The laboratory uses current CAD software packages for mechanical design. Projects involve applications of the basic principles using student's own as well as available software.

**ME 431. Introduction to Robotics and Automation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 101, MECH 236. Introduction to mechanics and control of robotic manipulators. Topics include spatial transformations, kinematics, dynamics, trajectory generation, actuators and control, and relations to product design and flexible automation.

**ME 432. Principles of Air Conditioning and Refrigeration. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 304, ME 312; Corequisite: ME 407. A course in the fundamentals of air conditioning and refrigeration. Topics covered are psychometrics, cooling and heat load calculations, air distribution systems, duct design, vapor compression and absorption systems, and the principles of cooling towers.

**ME 433. Vibration Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 236, MATH 222. An introduction to the fundamental theory of mechanical vibrations. Undamped and damped systems with single and multiple degrees of freedom, transient vibration, vibrations of continuous media, and analog and numerical methods.

**ME 435. Thermodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211, PHYS 111. Intended for non-mechanical engineering students of all disciplines. Topics include the basic laws of thermodynamics, properties of fluids and solids, analysis of open and closed systems, gas and vapor power cycles, refrigeration and air conditioning, and an introduction to heat transfer. Cannot be taken for credit by mechanical engineering students.

**ME 437. Structural Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ME 315. Fundamentals of structural analysis. Consideration of stresses and deflections of beams as well as the design of beams, columns, trusses, and structural connections of steel, reinforced concrete, and timber structures.

**ME 438. Introduction to Physical Metallurgy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126 or CHEM 122, and ME 215. Introduction to metallic microstructures, solid solutions and the mechanical properties of metals and alloys. Physical understanding of diffusion processes is emphasized in covering the relationship between the nature of metals and different heat treating processes.

**ME 439. Principles of Tribology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126, MECH 237. An introduction to the principles of wear resistance of machine parts and tribology. Physical understanding of different mechanisms of wear and friction and methods of increasing durability.

**ME 441. Computer Simulation and Analysis in Mechanical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 430. This course covers various topics in Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE). The course provides an in-depth understanding and skill of constructing 2-D drawings using well-known commercial CAD package, and integrating 3-D solid modeling techniques into simulation, and analysis animation of new designs using commercial CAD/CAE software. The students will have hands-on experience to analyze Structure, Heat Transfer, and Computational Fluid Dynamics problems by using several different software packages. The course also focuses on CAD Product Data Exchange using both Direct Database conversion and International Standards based conversion methods between major CAD/CAE systems. Typical industrial applications will be illustrated.

**ME 451. Introduction to Aerodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 304, ME 311. Introduction to the basic principles and properties of fluid flow around immersed bodies. Topics include the kinematics and dynamics of fluid fields, the thin airfoil, finite wing theory, and one-dimensional compressible flow.

**ME 452. Dynamics of Space Flight. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 236, MATH 222. An introduction to the mechanics of space flight. After a brief introduction to the physics of the solar system, the dynamics of space flight are developed from the Newtonian viewpoint. Covers the performance and propulsion methods of rocketry.

**ME 455. Automatic Controls. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ME 305. Introduction to the principles of automatic controls. Emphasis on systems, considering their mechanical, hydraulic, pneumatic, thermal, and displacement -aspects. First and second order linear systems. Introduction to system analysis techniques such as Nyquist and Bode diagrams and applications in system design.

**ME 470. Engineering Properties of Plastics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 215, MECH 237. A study of the physical properties of the various commerical thermosetting and thermoplastic resins. An introduction to linear viscoelastic theory and its relationship to measurable mechanical properties of plastics. Also, engineering properties such as flammability, chemical resistance, and electrical properties.

**ME 471. Introduction to Polymer Processing Techniques. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 304, ME 407. A study of the various plastics processing techniques, including extrusion, injection molding, blow molding, compression molding, thermoforming, rotational molding, casting, etc. The relationship between product design and choice of process will be presented.

**ME 490. Mechanical Engineering Project A. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: departmental approval required. One or more individually selected projects. Projects usually require library research, design, cost analysis, planning of testing. Also involves an engineering report and a technical presentation.

**ME 491. Mechanical Engineering Project B. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: ME 490 and departmental approval required. One or more selected projects. Projects usually require library research, design, cost analysis, planning of testing. Also involves an engineering report and a technical presentation.

**MECH 234. Engineering Mechanics. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: PHYS 111, MATH 112. A course for industrial and mechanical engineering students in which the equilibrium of particles and rigid bodies subject to concentrated and distributed forces is studied.

**MECH 235. Statics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 111, MATH 112. Available for CE students only. Provides an understanding of equilibrium of particles and rigid bodies subject to concentrated and distributed forces.

**MECH 236. Dynamics. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: MECH 234 or MECH 235 with a grade of C or better or MECH 320 and Math 112, Phys 111/111A. Provides an understanding of the mathematics of the motion of particles and rigid bodies, and of the relation of forces and motion of particles.

**MECH 237. Strength of Materials. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: MECH 234 or MECH 235 with a grade of C or better and MATH 112, PHYS111/111A. A working knowledge of statics with emphasis on force equilibrium and free body diagrams. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions. Lab should be taken concurrently.

**MECH 320. Statics and Strength of Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 111, MATH 112. For chemical engineering and electrical engineering majors. Statics provides an understanding of the equilibrium of particles and rigid bodies, including simple machines, trusses, and frictional forces. Mechanics of materials covers pressure vessels, thermal stresses, torsion of shafts, stresses and deflection in beams, and column action.

**MET 103. Engineering Graphics and Intro. to CAD. 2 credits, 3 contact hours (1;2;0).**
A first course in Computer Aided Design (CAD), includes lab work using AutoCAD software. Topics include fundamentals of engineering graphics, AutoCAD command structure, setting units and limits, drafting primitives, layering, use of editing tools; grid, snap, and axis commands. Upon successful completion of this course, students should be able to effectively produce two-dimensional drawings using the AutoCAD software program.

**MET 105. Applied Computer Aided Design. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: MET 103. A second course in Computer Aided Design (CAD), additional AutoCAD topics include blocks, move and copy, array, mirror, text, text styles, 3D and isometric modes. Upon successful completion of this course, students should be able to use advanced AutoCAD commands to quickly and efficiently produce 2D and 3D drawings, and also be able to modify the AutoCAD environment (e.g., menues, macros, etc.) to boost productivity.

**MET 205. Advanced Computer Aided Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET 105. This course introduces advanced CAD applications, including attribute and attribute extraction, external reference files, solid modeling, surface rendering and animation. Upon successful completion of this course, students should be able to use a CAD software package to develop animations consisting of 3D models with rendered surfaces.

**MET 235. Statics for Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 102 and MATH 238. Provides an understanding of equilibrium of particles and rigid bodies subject to concentrated and distributed forces. Upon successful completion of this course, the students should be able to analyze problems involving the equilibrium of particles and rigid bodies, including simple machines, trusses, and frictional forces.

**MET 236. Dynamics for Technology. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: MET 235 or MECH 235. Provides an understanding of the mathematics of the motion of particles and rigid bodies, and of the relation of forces and motion of particles. Upon successful completion of this course, the students should be able to describe the motion of particles and rigid bodies as functions of time and position, develop their equations of motions due to applied forces, and determine post impact behavior.

**MET 237. Strength of Materials for Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET 235 or MECH 235. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structured problems, and an understanding of the mechanical behavior of materials under various load conditions. The laboratory experience is integrated within the course. Upon successful completion of this course, the students should be able to determine stresses and deformations for a variety of simple structural problems.

**MET 301. Analysis and Design of Machine Elements I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Elementary strength of materials, calculus (AAS level), Physics I, C++ or BASIC. The principles of strength of materials are applied to mechanical design. Topics include theory of failure, stress concentration factors and fatigue, the design and analysis of shafts subjected to static and dynamic loadings, and critical speed of a rotating shaft.

**MET 302. Analysis and Design of Machine Elements II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MET 301. A continuation of MET 301, including analysis and design of power screws, brakes, clutches, belts, chain drives, gears, gear trains, bearings, and other machine elements.

**MET 303. Applied Thermodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Calculus (AAS level), C++ or BASIC, Physics II. Basic principles of thermodynamics and their applications to internal combustion engines, turbines, compressors, power generating and refrigeration systems.

**MET 304. Applied Fluid Mechanics. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MATH 238 or MATH 112, PHYS 103 or PHYS 121. An introduction to fluid statics and the basic laws of fluid flow; conservation of mass, momentum and energy. Applications of the basic laws to internal and external incompressible flow, including specific topics in pipe flow systems, centrifugal pumps and fans, streamlining, and fluid flow meters.

**MET 307. Plastics Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET junior standing. An introduction to the basic concepts of plastics conversion, resin classification, processing techniques and significant engineering properties.

**MET 308. Plastics Processing Techniques. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MET junior standing, MET 307. A study of the various processing techniques for both thermoset and thermoplastic materials. Topics include extrusion, injection molding, blow molding, compression moldings, and casting processes.

**MET 314. Dynamics of Machinery. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Dynamics or kinematics (mechanisms), calculus (AAS level), C++ or BASIC. Acquaints students with motion and forces in machines. Topics include velocity and accelerations in linkages, gears, cam and gear trains, static and dynamic forces, and torques in linkages.

**MET 395. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of freshmen year. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**MET 401. Mechanical Design Project I. 2 credits, 2 contact hours (2;0;0).**
Prerequisites:MET 302, MET 303, MET 304, MET 314, ECET 329, ENG 352. Project and lecture applies the principles learned in all technical courses to more advanced design situations. Proposal of a typical mechanical engineering system is presented by an individual or by small groups. The proposal must meet the approval of course instructor. A formal proposal is required.

**MET 403. Applied Thermodynamics II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MATH 309, MET 303 or its equivalent, MET 304. Builds on a first course on thermodynamics and covers thermodynamic properties of steam, first and second law of thermodynamics. Topics include power and refrigeration cycles, psychrometric chart and combustion.

**MET 404. Applied Heat Transfer. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MATH 309, MET 303, MET 304. An introduction to the fundamental theories and applications of heat transfer. Emphasizes understanding and practical problem solving in covering the three fundamental modes of heat transfer: conduction, convection, and radiation.

**MET 407. Structural Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: C++ or BASIC, elementary strength of materials. Acquaints students with the fundamentals of structural design. Topics include analysis and design of structural members due to various loadings (tension, compression, bending, torsion, and shear), deflections of structural members, truss analysis, stress analysis of weldment.

**MET 409. AirConditioning and Refrigeration. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MET 303, MET 304. Calculation of building cooling and heating loads, psychrometric charts, air distribution and duct design. Topics also include compression and absorption refrigeration cycles, automatic control of refrigeration systems, and building energy management.

**MET 415. Automatic Control Systems. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MET senior standing. Introduction to programmable logic controllers (PLC) as a tool for industrial controls of machines and process. Includes selections of hardware and software, ladder logic programming, wiring methods, maintenance and trouble shooting of.

**MET 448. Mechanical Design Project II. 1 credit, 2 contact hours (2;0;0).**
Prerequisite: MET 401. Continuation of project MET 401. Oral presentation and formal written report are required.

**MET 491. Special Projects in MET. 1 credit, 3 contact hours (3;0;0).**
One-credit special project course for MET students. Must have an instructor agreeing to sponsor the project. Approval by program coordinator is required.

**MET 492. Special Projects in MET. 2 credits, 3 contact hours (3;0;0).**
Two-credit special project course for MET students. Must have an instructor agreeing to sponsor the project. Approval by program coordinator is required.

**MET 493. Special Projects in MET. 3 credits, 3 contact hours (3;0;0).**
Three-credit special project course for MET students. Must have an instructor agreeing to sponsor the project. Approval by program coordinator is required.

**MET 495. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: MET 395. Approval of the department, and permission of the Office of Cooperative Education and Internships. Full-time work experience for approximately one semester. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project.

**MIT 326. Electronic Medical Record Design. 3 credits, 4 contact hours (2;2;0).**
This course will prepare students to manage medical records and related information in different medical settings like individual/group medical practices, health care organizations, long-term care settings, insurance companies, health-care software consulting companies, and/or government agencies. This course will also enable Medical Informatics student interns to become well versed in technology used during their internships. This course has two main objectives; first planning for Electronic Medical Record (EMR) adoption and implementation, and second, practical techniques of implementing and customizing Electronic Medical Records.

**MIT 360. Introduction to Gerontology. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Junior level standing. R920 201 or R830 101. Introduction to Gerontology is an introduction to the field of human aging. The course of study will include a multidisciplinary examination of the way in which human aging is viewed and how we perceive the process of growing older and how society responds to the issues of aging. The class will look at aging from multiple perspectives that include the social, political and biological sciences, arts and humanities, care giving and social services. This proposed course will provide students with an understanding of the unique challenges individuals experience as they age. Second it provides some basic hands/labs covering assistive technologies and personal and mobile sensors.

**MIT 362. Geriatric Engineering I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MIT 360 and (CS 106 or CS 113 or CS 115 or CPT 341) and (MATH 305 or MNET 315.) This course will first provide students with an understanding of the unique challenges individuals experience as they age. It introduces system design techniques to facilitate assistive technologies that foster independent living. The course provides a labs for the emerging field of designing assistive technologies and personal and mobile sensors. Labs will incorporate A hands low-power small footprint computing devices for sensor monitoring. Students will explore the feasibility of using, for example Raspberry Pi, and Arduino platforms, to monitor vital signs and export data to Electronic Health Record (EHR) platforms. Big Data challenges will be explored in preparation for meaningful use applications required by all EHR systems.

**MIT 440. Clinical Internship. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Junior Level Standing, CPT 325 and permission MIT program coordinator. During the course of a semester the student gains 100 hours of experience in the IT or Network and Security department of a hospital. The student is under the supervision, and is evaluated by, the director of the corresponding program at the hospital. A final report is submitted to and graded by the BS, MIT Program Advisor at NJIT.

**MNET 300. Concepts In Machining. 3 credits, 3 contact hours (3;0;0).**
Applications in the machining of various materials. Topics include speeds and feeds calculations, tooling concepts, gaging techniques and prototype construction.

**MNET 303. Advanced Techniques in CAD/CAM. 3 credits, 4 contact hours (2;2;0).**
Applications including hands-on experience with CAD/CAM systems. Emphasis is on understanding how displayed objects are represented and manipulated on the computer. Laboratory experiences contribute to an understanding of the advantages and limitations of CAD/CAM systems.

**MNET 315. Industrial Statistics. 3 credits, 4 contact hours (2;2;0).**
Introduction to statistics covering data collection, analysis and presentation. Specialized topics include probability, control charts, correlation, regression, hypothesis testing, and -experimentation.

**MNET 318. Mnfg Process Design. 3 credits, 4 contact hours (2;2;0).**
A development of the principles of production, methodology and economics in view of production requirements with respect to materials, tolerances and finish. Production processes are matched to the product requirements. Laboratory work supports the lecture. Computer problem solving is incorporated in the course.

**MNET 395. Coop Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**MNET 405. Numc Control Machn Tools. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MNET 300 or equivalent. Fundamental concepts of numerical control systems. Assignments include mill and lathe programming techniques, sheet metal processing, and CNC economics.

**MNET 414. Industrial Cost Analysis. 3 credits, 3 contact hours (3;0;0).**
An introduction to general costing techniques. Time value of money concepts are introduced to decision-making matters such as equipment justification, design selection and fabrication costs.

**MNET 416. Production Scheduling. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MNET 315. A study of manual and computerized methods for setting schedules. Gantt charts, CPM, PERT, PERT/COST, and Line of Balance are some of the topics treated. Problems of line balancing and machine loading are discussed.

**MNET 420. Quality Systems. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: Basic statistics. Introduction in quality control that emphasizes design quality, total quality management and statistical process control. Additional topics include quality economics, ISO, reliability, service quality, measurement and acceptance sampling.

**MNET 421. Contracts & Specs. 3 credits, 3 contact hours (3;0;0).**

**MNET 422. Tool Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MNET 300 and MNET 303. Introduction to the design of cutting tools with emphasis on speeds, feeds, and power requirements. Covers design of jigs, fixtures, punch and dies, gaging and inspection tooling with emphasis on current industrial practices.

**MNET 423. Motion & Time Study Tech. 3 credits, 4 contact hours (2;2;0).**
A study of the basic principles of motion study concerning workplace design and related techniques involving process analyses, man-machine charts and micromotion study. Covers stopwatch time study techniques as well as predetermined time standards, work sampling and wage incentive system.

**MNET 426. Manufacturing Project. 2 credits, 4 contact hours (1;3;0).**
Prerequisite: Senior standing. A capstone project requiring a formal written report and oral presentation.

**MNET 495. Cooperative Experien II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MNET 395 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.

**SET 200. Introduction to Geomatics. 3 credits, 6 contact hours (3;3;0).**
Plane surveying with angle and distance measurements; leveling; topographic mapping; traverse and area computations; horizontal and vertical curves; cross sections; triangulation; state plane coordinates; 3-D surveying using global positioning system (GPS), Geographic Information Systems (GIS) and remote sensing technology for surveying and mapping applications. Emphasis is on the use of the computer for solving typical field and office problems. Field exercises in conjunction with the classroom exercises in SET 200 utilizing classical and electronic instruments and COGO/CAD software.

**SET 207. Evidence and Procedures for Property Surveys. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 200. Introduction to surveying law and to the concept of evidence related to boundary locations as discoverable on the ground and through deeds or other written records. Understanding of the principles of property law, titles, land ownership, transfer of land ownership, deed descriptions, evidence recovery and conflict resolutions.

**SET 280. Marine Surveying. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: CE 200 or SET 200. Marine Surveying builds on the core competencies introduced in "Introduction to Geomatics":. This course focuses on computer generated solutions for nautical charts and water boundary delineations using imaging, optical, LiDAR, and acoustic observations via marine, airborne, and space-based platforms; to understand marine surveying technology for solutions on environmental problems; develop skills and techniques to enhance, interpret, and analyze acoustic measurements using computer-based methods.

**SET 301. Route Surveying (Surveying III). 4 credits, 6 contact hours (3;3;0).**
Prerequisites: CE 200 or equivalent. Horizontal and vertical curves computation and layout with regard to highway design. Special emphasis on complex curves. Topics include control, positioning, error analysis, highway design problems, and layout. Also included is a review of the concepts of right-of-way surveys.

**SET 302. Geodetic Control Surveying (Surveying IV). 4 credits, 6 contact hours (3;3;0).**
Prerequisites: CE 200 or equivalent. A study of the higher order methods and techniques of surveying such as Global Positioning System (GPS) with observations of HARNs, 1st, 2nd and 3rd Orders of Accuracy along with the requisite computations to reduce these observations to measurements and the applications of these measurements to the State Plane Coordinate systems and the geoid.

**SET 303. Photogrammetry and Aerial Photo Interpretation. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: CE 200 or equivalent. A review of the principles of photography, including the physical science of optics as related to the use of aerial photos, to engineering and land surveying projects. Includes the necessary mathematics of photogrammetry and the process of designing and establishing the required data for proper acquisition of photogrammetric information.

**SET 304. Adjustment Computations I. 4 credits, 4 contact hours (4;0;0).**
Prerequisites: Calculus I or equivalent. A course designed to give the student the necessary knowledge to reduce survey observations to measurements; to analyze the data to determine the relationship of adjusted measurements to the observations; to verify that the mathematical constraints have been met; and to introduce approximate and least squares adjustments of surveying observations.

**SET 307. Boundaries and Adjacent Properties. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: SET 207. A course on legal principles regarding boundaries and the constructive solutions of the problems of boundary surveying by a consideration of deed descriptions and examples of their application to surveying.

**SET 360. Digital Surveying Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: SET 200 or MET 205 or equivalent, or instructor permission. Digital surveying methods focus on skills using robotic and digital geospatial data collection technologies for mapping using CAD methods. Topics include digital data collection, data preparation, reductions, and data processing for coordinate computations. Topics in CAD focus preparing as-built site plans, plat or survey diagram, Digital Elevation Model (DEM) or a Digital Surface Model (DSM) development. Students will experience "hands on" exercises in the practice of geospatial data collection, handling instrumentation, data processing and data representation.

**SET 401. Fundamentals of Geodesy (Surveying V). 3 credits, 3 contact hours (3;0;0).**
Prerequisite: SET 302 and SET 303. Geodesy and its relation to surveying and other disciplines. Topics include geometric, physical and satellite geodesy. Also includes the concept of map projection.

**SET 403. Remote Sensing Principles for Geomatics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 200 or SET 200. Principles of remote sensing for Geomatics application build on the core competencies introduced in Introduction to Surveying. This course focuses on computer generated solutions from technologies used for the acquisition and production of geospatial data via terrestrial, airborne, and space-based platforms; to understand remote sensing technology for solutions on scientific environmental problems; develop skills and techniques to enhance, interpret, and analyze digital imagery using computer-based methods.

**SET 404. Adjustment Computations II. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: SET 304. Introduction to the concepts of observations and models. A continuation of the theory of least squares and the mathematical weighting of observations. Also includes the statistical evaluation of least square results.

**SET 407. Boundary Line Analysis. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: SET 307. Develops the analytical synthesis of real property law, land surveying procedures, and scenario development compatible with current case law decisions for the development of most probable scenarios of boundary location for the court's consideration.

**SET 420. Geographic/Land Information Systems. 4 credits, 6 contact hours (3;3;0).**
Prerequisites: SET 307 or MET 205 or permission of instructor. Geographic/Land Information System builds on the core competencies that were introduced in the course "Introduction to Surveying". This course focuses on understanding the fundamentals of Geographic/Land Information Systems (GIS/LIS) and Multi-Purpose Cadastres. Topics on LIS emphasize issues relating to the design, implementation, and maintenance of land records. Topics on GIS emphasize GIS data models (vector versus raster) and database development for applications in diverse fields like criminal justice, economics, and infrastructure. Students will learn practical skills on web-based mapping and GIS.

**SET 440. Land Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: SET 207 and CE 321 or equivalent. Understanding the process of development of land through the study of land use law, federal, state and municipal land use regulations, federal and state regulations regarding environmental issues and the administrative and statutory laws governing the preparation of land surveys; impart the ability to prepare a land survey from initial contact and the proposal phase to preliminary and final plan approval through a class project designed to cover all of these phases.

**SET 490. Senior Project in Surveying. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: Senior standing. The student works on an individual surveying project guided by the department staff. The project should concentrate on a specific aspect of surveying, not necessarily on field measurements. Project includes library research, written report and oral presentation of findings.

**SET 491. Special Projects in Surveying. 1 credit, 1 contact hour (0;0;1).**
This course provides students with research experience in Geomatics/Surveying at the undergraduate level. Course content and scope of study will be approved by the coordinator of the SET program. Topics can include GPS data processing, marine surveying for bathymetric modeling and generalization, and geophysical surveying using gravity and topography data. Course outcomes include knowledge of advanced data processing, data analysis, and interpretation at the undergraduate level.

**SET 492. Special Projects in Surveying. 2 credits, 2 contact hours (0;0;2).**
This course provides students with research experience in Geomatics/Surveying at the undergraduate level. Course content and scope of study will be approved by the coordinator of the SET program. Topics can include GPS data processing, marine surveying for bathymetric modeling and generalization, and geophysical surveying using gravity and topography data. Course outcomes include knowledge of advanced data processing, data analysis, and interpretation at the undergraduate level.

**SET 493. Special Projects in Surveying. 3 credits, 3 contact hours (0;0;3).**
This course provides students with research experience in Geomatics/Surveying at the undergraduate level. Course content and scope of study will be approved by the coordinator of the SET program. Topics can include GPS data processing, marine surveying for bathymetric modeling and generalization, and geophysical surveying using gravity and topography data. Course outcomes include knowledge of advanced data processing, data analysis, and interpretation at the undergraduate level.

**TMT 301. Digital Electronics for Telecommunications. 3 credits, 4 contact hours (2;2;0).**
Studies the fundamentals of digital electronics including combinational and sequential logic. Emphasizes those signals and configurations commonly employed in telecommunication systems. Theory is reinforced in hardware and simulation laboratory exercises.

# Biomedical Engineering

## Objectives of Biomedical Engineering Program

The principal objective of our undergraduate program is to prepare students for productive careers in the field of biomedical engineering. As a department in New Jersey's technological research university, we anticipate that a significant number of our graduates will serve in the medical device and biotech industries in the state. But we also anticipate that many of our graduates will utilize their preparation in biomedical engineering to enter into other related fields such as medicine, dentistry, law, business or management.We expect our graduates to demonstrate effective leadership and to be prepared to work in culturally diverse environments. We also expect them to be able to use their multidisciplinary background to foster communication across professional and disciplinary boundaries and to remain mindful of the ethical and social implication of their work.We expect them to be able to integrate their fundamental knowledge in the basic sciences, mathematics, and engineering to address and solve a wide range of problems in medicine and biology. In keeping with the complex and continuously evolving nature of the field of biomedical engineering, we expect that most of our graduates will continue their formal education in advanced programs and that our alumni will engage in life-long learning.

## Description of Biomedical Engineering Programs

Biomedical engineering students combine a study of fundamental physiological and biological fundamental processes with a study of engineering methods. Within the biomedical engineering program, there are a number of focus areas, which lead to specific program tracks for undergraduate study. The bioinstrumentation track utilizes electrical engineering methods extensively. The biomechanics track brings mechanics and mechanical engineering methods into play. The biomaterials and tissue engineering track employs tools from chemical engineering and materials science.

For students committed to pursuing a professional career in an area other than engineering, the Engineering Science Accelerated Programs for Pre-Health and Pre-Law offer challenging educational opportunities. These programs involve a concentration in Biomedical Engineering while also meeting the broad requirements for the degree of Bachelor of Science in Engineering Science. These non-accelerated programs have attenuated engineering course requirements and are designed to prepare the student upon graduation to pursue advanced education in a professional school in medicine, dentistry, optometry, physical therapy or law.

The program requires only three years of attendance at NJIT with subsequent completion of the program via courses taken during the first year of professional school.Examples of research activity within the biomedical engineering field include signal processing of electrocardiograms, electroencephalograms, electromyograms; design of clinical instrumentation (e.g., for ophthalmology); design and analysis of prosthetic devices such as knees, hips and heart valves; design of robotic techniques for rehabilitation; experimental testing of the control of eye movements and other skeletal motor control systems; gait and limb motion analysis; development of new biomaterials (including many containing living cells) for both hard tissues (bone and teeth) and soft tissues (muscle, skin, cartilage, blood vessels), biomechanical testing of myocardial and vascular tissue; modeling and simulation of cardiac and vascular dynamics; modeling and simulation of the function of other organs such as lungs and kidneys; clinical image processing; biomedical applications of MEMS (micro electro-mechanical systems). Research is conducted cooperatively between NJIT and neighboring medical institutions.

## Mission of Biomedical Engineering

1. Educate undergraduate students for productive careers and life-long learning, especially in the health-related areas of industry, the professions, and government service
2. Educate biomedical engineering graduate students for employment in industry, health professions, government, or academe
3. Emphasize preparation for leadership roles for all levels of students, both undergraduate and graduate
4. Engage in research to support the advanced education of graduate students, maintain the intellectual vitality of the faculty, and expand the frontiers of knowledge in areas of importance to the state and the nation
5. Publish and present the results of our intellectual activities, resulted from both research and teaching advances
6. Serve our profession through membership and leadership in national and international societies
7. Serve our wider constituencies by offering our expertise to other health-related professionals, industries, and state and local communities

## Program Educational Objectives

1. To prepare students for productive careers related broadly to biomedical engineering. It is anticipated that BME graduates will embark upon diverse career paths, serve the medical device/pharmaceutical/biotechnology industries, and use their education in a variety of related endeavors including medicine, dentistry, law, business, government, and other engineering/scientific fields.
2. While working within their selected career path, we expect that our alumni will demonstrate the following traits:
    a. **BME alumni are integrators:** We expect BME graduates to successfully and effectively integrate their fundamental knowledge of sciences, mathematics, liberal arts, and engineering analysis into actions that address and solve a wide range of problems, especially those related to medicine and biology.
    b. **BME alumni continue their professional growth:** We expect BME graduates to advance their skills through professional growth and development opportunities provided by participation in a professional society, continuing education, or graduate study in engineering or other professional fields.
    c. **BME alumni are engaged in service:** We expect BME graduates to engage themselves in service to their chosen professional societies as well as their local, national, or global communities.

## Program Outcomes

By the time they graduate from the Biomedical Engineering Program, students will demonstrate that they possess the following knowledge and skill sets:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Similar to students outcomes Biomedical Engineering specific program criteria are incorporated throughout curriculum and linked to specific learning outcomes. Program-specific criteria:

- An understanding of biology and physiology
- The capability to apply advanced mathematics (including differential equations and statistics) to solve the problems at the interface of engineering and bilogy.

- The capability to apply advanced science and engineering to solve the problems at the interface of engineering and biology.
- The ability to make measurements on and interpret data from living systems.
- Addressing the problems associated with the interaction between living and non-living materials and systems.

The program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 - telephone (410)347-7700 http://abet.org.

## NJIT Faculty

### A

Adamovich, Sergei, Associate Professor

Alvarez, Tara L., Professor

Arinzeh, Treena L., Professor

### B

Biswal, Bharat, Professor

### C

Chandra, Namas, Professor

Chaudhry, Hans, Research Professor

Cho, Cheul, Assistant Research Professor

### D

Di, Xin, Assistant Research Professor

### F

Foulds, Richard A., Associate Professor

### G

Georges Deveau, Penelope, University Lecturer

### H

Haorah, James, Associate Professor

Hunter, William C., Professor

### I

Ihlefeld, Antje, Assistant Professor

### J

Jaffe, Michael, Research Professor

Jiang, Zhiguo, Research Professor

### L

Lee, Eun Jung, Assistant Professor

Li, Xiaobo, Associate Professor

### M

Mantilla, Bruno Antonio, University Lecturer

### O

Ophir, Zohar, Research Professor

## P

Perez-Castillejos, Raquel, Assistant Professor

Peringady, M. A. Muneer, Assistant Research Professor

Pfister, Bryan J., Chair

## R

Reisman, Stanley, Professor Emeritus

## S

Sahin, Mesut, Professor

Schesser, Joel, Senior University Lecturer

Skotak, Maciej, Assistant Research Professor

## V

Van Buskirk, William C., Distinguished Professor Emeritus

# Programs

- Biomedical Engineering - B.S. (p. 465)

# Accelerated Programs (p. 92)

- Biomedical Engineering, Pre-Health - Accelerated B.S. (http://catalog.njit.edu/undergraduate/newark-college-engineering/biomedical/accelerated-bs-prehealth)

Biomedical Engineering Minor (p. 469) (for Engineering Science students)

Nanotechnology Minor (p. 469)

# Biomedical Engineering Courses

**BME 101. Introduction to Biomedical Engineering. 0 credits, 3 contact hours (3;0;0).**
This course is open only to freshmen and new transfer students. Faculty members describe their research in biomedical engineering.

**BME 102. Biomedical Engr Research. 1 credit, 1 contact hour (1;0;0).**
Corequisite: FED 101 OR BME 111 Students at our prehealth program aim to be in medical practice. This course offers them to critically read medical engineering articles, understand it, research it and present engineering design principles to our faculty. This will enhance their ability to both succeed professionally and to contextualize their chosen vocations.

**BME 105. Introduction to Human Physiology I. 2 credits, 2 contact hours (2;0;0).**

**BME 106. Introduction to Human Physiology II. 1 credit, 1 contact hour (1;0;0).**

**BME 111. Introduction to Physiology. 3 credits, 3 contact hours (3;0;0).**
This course is open only to freshmen and transfer students. An overview of human physiology is presented as an introduction to subsequent core courses in the Biomedical Engineering curriculum. Not intended to be an exhaustive review of physiology, the course will instead emphasize key examples that highlight understanding of the interaction between the biomedical and engineering worlds.

**BME 301. Electrical Fundamentals of Biomedical Engineering. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: Grade of C or higher in PHYS 121 and MATH 112. Course lectures and laboratories will address important issues for biomedical engineers at the introductory level; covering the origins of bio-electric signals and the instrumentation involved in collection of biopotentials from the electrodes to processing of the signals on the computer. Some other topics included are the transducers/sensors and modern engineering software used in bio-instrumentation. Laboratory work will provide hands-on experience in all of these areas. The course will also address practical issues in design of medical devices such as noise, resolution, linearity, and saturation. This course is offered in Studio format that involves the integration of lectures and labs into one highly participatory structure.

**BME 302. Mechanical Fundamentals of Biomedical Engineering. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: Grade of C or higher in PHYS 121 and MATH 112. BME 301 is not a prerequisite. The format is identical to that of BME 301. Course lectures and laboratories will address important issues covering the mechanical fundamentals that are important bases for later learning experiences. This course introduces the students to to engineering mechanics and how those principles are relevant to biomechanical issues. This course is offered in Studio format that involves the integration of lectures and labs into one highly participatory structure.

**BME 303. Biological and Chemical Foundations of Biomedical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Grade of C or higher in (CHEM 126 or CHEM 122) and PHYS 121. This course covers organic chemistry, biochemistry and cellular mechanics in sufficient depth to give biomedical engineering students a strong enough background for them to understand the introductory aspects of the discipline, which focus on the application of engineering principles to medicine and surgery.

**BME 304. Material fundamentals of Biomedical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: A Grade of C or higher in (CHEM 126 or CHEM 122) and BME 111.This course is an introduction to the field of biomaterials with an emphasis on the wound healing process and interactions between the human body and implanted devices fabricated from various types of biomaterials. The thrust of this course will be to illuminate the processes occurring at the tissue-biomaterial interface. Attention will be given to the biological events occurring at the molecular level on the surface of an implanted device. The nature of these surfaces and the physiological consequences of these processes will be examined in terms of how the body and functioning of the device are impacted.

**BME 310. Biomedical Computing. 3 credits, 4 contact hours (3;1;0).**
Prerequisite: Grade of C or higher in BME 111 and BME 301 and CS 101. This course covers the application of digtal signal processing to biomedical problems. Application of programming language common in engineering, for signal acquisition and processing. Applications include analysis of the electrocardiogram and other electrical signals generated by the body.

**BME 311. Co-op Work Experience. 3 credits, 3 contact hours (0;0;3).**
Restriction: sophomore standing or above, approval of department, and permission of Career Development Services. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**BME 321. Adv Mechanics for Biomed Engr. 3 credits, 3 contact hours (3;0;0).**
Prerequisite:BME 302 with a grade of C or better This course provides an understanding of engineering mechanics, especially as applied to biomechanical systems. Students should be familiar with static equilibrium analysis and concepts of stress and strain. Course topics include method of sections, area moment of inertia, mechanical properties of materials, torsion, bending, stress transformation, Mohr’s circle, and deflection of beams.

**BME 333. Biomedical Signals and Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 310 and MATH 222. BME Tools such as the Laplace and Fourier Transforms, time-frequency analysis are introduced. Applications include signals and noise, processing of the ECG, mathematics of imaging and derivation of useful physiological parameters from input signals.

**BME 351. Introduction to Biofluid Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 111, BME 302, MECH 236 and MECH 320 all with a C or bettter. Introduction to the principles of fluid flow. Basic fluid principles, such as fluid properties, fluid statics, conservation of mass, momentum, and energy will be discussed and presented in BME context. Special attention will be given to the non-Newtonian nature of blood, viscous flow in arteries, unsteady flows, and to the fluidic output of the heart. The textbook material will be supplemented throughout the course to emphasize examples relative to BME.

**BME 372. Biomedical Electronics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite:BME 111 and BME 301 with a C or better. The first of a two-semester sequence that covers the design of electronic circuits for Biomedical applications. This course covers basic operational amplifier circuits as well as the operation of semiconductor diodes and transistors. An introduction to digital logic circuits is also provided. Computer simulation as well as hands-on breadboarding of electronic circuits are used throughout the course to supplement the lectures.

**BME 373. Biomedical Electronics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BME 372. This is a continuation of BME 372 emphasizing biomedical applications of oscillators, active filters, and wave-shaping circuits.

**BME 382. Engineering Models of Physiological Systems. 3 credits, 5 contact hours (5;0;0).**
Prerequisites: BME 111, BME 301, BME 302 and Math 222 all with a C or better. Students learn to develop quantitative models of organs and organ systems from an engineering viewpoint. Students translate their understanding of physiological systems into models that evolve dynamically based on engineering block diagrams. Additional topics include: hierarchical structure, sensitivity analysis, parameter estimation, negative feedback control, and characteristic traits of models. Students will use models to gain insight into how a physiological system functions and to design a biomedical engineering device or procedure that interacts with the physiological system. Systems studied include the cardiovascular system, gas exchange in the lungs, nerve and muscle action potentials, and musculo-skeletal spinal reflex.

**BME 383. Measurement Lab for Physiological Systems and Tissue. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: BME 302, BME 310, and (MATH 279 or MATH 333). Through laboratory experiences, students will apply engineering methods for measuring and interpretating the properties of physiological systems and biological tissues. Topics include measurements relevant to cardio-pulmonary, nerve and muscular systems.

**BME 384. Biomechanics Laboratory. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: BME 111, BME 302, MECH 236, MECH 320, CS 101 and MATH 279 all wtih a C or better. This course is an introduction to the experimental analysis of the biomechanics of human motion. Laboratory experiments include the application and integration of anatomical and mechanical concepts to a wide variety of activities. Students will develop basic competence in a systematic approach to the observation, analysis and evaluation of human movement in clinical, educational, and industrial environments.

**BME 385. Cell and Biomaterial Engineering Laborarory. 3 credits, 4 contact hours (1;3;0).**
Prerequisite: MATH 112, PHYS 121 BME 304 and (MATH 279 or MATH 333) all with a C or better. This laboratory course is designed to provide students with valuable hands-on experience in the field of cellular and biomaterial engineering. Experiments include biomaterial fabrication and characterization, mechanical testing of biomaterials, colorimetric protein assay, cell-based assay, the basics of cell culture techniques, the basics of light and electron microscopy, and image capture and analysis. A lecture on the principles of a given technique will be followed by laboratory activity.

**BME 386. Bioinstrumentation Laboratory. 3 credits, 4 contact hours (1;3;0).**
Prerequisites: ECE 251, BME 372 and (MATH 279 or MATH 333). Laboratory exercises involve projects at all levels of a bioinstrumentation system from sensors to data acquisition and data processing. Analog and digital circuits are constructed to condition the signals from sensors and convert them into a format that can be displayed or acquired into a computer. The final projects help to develope the skills to integrate various parts of a bioinstrumentation system, collect and analyze data and troubleshoot a circuit.

**BME 411. Co-op Work Experience. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: BME 311 and completion of sophomore year, approval of department, and permission of Career Development Services. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report. May count as BME or approved elective. Grade will now be issued as a letter grade.

**BME 420. Advanced Biomaterials Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 302, BME 304, MATH 222 and MTSE 301. The goal of this course is to understand material selection, important properties of materials for use in the body and failure modes of applied biomaterials. The course will cover the structure and properties of materials used as biomaterials including metals, ceramics, synthetic polymers, and biopolymers. The structure of these materials will be explored to understand how it defines the behavior of a material. The bulk behavior of materials will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced (including thermal strain, surface properties, and viscoelasticity). Students will be presented with problems of property characterization, failure analysis and performance testing. Students will work in teams to analyze a marketed implant or device using biomaterial(s) using the tool and concepts learned in the course.

**BME 422. Biomaterials Characterization. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Math 112, Phys 121, BME 304 and MTSE 301 all with a C or better. The quantum mechanical origins of spectroscopy, the relationship of spectroscopic behavior to thermal characteristics of a material, and the differences in approach to the chemical and physical characterization of synthetic and biological polymers are discussed.

**BME 427. Biotransport. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222, (BME 303 or R120 102), and CHE 230. This course provided an introduction to basic concepts in thermodynamics and transport phenomena as applied to biological systems. The structure and composition of the body will be covered followed by an exploration of the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Design of artificial kidneys and heart-lung machines is also explored.

**BME 430. Fundamentals of Tissue Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BME 302, (BME 303 or R120 102), BME 304, MATH 222 and MTSE 301. This course is an introduction to the field of tissue engineering as a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated by delivering cells, scaffolds, DNA, proteins, and/or protein fragments at surgery. This course will cover the advances in the fields of cell biology, molecular biology, material science and their relationship towards developing novel "tissue engineered" therapies.

**BME 451. Biomechanics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 302, MECH 236 and MECH 320. Tensor analysis. Kinematics of continuous media. Stress. The elastic solid. Newtonian fluid. Conservation principles of mass, momentum and energy. Viscometric flows. Formulation of constitutive equations. Applications to the modeling of bone and other living tissues.

**BME 452. Mechanical Behavior and Performance of Biomaterials. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: BME 302, BME 304, MATH 222, MATH 337, MATH 279, and MECH 320. Biomaterial selection and performance is essential to the design and implementation of most any biomedical application. Students will learn about important properties of materials for use in the body and failure modes of applied biomaterials. Material behavior will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced including thermal strain, surface properties, and viscoelasticity. Material biocompatibility will be introduced in regards to body responses including cell and tissue interaction, toxicity and safety.

**BME 471. Principles of Medical Imaging. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 301 and BME 310 This is an introductory undergraduate course in biomedical imaging. This course will cover medical physics, instrumentation, data aquisition and processing to generate structural and functional images. A number of modalities including X-ray, Computer Tomography, Ultrasound, and magnetic resonance imaging systems are included. This course is an elective in te Bioinstrumentation track.

**BME 478. Introduction to CAD for Biomechanics. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: BME 302 and MECH 320. Introduction to Computer Aided Designing and analysis as applied to biomedical engineering design programs. Topics include theoretical insight into the process of design and geometrical modeling and design using industry standard CAD (Computer Aided Design) software packages. The course will also include several projects involving the applicaiton of design principles to standard problems in biomedical design.

**BME 479. BioMicroElectroMechanical Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 301, BME 302, and BME 304. This course focuses on the study of the broad body of knowledge required to design, fabricate, and test BioMEMS. We define BioMEMS as any type of biomedical devices for the fabrication of which miniaturization techniques (at least in part) are required. BioMEMS are used in advanced analytical techniques (microfluidic devices), implantable chips, biomedical sensors and actuators, and in-vitro tissue modeling. BioMEMS for diagnosis as well as for cell biology and tissue engineering are studied. This course provides a hands-on approach to BioMEMS and microfluidic devices and allows students to design, fabricate, and characterize their own BioMEMS.

**BME 489. Medical Instrumentation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: BME 372, BME 310. This course covers the hardware and instrumentation needed to measure variables from different physiological systems. The following topics will be taught: electrodes, sensors and transducers. Bioelectric amplifiers, electrical safety and computing. Applications include the study and design of instrumentation for measurement of the ECG, EEG, EMG, respiratory system, nervous system in general.

**BME 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
In depth research experience taught under the guidance of a professor typically within a laboratory. Approved requirements are needed for engineering credit. Research thesis required. Needs permission of professor.

**BME 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: BME 491. Approved requirements are needed for engineering credit. Research thesis required. Needs permission of professor.

**BME 493. Honors Research Thesis I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: GPA 3.5, an appropriate research methods course and ENG 352 Part of a two semester undergraduate research thesis. Students will learn how to formulate a hypothesis, design a scientific based experiment, analyze data using statistics, interprete data, and describe work within oral defense and written thesis.

**BME 494. Honors Research Thesis II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: BME 393 Part of a two semester undergraduate research thesis. Students will learn how to formulate a hypothesis, design a scientific based experiment, analyze data using statistics, interprete data, and describe work within oral defense and written thesis.

**BME 495. Capstone Design I. 3 credits, 4 contact hours (1;3;0).**
Restriction: Senior standing. Prerequisite: BME 372 or MTSE 301 or (MECH 236 and MECH 320). The goal of this course is to provide students with the guidance to choose a capstone design topic and advisor conduct library/search engine background research and to prepare the design proposal for their chosen project. The course introduces the student to the definition of design as well as introducing issues of intellectual property, bioethics and safety, and professional societies.

**BME 496. Capstone Design 2. 3 credits, 4 contact hours (1;3;0).**
Prerequisite: BME 495. Implementation of the project approved in BME 495. This portion of the project includes library research, time and cost planning, oral and written reports, as well as construction, troubleshooting and demonstration of a working prototype.

**BME 498. ST:. 3 credits, 3 contact hours (3;0;0).**

# Accelerated B.S. in Biomedical Engineering

(133 credits minimum)

This program is designed to prepare the student upon graduation to pursue advanced education in a professional school (for medicine or dentistry).

The criteria for enrollment in this accelerated program include:

- Acceptance into the Albert Dorman Honors College.
- Acceptance into an accelerated pre-professional program.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| CHEM 125 | General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| FED 101 | Fundamentals of Engineering Design | 2 |
| BME 101 | Introduction to Biomedical Engineering | 0 |
| BME 105 | Introduction to Human Physiology I | 2 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| PHYS 121 | Physics II | 3 |

| | | |
|---|---|---|
| PHYS 121A | Physics II Laboratory | 1 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 112 | Calculus II | 4 |
| BME 106 | Introduction to Human Physiology II | 1 |
| | **Term Credits** | **19** |
| **Summer** | | |
| BME 302 | Mechanical Fundamentals of Biomedical Engineering | 3 |
| MATH 279 | Statistics and Probability for Engineers | 2 |
| MECH 320 | Statics and Strength of Materials [1] | 3 |
| Humanities and Social Sciences (upper-level) or English Composition and Cultural History (lower-level) GUR Elective | | 3 |
| | **Term Credits** | **11** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 211 | Calculus III A | 3 |
| R120 101 | General Biology | 4 |
| CHEM 243 | Organic Chemistry I | 3 |
| BME 301 | Electrical Fundamentals of Biomedical Engineering | 3 |
| BME 420 | Advanced Biomaterials Science [1] | 3 |
| MTSE 301 | Principles of Material Science and Engineering [1] | 3 |
| | **Term Credits** | **19** |
| **2nd Semester** | | |
| BME 310 | Biomedical Computing | 3 |
| R120 102 | General Biology | 4 |
| CHEM 244 | Organic Chemistry II | 3 |
| CHEM 244A | Organic Chemistry II Laboratory | 2 |
| BME 422 | Biomaterials Characterization [1] | 3 |
| MATH 222 | Differential Equations | 4 |
| | **Term Credits** | **19** |
| **Summer** | | |
| Social Science (lower level) GUR Elective | | 3 |
| MGMT 390 | Principles of Management | 3 |
| BME 491 | Research and Independent Study I [1] | 3 |
| MATH 337 | Linear Algebra | 3 |
| | **Term Credits** | **12** |
| **Third Year** | | |
| **1st Semester** | | |
| Social Science (lower level) GUR Elective | | 3 |
| CHE 230 | Chemical Engineering Thermodynamics I [1] | 3 |
| BME 430 | Fundamentals of Tissue Engineering [1] | 3 |
| BME 495 | Capstone Design I | 3 |
| BME 479 | BioMicroElectroMechanical Systems [1] | 3 |
| Physical Education GUR Elective | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| 300- or 400-level Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| Open Elective in Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| BME 427 | Biotransport [1] | 3 |
| BME 382 | Engineering Models of Physiological Systems | 3 |
| BME 495 | Capstone Design I | 3 |
| Humanities and Social Sciences (upper-level) Capstone GUR Elective | | 3 |

| | | |
|---|---|---|
| Physical Education GUR Elective | | 1 |
| | **Term Credits** | **19** |
| | **Total Credits** | **133** |

1 Suggested course to fulfill B.S. in BME requirements; may be replaced by BME approved course.

# B.S. in Biomedical Engineering

The following is a model timeline to complete the requirements for the degree. Beyond the 4th semester, semester credits and BME track course credits may differ from those listed, according to the track requirements provided.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| CHEM 125 | General Chemistry I | 3 |
| MATH 111 | Calculus I | 4 |
| FED 101<br>or BME 111 | Fundamentals of Engineering Design<br>or Introduction to Physiology | 2-3 |
| BME 101 | Introduction to Biomedical Engineering | 0 |
| | **Term Credits** | **16-17** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| MATH 112 | Calculus II | 4 |
| FED 101<br>or BME 111 | Fundamentals of Engineering Design<br>or Introduction to Physiology | 2-3 |
| | **Term Credits** | **17-18** |
| **Second Year** | | |
| **1st Semester** | | |
| Cultural History (lower-level) GUR Elective | | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| BME 301<br>or BME 302 | Electrical Fundamentals of Biomedical Engineering<br>or Mechanical Fundamentals of Biomedical Engineering | 3 |
| BME 303<br>or BME 304 | Biological and Chemical Foundations of Biomedical Engineering<br>or Material fundamentals of Biomedical Engineering | 3 |
| MATH 211 | Calculus III A | 3 |
| MATH 279 | Statistics and Probability for Engineers [2] | 2 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| Social Sciences (lower-level) GUR Elective | | 3 |
| BME 301<br>or BME 302 | Electrical Fundamentals of Biomedical Engineering<br>or Mechanical Fundamentals of Biomedical Engineering | 3 |
| CHEM 243 | Organic Chemistry I | 3 |
| BME 303<br>or BME 304 | Biological and Chemical Foundations of Biomedical Engineering<br>or Material fundamentals of Biomedical Engineering | 3 |
| MATH 222 | Differential Equations | 4 |
| Physical Education GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **Third Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| Social Sciences (lower-level):GUR Elective | | 3 |
| BME 382<br>or BME 383 | Engineering Models of Physiological Systems<br>or Measurement Lab for Physiological Systems and Tissue | 3 |
| BME 310 | Biomedical Computing | 3 |
| BME core concentration course | | 3 |
| MATH 337 | Linear Algebra | 3 |
| BME core concentration course | | 3 |
| Physical Education GUR Elective | | 1 |
| | **Term Credits** | **19** |
| **2nd Semester** | | |
| Humanities and Social Science (upper-level) GUR Elective [1] | | 3 |
| BME 382<br>or BME 383 | Engineering Models of Physiological Systems<br>or Measurement Lab for Physiological Systems and Tissue | 3 |
| BME core concentration course | | 3 |
| BME core concentration course | | 3 |
| BME core concentration or elective course [3] | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MGMT 390 | Principles of Management [1] | 3 |
| BME 495 | Capstone Design I | 3 |
| BME core concentration course | | 3 |
| BME core concentration course | | 3 |
| BME core concentration or elective course | | 3 |
| BME concentration laboratory elective | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Capstone seminar or Humanities and Social Science (upper-level) GUR Elective [1] | | 3 |
| Select one of the following: | | 3 |
| Lit, Hist, Phil (upper-level) GUR Elective | | |
| PHIL 351 | Biomedical Ethics | |
| HIST 379 | History of Medicine | |
| HIST 381 | Germs Genes and Body: Sci. and Tech. in Modern Medicine | |
| BME 496 | Capstone Design 2 | 3 |
| BME concentration elective | | 3 |
| BME concentration elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **134-136** |

[2] MATH 279 Statistics and Probability for Engineers is a co-requisite with BME 302 Mechanical Fundamentals of Biomedical Engineering.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success, which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## BME Tracks:

## (34 credits). BME students are required to select a track before their 4th semester. The curriculum for each track requires 34 credits, 27 of which must be in engineering and science or design.

## Bioinstrumentation Track

| | | |
|---|---|---|
| BME 372 | Biomedical Electronics | 3 |

| | | |
|---|---|---|
| BME 333 | Biomedical Signals and Systems | 3 |
| BME 373 | Biomedical Electronics II | 3 |
| BME 489 | Medical Instrumentation | 3 |
| ECE 251 | Digital Design | 3 |
| ECE 252 | Microprocessors | 3 |
| BME 386 | Bioinstrumentation Laboratory | 3 |
| Advanced Elective [1,2] | | 9 |
| BME 471 | Principles of Medical Imaging | 3 |
| **Total Credits** | | **33** |

[1] Chosen in consultation with advisor.
[2] Six credits must be engineering science or design.

## Biomaterials and Tissue Engineering Track

| | | |
|---|---|---|
| BME 385 | Cell and Biomaterial Engineering Laborarory | 3 |
| BME 420 | Advanced Biomaterials Science | 3 |
| BME 427 | Biotransport | 3 |
| BME 430 | Fundamentals of Tissue Engineering | 3 |
| BME 422 | Biomaterials Characterization | 3 |
| CHE 210 | Chemical Process Calculations I | 2 |
| CHE 230 | Chemical Engineering Thermodynamics I | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| MTSE 301 | Principles of Material Science and Engineering | 3 |
| Advanced Elective [1] | | 5 |
| **Total Credits** | | **31** |

[1] Chosen in consultation with advisor.
[2] Five credits must be engineering science or design.

## Biomechanics Track

| | | |
|---|---|---|
| BME 351 | Introduction to Biofluid Mechanics | 3 |
| BME 384 | Biomechanics Laboratory | 3 |
| BME 451 | Biomechanics I | 3 |
| BME 452 | Mechanical Behavior and Performance of Biomaterials | 3 |
| BME 420 | Advanced Biomaterials Science | 3 |
| BME 478 | Introduction to CAD for Biomechanics | 3 |
| MECH 236 | Dynamics | 2 |
| BME 321 | Adv Mechanics for Biomed Engr | 3 |
| Advanced Elective [1,2] | | 8 |
| **Total Credits** | | **31** |

[1] Chosen in consultation with advisor.
[2] Four credits must be engineering science or design.

## Pre-Health Track

| | | |
|---|---|---|
| BME 385 | Cell and Biomaterial Engineering Laborarory | 3 |
| BME 420 | Advanced Biomaterials Science | 3 |
| BME 427 | Biotransport | 3 |
| BME 430 | Fundamentals of Tissue Engineering | 3 |
| BME 422 | Biomaterials Characterization | 3 |
| CHE 210 | Chemical Process Calculations I | 2 |
| CHE 230 | Chemical Engineering Thermodynamics I | 3 |

| | | |
|---|---|---|
| CHEM 244 | Organic Chemistry II | 3 |
| MTSE 301 | Principles of Material Science and Engineering | 3 |
| Advanced Elective [1] | | 5 |
| **Total Credits** | | **31** |

1 Chosen in consultation with advisor.
2 Five credits must be engineering science or design.

# Bioinstrumentation Concentration

## Bioinstrumentation Track

| | | |
|---|---|---|
| BME 372 | Biomedical Electronics | 3 |
| BME 333 | Biomedical Signals and Systems | 3 |
| BME 373 | Biomedical Electronics II | 3 |
| BME 489 | Medical Instrumentation | 3 |
| ECE 251 | Digital Design | 3 |
| ECE 252 | Microprocessors | 3 |
| BME 386 | Bioinstrumentation Laboratory | 3 |
| Advanced Elective [1,2] | | 18 |
| Technical Electives (upper-level) [1] | | 3 |
| **Total Credits** | | **42** |

1 Chosen in consultation with advisor.
2 Six credits must be engineering science or design.

# Biomaterials and Tissue Concentration

## Biomaterials and Tissue Engineering Track

| | | |
|---|---|---|
| BME 385 | Cell and Biomaterial Engineering Laborarory | 3 |
| BME 420 | Advanced Biomaterials Science | 3 |
| BME 427 | Biotransport | 3 |
| BME 430 | Fundamentals of Tissue Engineering | 3 |
| BME 422 | Biomaterials Characterization | 3 |
| CHE 210 | Chemical Process Calculations I | 2 |
| CHE 230 | Chemical Engineering Thermodynamics I | 3 |
| CHEM 244 | Organic Chemistry II | 3 |
| MTSE 301 | Principles of Material Science and Engineering | 3 |
| Advanced Elective [1] | | 5 |
| **Total Credits** | | **31** |

1 Chosen in consultation with advisor.
2 Five credits must be engineering science or design.

# Biomechanics Track

## Biomechanics Track

| | | |
|---|---|---|
| BME 351 | Introduction to Biofluid Mechanics | 3 |
| BME 384 | Biomechanics Laboratory | 3 |
| BME 451 | Biomechanics I | 3 |
| BME 452 | Mechanical Behavior and Performance of Biomaterials | 3 |
| BME 420 | Advanced Biomaterials Science | 3 |
| BME 478 | Introduction to CAD for Biomechanics | 3 |
| MECH 236 | Dynamics | 2 |

| | | |
|---|---|---|
| MECH 320 | Statics and Strength of Materials | 3 |
| Advanced Elective [1,2] | | 8 |
| **Total Credits** | | **31** |

1 Chosen in consultation with advisor.
2 Four credits must be engineering science or design.

# Biomedical Engineering Minor (for Engineering Sciences students)

Students must be honors students in the 7-year accelerated ESC premed or dental program. Requires a minimum of 18 credits of Biomedical Engineering courses:

| | | |
|---|---|---|
| BME 105 | Introduction to Human Physiology I | 2 |
| BME 106 | Introduction to Human Physiology II | 1 |
| BME 301 | Electrical Fundamentals of Biomedical Engineering | 3 |
| BME 302 | Mechanical Fundamentals of Biomedical Engineering | 3 |
| Select two of the following: | | 6 |
| BME 310 | Biomedical Computing | |
| BME 382 | Engineering Models of Physiological Systems | |
| BME 383 | Measurement Lab for Physiological Systems and Tissue | |
| BME 3XX or BME 4XX | Upper-division BME course | 3 |
| **Total Credits** | | **18** |

# Nanotechnology Minor

(18 credits)

Requires approval by Nanotechnology minor coordinator and academic advisor in student's major.

| | | |
|---|---|---|
| NANO 488 | Intro to Nanotechnology | 3 |
| Select five of the following (choose up to one Independent Research course): [1] | | 15 |
| BME 420 | Advanced Biomaterials Science | |
| BME 430 | Fundamentals of Tissue Engineering | |
| BME 479 | BioMicroElectroMechanical Systems | |
| BME 491 | Research and Independent Study I | |
| BME 492 | Research and Independent Study II | |
| CHE 375 | Structure, Properties and Processing of Materials | |
| CHE 380 | Introduction to Biotechnology | |
| CHE 491 | Research and Independent Study I | |
| CHE 492 | Research and Independent Study II | |
| CHE 619 | Nano-scale Characterization of Materials | |
| CHEM 340 | Chemistry and Engineering of Materials | |
| CHEM 437 | Applications of Computational Chemistry and Molecular Modeling | |
| CHEM 473 | Biochemistry | |
| CHEM 491 | Research and Independent Study I | |
| CHEM 492 | Research and Independent Study II | |
| ECE 374 | Electronic Device I | |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | |
| ECE 463 | Optoelectronics | |
| EVSC 335 | Environmental Law | |
| EVSC 416 | Environmental Toxicology | |
| EVSC 391 | Research and Independent Study | |
| MATH 448 | Stochastic Simulation | |
| MATH 491 | Independent Study in Mathematics | |
| ME 438 | Introduction to Physical Metallurgy | |

| | | |
|---|---|---|
| MTSE 301 | Principles of Material Science and Engineering | |
| OPSE 301 | Introduction to Optical Science and Engineering | |
| OPSE 402 | High Power Laser and Photonics Applications | |
| OPSE 410 | Biophotonics | |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II | |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | |
| PHYS 350 | Biophysics I | |
| PHYS 418 | Fundamentals of Optical Imaging | |
| PHYS 490 | Independent Study | |
| **Total Credits** | | **18** |

[1] Research topic must be nanotechnology related.

# Chemical, Biological, and Pharmaceutical Engineering

Chemical engineers use chemistry, biology, physics and math in an integrated engineering mode in order to manufacture materials and products to modern society. They are involved with the full scale of processes, from the laboratory bench to the pilot plant and eventually to the manufacturing facility. The academic training of chemical engineers provides a strong background for a variety of areas, including;

- Process Design
- Pharmaceutical Engineering
- Production Engineering
- Research and Development
- Marketing/Technical Sales
- Environmental and Waste Management
- Safety

At present, chemical engineers are involved in areas such as producing more effective pharmaceuticals and more durable plastics, developing, biotechnology, genetic engineering applications, and producing electronic materials. They are also involved in the more traditional areas of petroleum refining and chemical manufacturing. A Chemical engineer may choose to work in a variety of industries which include chemicals, pharmaceuticals, food, energy, and environmental control. A chemical engineering degree also serves as a good preparation for law, business, or medical school.

The Mission of the Department is to:

1. Educate undergraduate students for employment in industry and the pursuit of graduate studies;
2. Educate graduate students for employment in industry, government, or academe;
3. Educate students, both undergraduate and graduate, for leadership roles;
4. Engage in research to support the advanced education of graduate students, maintain the intellectual vitality of the faculty, and expand the frontiers of knowledge in areas of importance to the state and nation;
5. Publish and present the results of our intellectual activities, resulting from both research as well as teaching advances;
6. Serve our profession through membership and leadership on national and international societies, journals and editorial boards; and
7. Serve our wider constituencies by offering our expertise to industries, state and local communities, and pre-college students and teachers.

## Chemical Engineering Program Education Objectives

### Engineering Practice

Graduates of our program are successfully engaged in the practice of chemical engineering within industry, academe and government working in a wide array of technical specialties including but not limited to process and plant design operations.

### Professional Growth

Graduates of our program advance their skills through professional growth and development activities such as graduate study in engineering or complimentary disciplines, and continuing education; some graduates will transition into other professional fields such as business, law and medicine through further education.

### Service

Graduates of our program perform service to the society and the engineering profession through participation in professional societies, government, civic organizations, and humanitarian endeavors.

## Chemical Engineering Program Outcomes

Graduates of the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering will have:

- an ability to apply knowledge of mathematics, science and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data of importance to the design and analysis of chemical processes.
- an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- an ability to function on multi-disciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively through written reports and oral presentations.
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- an introduction to contemporary issues in chemical engineering
- an ability to use the techniques, skills and modern engineering tools necessary for chemical engineering practice.

This program is accredited by the Engineering Accreditation Commission of ABET, http://abet.org.

## Advisement

All students are required to see their advisor at least once each semester immediately prior to formal registration for the following semester(s). Registration holds are removed following the meeting. All undergraduates must schedule their appointments online using Map-Works, to see their undergraduate advisor, Gordana Obuskovic.

### Freshman Advisement

Some freshmen are assigned courses (CHEM 121 Fundamentals of Chemical Principles I-CHEM 122 Fundamentals of Chemical Principles II; ENG 095 General Skills in English as a Second Language-HUM 099 English Composition: Reading, Writing, Speaking I-HUM 100 English Composition: Reading, Writing, Speaking II) and/or lightened credit loads. It is particularly important for these students to see their advisor to plan their courses for subsequent semesters. Completing pre-requisites for sophomore courses may involve attending summer sessions and/or spending an additional semester at NJIT.

## NJIT Faculty

### A

Armenante, Piero M., Distinguished Professor

### B

Baltzis, Basil C., Professor

Barat, Robert B., Professor

Basuray, Sagnik, Assistant Professor

Bilgili, Ecevit A., Associate Professor

### D

Dave, Rajesh N., Distinguished Professor

Dreyzin, Edward L., Distinguished Professor

### G

Gogos, Costas, Distinguished Research Professor

Gor, Gennady, Assistant Professor

Guvendiren, Murat, Assistant Professor

### H

Hanesian, Deran, Professor

Huang, Ching-Rong, Professor Emeritus

## K

Khusid, Boris, Professor

Kimmel, Howard, Professor Emeritus

## L

Loney, Norman, Professor

## P

Perna, Angelo, Professor

Pfeffer, Robert, Distinguished Professor Emeritus

## R

Rosty, Roberta, Senior University Lecturer

## S

Schoenitz, Mirko, Associate Research Professor

Sebastian, Donald H., Professor

Simon, Laurent, Associate Professor

Sirkar, Kamalesh K., Distinguished Professor

## T

Tomkins, Reginald P.T., Professor

## V

Voronov, Roman S., Assistant Professor

## W

Wang, Xianqin, Associate Professor

## X

Xu, Xiaoyang, Assistant Professor

- Chemical Engineering - B.S. (p. 475)
- Chemistry Minor (p. 476) (for Chemical Engineering majors)

# Chemical, Biological, and Pharmaceutical Engineering Courses

**CHE 101. Introduction to Chemical Engineering. 0 credits, 1 contact hour (1;0;0).**
Prerequisites: None. An introduction to the field of chemical engineering and to the Otto H. York Department of Chemical Engineering. Topics include the curriculum, tours of department teaching laboratories and computing facilities, undergraduate research opportunities, cooperative employment, and student professional societies. Also included are visits by alumni who discuss their careers after graduation from the department.

**CHE 210. Chemical Process Calculations I. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126 or CHEM 122. Corequisites: MATH 112 and CS 115. Analysis of chemical processes is introduced, emphasizing steady and unsteady-state mass and species balances. This course uses primarily chemistry and algebra to determine, for a wide variety of processes and applications, the flow and concentrations of different chemical species.

**CHE 210W. Chemical Process Calculations I. 0 credits, 1 contact hour (1;0;0).**
Workshop.

**CHE 230. Chemical Engineering Thermodynamics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126, (or CHEM 122), MATH 112, PHYS 111. Corequisite MATH 211 (or MATH 213). The Fundamentals of thermodynamics are applied to chemical engineering processes. Thermophysical properties and their engineering correlations are covered. Applications include chemical engineering and related fields such as environmental and biomedical engineering.

**CHE 230W. Chemical Engineering Thermodynamics I Workshop. 0 credits, 1 contact hour (1;0;0).**
Workshop.

**CHE 240. Chemical Process Calculations II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 210 and CHE 230 This course covers the basic principles of energy balances for a variety of engineering systems. Combined with material from other sophomore courses, simple designs of chemical processes are considered. The course also introduces chemical process simulation software.

**CHE 240W. Chemical Process Calculations II. 0 credits, 1 contact hour (1;0;0).**
Workshop.

**CHE 260. Fluid Flow. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CHE 230. Corequisite: CHE 240, MATH 222. This course considers the principles of molecular and turbulent transport of momentum, particularly as they apply to pressure drop calculations in piping systems, packed columns, and other flow devices. Flow around submerged objects is also considered.

**CHE 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience.

**CHE 311. Co-op Work Experience II. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: CHE 310. Restriction: permission of undergraduate advisor. Cannot be used for degree credit.

**CHE 312. Chemical Process Safety. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior standing. A study of the technical fundamentals of chemical process safety: includes impact of chemical plant accidents and concepts of societal and individual risk; hazards associated with chemicals and other agents used in chemical plants, including toxic, flammable and reactive hazards: concepts of inherently safer design; control and mitigation of hazards to prevent accidents, including plant procedures and designs; major regulations that impact safety of chemical plants; consequences of chemical plant incidents due to acute and chronic chemical release and exposures; hazard identification procedures; introduction to risk assessment.

**CHE 342. Chemical Engineering Thermodynamics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 230, MATH 211 (or MATH 213), CHEM 236. The principles and methods developed in Chemical Engineering Thermodynamics I are extended to multicomponent systems, and used to treat phase and chemical equilibrium as well as such applications as chemical reactors and refrigeration systems.

**CHE 349. Kinetics and Reactor Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 342, CHE 370, MATH 222, CHEM 236. Derive and solve species and energy balances for single chemical reactors; introduces heterogeneous catalysis, non-ideal reactors as ideal reactor combinations, and special topics such as polymeric or biochemical reactions.

**CHE 360. Separation Processes I. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 342, CHE 370. This is the first course in separations, examines traditional methods and technologies by which chemical engineers separate and purify mixtures. Emphasis here is on strippers, absorbers, distillations, and extractions.

**CHE 365. Techniques for Process Simulation. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 370. Corequisite: CHE 360 Course Description: Introduction to basic concepts of computational methods for solving chemical engineering problems and performing process simulations. Topics include various numerical techniques for the solution of linear and non-linear algebraic equations and ordinary differential equations, differentiation/integration, and interpolation/regression of data. Students will be exposed to various computational software and commercial process simulators for simulating chemical processes.

**CHE 370. Heat and Mass Transfer. 4 credits, 4 contact hours (4;0;0).**
Prerequisites: CHE 240, CHE 260, MATH 222. The principles of heat and mass transfer in chemical engineering systems are covered. Steady and unsteady heat transfer is examined, with emphasis on the heat exchanger design. Mass transfer by steady and unsteady molecular diffusion, and turbulent convective mass transfer is studied.

**CHE 375. Structure, Properties and Processing of Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 236 or CHEM 235 Tailoring materials properties by engineering their microscopic/macroscopic structures via processing is central to product design and development in the chemical industry. This course introduces the principles of materials engineering from the perspective of structure-property-processing relationships. Instead of covering different types of materials separately, this course will use the principles common to engineering of all important materials as an underlying theme. These are atomic/molecular structure, nanoscale, morphology, principles of phase transformation, structure development during processing, and property dependence on structure. All these topics will be introduced through the paradigm of comparing metals, ceramics and polymers. Besides single component systems, advanced materials such as multiphase and/or multicomponent systems (e.g. composites and gels) and nanomaterials will be discussed based on these principles. An integral part of this course will be the criteria for selection of materials for the chemical process industry.

**CHE 380. Introduction to Biotechnology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 122 or CHEM 126. Basic principles of molecular biotechnology with selected examples of applications.

**CHE 396. Chemical Engineering Laboratory I. 3 credits, 5 contact hours (0;5;0).**
Prerequisites: CHE 370, ENG 352. Corequisite: MATH 225A. In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

**CHE 402. Applied Optics in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Junior or senior standing in chemical engineering. Combined laboratory and lecture course emphasizing photonics and laser applications in chemical engineering.

**CHE 411. Work Experience III. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: CHE 311. Continuation of CHE 311. Cannot be used for degree credit.

**CHE 427. Biotransport. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 230 and MATH 222. Introduction to basic concepts of transport phenomena as applied to biological systems. Topics include the structure and composition of the human body, the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Students learn to analyze solute transport in biological systems and apply it to the design of biomedical devices.

**CHE 444. Introduction to Polymer Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 370. Introduction to the basic concepts of polymer engineering. Topics covered include rheology, heat transfer, and kinetics of polymerization reactors.

**CHE 460. Separation Processes II. 2 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 360. This second course in separations examines non-traditional methods and technologies such as fixed-bed processes, membranes, crystallization, and mechanical separations.

**CHE 472. Process and Plant Design. 4 credits, 4 contact hours (4;0;0).**
Prerequisites: CHE 349, CHE 365, CHE 375, CHE 380, IE 492. Corequisite CHE 460. A capstone course in the chemical engineering program. This class is divided into three- or four-person groups. Each group must complete an open-ended process design problem, including equipment specification and economics.

**CHE 473. Mathematical Methods in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, CHE 349, CHE 360, and CHE 370. An introduction to the use of differential equations to solve chemical engineering problems.

**CHE 476. Introduction to Biochemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 245, CHE 349. Corequisite: CHE 349. The application of chemical engineering to biochemical processes. Topics include enzyme reactions, dynamics of microbial populations, fermentation equipment, bioreactor design, and sterilization.

**CHE 489. Process Dynamics and Control. 3 credits, 4 contact hours (4;0;0).**
Prerequisites: CHE 349, CHE 365. This course is an introduction to chemical process dynamics and control. Topics include analysis of the dynamics of open-loop systems, the design of control systems, and the dynamics of closed-loop systems. Control techniques and methodologies, used by practicing chemical engineers, are emphasized.

**CHE 490. Special Topics in Chemical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHE 349, CHE 360. Topics of current interest in chemical engineering, such as supercritical fluid extraction, combustion research, environmental problems, biotechnology, technologies in hazardous and toxic substance management, etc. AS interests develop, other topics will be considered.

**CHE 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in chemical engineering, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. Normally a GPA greater than 3.0 is required to participate in the course. Provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion.

**CHE 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: CHE 491. A continuation of CHE 491.

**CHE 492H. Research and Independent Study II Honors. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: CHE 491. Same as CHE 492, with special projects for Honors students.

**CHE 495. Chemical Engineering Lab I. 3 credits, 5 contact hours (0;5;0).**
Prerequisites: CHE 370, ENG 352, MATH 225A Course Description: In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

**CHE 496. Chemical Engineering Laboratory II. 3 credits, 6 contact hours (0;6;0).**
Prerequisites: CHE 349, CHE 360, CHE 380, CHE 396, CHEM 339, MATH 225A. Corequisites: CHE 460, CHE 489. In this second course in chemical engineering capstone laboratory, experiments are conducted in the areas of mass transfer, separations, reaction engineering, and process dynamics and control. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students.

# B.S. in Chemical Engineering

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| FRSH SEM | Freshman Seminar | 0 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| Physical Education:GUR | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHE 101 | Introduction to Chemical Engineering | 0 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 126 | General Chemistry II | 3 |
| CS 115 | Intro. to CS I in C++ | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| Physical Education Elective:GUR | | 1 |
| | **Term Credits** | **19** |
| **Second Year** | | |
| **1st Semester** | | |
| CHE 210 | Chemical Process Calculations I | 2 |
| CHE 210W | Chemical Process Calculations I | 0 |
| CHE 230 | Chemical Engineering Thermodynamics I | 3 |
| CHE 230W | Chemical Engineering Thermodynamics I Workshop | 0 |
| CHEM 245 | Organic Chemistry for Chemical Engineers | 4 |
| MATH 211 | Calculus III A | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| ECON 265 | Microeconomics | 3 |
| ENGR 210 | Career Planning Seminar for En | 1 |
| | **Term Credits** | **19** |
| **2nd Semester** | | |
| CHEM 238 | Analytical/Organic Chem Lab for Chemical Engineers | 2 |
| CHE 240 | Chemical Process Calculations II | 3 |
| CHE 240W | Chemical Process Calculations II | 0 |
| CHE 260 | Fluid Flow | 3 |
| CHEM 236 | Physical Chemistry for Chemical Engineers | 4 |
| ECON 266 | Macroeconomics | 3 |
| MATH 222 | Differential Equations | 4 |
| | **Term Credits** | **19** |
| **Third Year** | | |
| **1st Semester** | | |
| CHE 342 | Chemical Engineering Thermodynamics II | 3 |

| | | |
|---|---|---|
| CHE 370 | Heat and Mass Transfer | 4 |
| CHE 380 | Introduction to Biotechnology | 3 |
| ENG 352 | Technical Writing | 3 |
| CHEM 339 | Analytical/Physical Chem Lab for Chemical Engineers | 2 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CHE 312 | Chemical Process Safety | 3 |
| CHE 349 | Kinetics and Reactor Design | 3 |
| CHE 360 | Separation Processes I | 2 |
| CHE 365 | Techniques for Process Simulation | 2 |
| CHE 375 | Structure, Properties and Processing of Materials | 3 |
| IE 492 | Engineering Management | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CHE 460 | Separation Processes II | 2 |
| CHE 489 | Process Dynamics and Control | 3 |
| CHE 495 | Chemical Engineering Lab I | 3 |
| LIT, HIST, PHIL, STS GUR Elective [2] | | 3 |
| Technical Elective 1 | | 3 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| CHE 472 | Process and Plant Design | 4 |
| CHE 496 | Chemical Engineering Laboratory II | 3 |
| Technical Elective 2 | | 3 |
| Technical Elective 3 | | 3 |
| Humanities and Social Sciences (upper-level) Capstone Seminar: GUR [3] | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **136** |

1 Technical Electives: Student must complete 9 credits of technically oriented subject-related courses approved by his or her advisor. Acceptable subjects include, but are not limited to:
(1) CHE 310 Co-op Work Experience I
(2) CHE 491 Research and Independent Study I and CHE 492 Research and Independent Study II
(3) Courses taken within a Minor requirements
(4) Graduate level course taken within BS/MS or BS/PHD program
(5) Courses in ACCT 200:699 or BME 300:699 or CE 300:699 or CHE 300:699 or CHEM 300:699 or CPT 300:499 or ECE 200:699 or ENE 200:699 or ENTR 400:500 or EM 600:699 or EPS300:699 or EVSC300:699 or FIN 200:699 or HRM300:699 or MATH 300:699 or MGMT 300:699 or ME 300:699 or MRKT 300:499 or MTSE 300:699 or NANO 488 or OM 375 or PHB 600:699 or PHEN 500:699 or PHYS 200:699 (**)
Note (**) only one 200 level course is allowed in a case a 300 level course needs a 200 level course as a pre-requisite.

2 One 300-level course in Literature, History, Philosophy, or STS.

3 All students must take one 400-level capstone seminar offered by the Dept. of Humanities and Social Sciences.

Students must earn a 2.0 minimum GPA and must meet appropriate departmental regulations. These include an average GPA of 2.0 in all chemical engineering courses.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Chemistry Minor (for Chemical Engineering majors)

| | | |
|---|---|---|
| Select four of the following: | | 10-12 |
| R160 207 | Structure & Bonding | |
| CHEM 222 | Analytical Chemistry | |

| | | |
|---|---|---|
| CHEM 336 | Physical Chemistry III | |
| CHEM 360 | Environmental Chemistry I | |
| CHEM 361 | Environmental Chemistry II | |
| CHEM 412 | Inorganic Chemistry | |
| CHEM 440 | | |
| CHEM 443 | | |
| CHEM 473 | Biochemistry | |
| CHEM 480 | Instrumental Analysis | |
| CHEM 484 | | |
| CHEM 491 | Research and Independent Study I | |
| **Total Credits** | | **10-12** |

# Civil and Environmental Engineering

Civil engineering is about the planning, design, construction and operation of facilities essential to modern life, ranging from bridges to transit systems. Civil engineers are problem solvers, meeting the challenges of community planning, water supply, structures, traffic congestion, energy needs, pollution, and infrastructure improvements. Societal needs, economic conditions and public safety are paramount in the work accomplished by civil engineers. High-tech tools such as computer aided design (CAD), geographical information systems (GIS) and 3-D computer modeling are a necessity in all areas of civil engineering. Civil engineers are sought by both private companies and public agencies for a variety of professional positions. Many work for engineering consulting firms or construction companies as design engineers, field engineers and project managers. They also join government agencies to oversee transportation, water supply, environmental protection, and resource management. Graduates are equally prepared to pursue MS and Ph.D. degrees in allied fields, as well as business, management and law degrees.

## The Mission of Civil Engineering

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

## Program Educational Objectives

Our program educational objectives are reflected in the achievements of our recent alumni.

1. **Engineering Practice:** Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
2. **Professional Growth:** Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, professional registration, and continuing education; some graduates will transition into other professional fields such as business and law through further education.
3. **Service:** Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, and humanitarian endeavors.

## Student Outcomes

Our student outcomes are what students are expected to know and be able to do by the time of their graduation.

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design and conduct experiments, as well as to analyze and interpret data
- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- an ability to function on multidisciplinary teams
- an ability to identify, formulate, and solve engineering problems
- an understanding of professional and ethical responsibility
- an ability to communicate effectively
- the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- a recognition of the need for, and an ability to engage in life-long learning
- a knowledge of contemporary issues

- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

This program is accredited by the Engineering Accreditation Commission of ABET, http://abet.org.

## NJIT Faculty

### A

Adams, Matthew, Assistant Professor

Axe, Lisa B., Professor

### B

Bagheri, Sima, Professor

Bandelt, Matthew, Assistant Professor

Boufadel, Michel, Professor

### C

Chien, I Jy, Steven, Professor

### D

Daniel, Janice R., Associate Professor

Dauenheimer, Edward G., Professor Emeritus

Ding, Yuan, Associate Professor

Dresnack, Robert, Professor

E

Esmaili, Danial, University Lecturer

### G

Golub, Eugene B., Professor

Goncalves da Silva, Bruno, Assistant Professor

Greenfeld, Joshua S., Professor Emeritus

H

Hsieh, Hsin-Neng, Professor

### K

Karaa, Fadi A., Associate Professor

Khera, Raj P., Professor Emeritus

Kimmel, Howard S., Professor Emeritus

Konon, Walter, Professor

### L

Lee, Joyoung, Assistant Professor

Liu, Rongfang, Associate Professor

### M

Marhaba, Taha F., Professor

Meegoda, Jay N, Professor

Milano, Geraldine, Senior University Lecturer

## O

Olenik, Thomas J., Associate Professor

## R

Raghu, Dorairaja, Professor Emeritus

## S

Saadeghvaziri, Mohamad A., Professor

Saigal, Sunil, Distinguished Professor

Salek, Franklin, Professor Emeritus

Santos, Stephanie R, University Lecturer

Schuring, John, R., Professor

Spasovic, Lazar, Professor

## W

Wecharatana, Methi, Professor

## Z

Zhang, Wen, Assistant Professor

- Civil Engineering - B.S. (p. 482)
- Environmental Engineering Minor (p. 484)
- Geosystems Minor (p. 485)

# Civil and Environmental Engineering Courses

**CE 101. CE Computer Aided Design. 1 credit, 2 contact hours (0;2;0).**
Co-requisite or Pre-requisite: FED 101 Introduce students to the basics of Civil Engineering computer aided design and the application of practical engineering ideas with the linking of technology. CE CAD teaches students the use of basic tools, such as Autocad software, used in the preparation of Civil Engineering contract documents. Autocad is a widely used computer program for generating engineering drawings.

**CE 200. Surveying. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 111 or ENGR 101. Angle and distance measurement; leveling; topographic mapping; traverse and area computations; horizontal and vertical curves; cross sections; triangulation; state plane coordinates; global positioning system. Emphasis on the use of the computer for solving typical field and office problems. Lab should be taken concurrently.

**CE 200A. Surveying Laboratory. 1 credit, 3 contact hours (0;3;0).**
Corequisite: CE 200. Field exercises in conjunction with the classroom exercises in CE 200 utilizing classical and electronic instruments and COGO/CAD software.

**CE 210. Construction Materials and Procedures. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: HSS 101. Introduction to construction management organization, contracts, construction safety, engineering economics, and engineering ethics. Studies current practices of heavy construction including soil and rock excavation productivity, and building construction materials and procedures. Field trips to construction sites provide opportunities to directly view many of the practices.

**CE 260. Civil Engineering Methods. 3 credits, 3 contact hours (2;1;0).**
Prerequisite: HUM 101, CE 101, CE 200, CE 200A. Provides students with in-depth experience in computer applications in civil engineering and with written and oral communication.

**CE 307. Geometric Design for Highways. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A. Highway design based on a study of traffic distribution, volume, and speed with consideration for the predictable future. Analysis of elements of at-grade intersections and interchanges and the geometrics of highway design and intersection layout with advanced curve work including compound and transition curves.

**CE 311. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a -report.

**CE 320. Fluid Mechanics. 4 credits, 4 contact hours (4;0;0).**
Prerequisite or Co-requisite: MECH 236 with a grade of C or better. Prerequiste: Mech 235 with a grade of C or better, Math 112 and Phys 111/111A This course is designed to present the fundamental laws relating to the static and dynamic behavior of fluids. The emphasis is placed on applications dealing with the flow of water and other incompressible fluids. These include flow in pipe systems and natural channels.

**CE 320A. Hydraulics Laboratory. 1 credit, 3 contact hours (0;3;0).**
Prerequisite or corequisite: CE 320. Explores the principles of fluid mechanics through laboratory experiments. Investigates various hydraulic phenomena with both physical and computer models. Demonstrates basic civil engineering design principles for pipe networks, open channel systems, and ground water regimes.

**CE 321. Water Resources Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A, MATH 225 or MATH 279. Training in methods of developing water supplies and the means to treat supplies for consumptive use. Covers hydrologic techniques such as surface and ground water yield, hydrograph and routing analyses, and probabilistic methods related to hydrologic studies.

**CE 322. Hydraulic Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 320, CE 321. The objective is to provide the tools required to design water distribution systems, storm drains, and sanitary sewers. Examines related hydrologic and hydraulic techniques.

**CE 332. Structural Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 237 with a grade of C or better. A working knowledge of free body diagrams, equilibrium conditions for force systems and moments. The primary objective is an understanding of the various methods of analyzing determinate and indeterminate beams, frames, and trusses encountered in practice.

**CE 333. Reinforced Concrete Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 332. The student must have a working knowledge of structural analysis including determinate and indeterminate beams and frames. Primary objectives include the following: to acquaint the student with the properties of concrete and steel and with the behavior of reinforced concrete as a structural material; also, to develop methods for the design of reinforced concrete structural members such as beams, slabs, footings, and columns. Both ultimate strength design and working stress method will be studied.

**CE 341. Soil Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MECH 237 with a grade of C or better or equivalent. Corequisite: CE 341A. A study of soil types and properties is made with the objective of developing a basic understanding of soil behavior. The methods of subsurface investigation and compaction are presented. Fundamentals pertaining to permeability, seepage, consolidation, and shear strength are introduced. Settlement analysis is also presented. Lab must be taken concurrently.

**CE 341A. Soil Mechanics Laboratory. 1 credit, 3 contact hours (0;3;0).**
Corequisite: CE 341. Students perform basic experiments in soil mechanics.

**CE 342. Geology. 3 credits, 3 contact hours (3;0;0).**
Restriction: Sophomore status. Studies science of geology with emphasis on physical geological processes. Stresses the principle of uniformity of process in the context of rock and soil formation, transformation, deformation, and mass movement. Includes aspects of historical geology and geomorphology.

**CE 350. Transportation Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A. A study of the principal modes of transportation, with emphasis on the planning, design and construction of facilities for modern transportation systems.

**CE 351. Intro To Transportation System. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 200, CE 200A, CE 350 A study of the principal modes of transportation, with emphasis on the planning, design and construction of facilities for modern transportation systems.

**CE 360. Sustainable Civil Engr Mat. 3 credits, 3 contact hours (3;0;0).**
Prerequistes: CHEM 121 or 125 and MECH 237 (with a grade of C or better) This course will provide instruction on engineering materials used in the construction of civil engineering projects. Additionally, the fundamentals of sustainability and sustainable design within the context of civil engineering will be discussed. The engineering properties of aggregates, wood, metal, portland cement concrete and asphaltic concrete and design of these materials will be covered. These materials will be used to discuss sustainability concepts and design within civil engineering.

**CE 381. Geomorphology. 3 credits, 3 contact hours (3;0;0).**
This is a course in geomorphology, the study of landforms and the contemporary processes that create and modify them. The course will emphasize earth surface processes and quantitative analysis of landform change. Lectures will stress geomorphic principles and two field-based problems will enable students to apply these principles to contemporary geomorphic problems in engineering and management with a focus on the natural environment.

**CE 406. Remote Sensing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: PHYS 234. Principles of remote sensing are covered including general concepts, data acquisition procedures, data analysis and role of remote sensing in terrain investigations for civil engineering practices.

**CE 410. Construction Scheduling and Estimating. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 210. Quantity take off, cost estimate and CPM computer analysis of typical building or highway projects. A study is made of construction project organization, contract requirements and management control techniques with an introduction to computer applications.

**CE 412. Construction Codes and Specifications. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 210. Code and specification aspects of engineered construction. Topics include professional ethics, contracts, specifications, bidding procedures, building codes such as B.O.C.A. and New Jersey Uniform Construction Code, Energy Code Provisions, construction safety, and the impact of the EPA on construction.

**CE 413. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: CE 311 or equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements including a report and/or project.Note: Normal grading applies to this COOP Experience.

**CE 414. Engineered Construction. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 210, CE 332, CE 341. Design, erection, and maintenance of temporary structures and procedures used to construct an engineering project. Business practices, codes, design philosophies, construction methods, hardware, inspection, safety, and cost as they pertain to engineered construction projects.

**CE 431. Construction Materials Lab. 1 credit, 3 contact hours (0;3;0).**
Prerequisites: CE 210, MECH 237 with a grade of C or better, CE 210. This course provides an understanding of the basic properties of construction materials, and presents current field and laboratory standards and testing requirements for these materials. Students select a material or component assembly for testing, design a testing procedure, and present their results.

**CE 432. Steel Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 332. A working knowledge of structural analysis including determinate and indeterminate beams and frames is essential. The development of current design procedures for structural steel elements and their use in multistory buildings, bridges, and industrial buildings.

**CE 443. Foundation Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 341, CE 341A. Site investigation, selection of foundation types and basis for design, allowable loads, and permissible settlements of shallow and deep foundations. Computations of earth pressure and design of retaining walls.

**CE 450. Urban Planning. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: junior engineering standing. Introduction to urban planning, its principles, techniques, and use. Topics include development of cities, planning of new towns, redevelopment of central cities, and land use and transportation planning.

**CE 461. Professional Practice in CEE. 3 credits, 3 contact hours (3;0;0).**
Develop an understanding of the process to become a licensed professional engineer and familiarize the students with the professional practice of engineering including codes of ethics and professional business practices and to provide an adequate background for the Fundamentals of Engineering.

**CE 465. Green and Sustainable Civil Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 210 and Junior standing. Designed to teach students currently available approaches that incorporate renewable energy and sustainable development concepts in civil engineering projects. This will include various methods of planning, design, and evaluation which promote increased energy efficiency and sustainable use of materials. Cost estimating and life cycle planning will also be included. The course will encourage students to look beyond the information in the course, to come up with additional methodologies which may not currently be in use.

**CE 485. Special Topics in Civil Engineering. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of civil engineering not regularly covered in any other CE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**CE 490. Civil Engineering Projects. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in civil engineering and approval of the department. Work on an individually selected project, guided by the department faculty advisor. The project may include planning, research (library or laboratory), engineering reports, statistical or analytical investigations, and designs. Any of these may follow class-inspired direction or the student may select his or her own topic. The project must be completed and professionally presented by assigned due dates for appropriate review and recording of accomplishment.

**CE 491. Research Exper-Civil Engr. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Junior standing, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. This course provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion. Open to students with a GPA of 3.0 or higher.

**CE 494. Civil Engineering Design I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CE 210, CE 260, CE 320, CE 321, CE 350, CE 341 , CE 341A and senior standing in civil engineering. Simulates the submission and acceptance process normally associated with the initial design phases for a civil engineering project. Familiarizes students with the preparation of sketch plats, preliminary engineering design, and a related environmental assessment. Requirements include written submittals and oral presentations in defense of the project.

**CE 495. Civil Engineering Design II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 333, CE 432, CE 443 and CE 494. Provides students with the type of design experience they would receive if engaged in civil and environmental engineering design practice. Course will focus on one or more of these design areas: structural, geotechnical, transportation and planning, and sanitary and environmental engineering.

**ENE 262. Introduction to Environmental Engineering. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: CHEM 126, MATH 112, and PHYS 121. To introduce students to the integrated science, engineering, design and management concepts of engineered environmental systems. The course will cover environmental regulations and standards, environmental parameters, mass balance and natural systems, water quality management, water and wastewater treatment, air pollution control, noise pollution, and solid and hazardous waste management. Background material and laboratories in the environmental sciences and management areas will be covered. Group term papers and presentations will be required.

**ENE 360. Water and Waste Water Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ENE 262 and junior standing. Training in the methods used for water pollution control. Topics include the chemical, physical, and biological processes that occur in waste treatment design and in receiving waters; modeling schemes to determine allowable loadings in various bodies of water; and waste treatment processes used for water pollution control.

**ENE 361. Solid and Hazardous Waste Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ENE 262 and junior standing. Exposure to the area of air pollution control, solid waste disposal, and radioactive waste disposal. Topics include the chemistry of contaminated atmospheres; the influence on meteorological conditions of dispersion of pollutants; abatement processes used in the control of emissions; classification and nature of solid waste, and solid waste disposal techniques; sources and methods for the disposal of radioactive contaminants; and related health effects.

**ENE 362. Pollution Prevention. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Chem 126, Math 111, and Junior Standing. This course presents pollution prevention concepts and principles, terminologies, life cycle impact approaches, and management strategies. It will also serve as a community based service learning course. The course introduces available improvement techniques for industrial pollution prevention and control and examines specific applications to industries biological, chemical, physical, and thermal techniques.

**ENE 485. Special Topics in Environmental Engineering. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of environmental engineering not regularly covered in any other ENEcourse. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

**ENE 490. Senior Project. 3 credits, 3 contact hours (0;0;3).**

**ENE 491. Research Experience in ENE. 3 credits, 3 contact hours (3;0;0).**

**MECH 234. Engineering Mechanics. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: PHYS 111, MATH 112. A course for industrial and mechanical engineering students in which the equilibrium of particles and rigid bodies subject to concentrated and distributed forces is studied.

**MECH 235. Statics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 111, MATH 112. Available for CE students only. Provides an understanding of equilibrium of particles and rigid bodies subject to concentrated and distributed forces.

**MECH 236. Dynamics. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: MECH 234 or MECH 235 with a grade of C or better or MECH 320 and Math 112, Phys 111/111A. Provides an understanding of the mathematics of the motion of particles and rigid bodies, and of the relation of forces and motion of particles.

**MECH 237. Strength of Materials. 3 credits, 4 contact hours (3;1;0).**
Prerequisites: MECH 234 or MECH 235 with a grade of C or better and MATH 112, PHYS111/111A. A working knowledge of statics with emphasis on force equilibrium and free body diagrams. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions. Lab should be taken concurrently.

**MECH 320. Statics and Strength of Materials. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 111, MATH 112. For chemical engineering and electrical engineering majors. Statics provides an understanding of the equilibrium of particles and rigid bodies, including simple machines, trusses, and frictional forces. Mechanics of materials covers pressure vessels, thermal stresses, torsion of shafts, stresses and deflection in beams, and column action.

# B.S. in Civil Engineering

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| CE 101 | CE Computer Aided Design | 1 |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| ECON 201 | Economics [1] | 3 |

| | | |
|---|---|---|
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| CE 200 | Surveying | 3 |
| CE 200A | Surveying Laboratory | 1 |
| MATH 211 | Calculus III A | 3 |
| MATH 279 | Statistics and Probability for Engineers | 2 |
| MECH 235 | Statics | 3 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CE 210 | Construction Materials and Procedures | 3 |
| CE 260 | Civil Engineering Methods | 3 |
| EPS 202 | Society, Technology, and the Environment [1] | 3 |
| MATH 322 | Differential Equations for Applications | 3 |
| MECH 237 | Strength of Materials | 3 |
| ENE 262 | Introduction to Environmental Engineering | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 320A | Hydraulics Laboratory | 1 |
| CE 321 | Water Resources Engineering | 3 |
| CE 332 | Structural Analysis | 3 |
| MECH 236 | Dynamics | 2 |
| Cultural History GUR courses-Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CE 333 | Reinforced Concrete Design | 3 |
| CE 341 | Soil Mechanics | 3 |
| CE 341A | Soil Mechanics Laboratory | 1 |
| CE 350 | Transportation Engineering | 3 |
| CE 360 | Sustainable Civil Engr Mat | 3 |
| GUR- Lit/Hist/Phil/STS (upper-level) | | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **17** |

| | | |
|---|---|---|
| **Fourth Year** | | |
| **1st Semester** | | |
| CE 431 | Construction Materials Lab | 1 |
| CE 432 | Steel Design | 3 |
| CE 443 | Foundation Design | 3 |
| CE 494 | Civil Engineering Design I | 3 |
| CE Elective [3] | | 3 |
| GUR Open-Select one of the following: | | 3 |
| ENG 339 | Practical Journalism | |
| ENG 340 | Oral Presentations | |
| ENG 347 | Technical, Professional and Scientific Writing for Publication | |
| ENG 352 | Technical Writing | |
| ENG 369 | Creative Writing | |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CE 495 | Civil Engineering Design II | 3 |
| Science Elective-Select one of the following: [4] | | 3 |
| R120 101 | General Biology | |
| CE 342 | Geology | |
| EVSC 381 | Geomorphology | |
| HSS (upper-level) GUR Capstone Seminar | | 3 |
| Management-GUR-Select one of the following: | | 3 |
| MGMT 390 | Principles of Management | |
| IE 492 | Engineering Management | |
| HRM 301 | Organizational Behavior | |
| ENTR 410 | New Venture Management | |
| CE Designated Elective-Select one of the following: | | 3 |
| CE 307 | Geometric Design for Highways | |
| CE 410 | Construction Scheduling and Estimating | |
| CE 351 | Intro To Transportation System | |
| CE 414 | Engineered Construction | |
| CE 450 | Urban Planning | |
| ENE 360 | Water and Waste Water Engineering | |
| ENE 361 | Solid and Hazardous Waste Engineering | |
| | **Term Credits** | **15** |
| | **Total Credits** | **133** |

[1] This satisfied the lower lever Social Science GUR. Freshman placed in STS 201 Understanding Technological Society may substitute this course for EPS 202 Society, Technology, and the Environment. ECON 201 Economics is required for all CE majors.

[2] Technical Electives: MATH 337 Linear Algebra or any CE, CET, ENE, TRAN elective 300 level or higher, including graduate courses.

[3] CE Elective: Any CE, ENE, TRAN 300 level or above, including graduate courses.

[4] Science Elective: R120-101 Biology (see Rutgers course schedule), CE 342 Geology or EVSC 381 Geomorphology.

## GUR Electives

Refer to the **General University Requirement** section of this catalog for further information on GUR electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Environmental Engineering Minor

| | | |
|---|---|---|
| Select five of the following: | | 15 |
| CE 320 | Fluid Mechanics | |

| | | |
|---|---|---|
| CE 321 | Water Resources Engineering | |
| CE 322 | Hydraulic Engineering | |
| ENE 262 | Introduction to Environmental Engineering | |
| ENE 360 | Water and Waste Water Engineering | |
| ENE 361 | Solid and Hazardous Waste Engineering | |
| ENE 362 | Pollution Prevention | |
| Other courses approved by the minor coordinator. | | |
| **Total Credits** | | **15** |

# Geosystems Minor

| | | |
|---|---|---|
| CE 342 | Geology | 3 |
| R460 311 | Geologic Field Problems | 3 |
| Select one of the following: | | 3-4 |
| R460 206 & R460 207 | Env Geology and Env Geology Lab | |
| EVSC/CE 381 | Geomorphology | |
| Select six to eight credits from the following: [1] | | 6-8 |
| R460 314 | Stratigraphy | |
| R460 320 | Structural Geology | |
| R460 323 | Rocks and Minerals | |
| R460 331 | Oceanography | |
| R460 206 & R460 207 | Env Geology and Env Geology Lab | |
| R460 401 | Intro Geochemistry | |
| R460 406 | Applied Geophys | |
| R460 427 | Hydrogeology | |
| CE 321 | Water Resources Engineering | |
| CE 341 & 341A | Soil Mechanics and Soil Mechanics Laboratory | |
| CE 381 | Geomorphology | |
| CE 506 | Remote Sensing of Environment | |
| CE 545 | Rock Mechanics I | |
| CE 602 | Geographic Information System (depending on space available) | |
| CE 644 | Geology in Engineering | |
| SET 420 | Geographic/Land Information Systems | |
| EPS/STS 380 | Policy Issues in the Coastal Environment | |
| EVSC 381 | Geomorphology | |
| STS 382 | Geographical Perspectives on the Environment | |
| **Total Credits** | | **15-18** |

[1] Courses required for the BS degree in CE, CHEM, EVSC, or ET are not acceptable as elective courses for the Geosystems minor.

# Electrical and Computer Engineering

Electrical engineering is a diversified and challenging profession concerned with the design, development, fabrication, and control of the electrical devices upon which our technological society so largely depends. Electrical engineers utilize their knowledge of devices and systems design in a multitude of areas. These include electronic circuits and devices, computers, energy conversion and distribution (including novel energy sources, solar, tidal, wind), control systems (robotics), electro-optics (lasers, sensors), and communication systems (radio, TV, cellular telephones).

The curriculum provides a broad education in mathematics, the physical sciences, humanities, and social sciences. Upon this foundation is built a depth of understanding in electrical engineering and related fields. In the senior year, students may emphasize an area of interest by selecting from a broad range of electives, including a systems pair in communications, control, computers, solid state, bio-electronics or microwave/optics.

The program seeks to produce an electrical engineer who can think analytically and creatively, work effectively, and communicate clearly with others. Electrical engineering graduates may enter industry in professional engineering work or pursue advanced studies in electrical engineering or a related field, such as biomedical engineering. They may also use their electrical engineering background as the basis for further study in a different field such as law or medicine.

The curriculum, as described below, is for students entering NJIT as freshmen in the Fall of 2007 or thereafter. Students entering before that date may have a different program and should consult the department to learn which curriculum applies.

The interdisciplinary profession of computer engineering has evolved over the last decades. Computer engineering professionals develop, design, and test computer systems. They understand both computer hardware and software and possess enough engineering breadth to design computer systems for a variety of applications. Economics and Internet flexibility have led to the widespread use of computer engineering technology. The career potential for graduates with this knowledge has been strong for many years. Computer engineering consists of basic electrical engineering and computer science curricula combined with a set of special courses in computer systems. Computer engineering students will have a broad engineering background combined with in-depth knowledge of computer hardware, software, and application tradeoffs, and the basic modeling techniques representing the computing process.

The core subject areas of computer engineering are discrete mathematics, fundamentals of computing, data structures, system software and software engineering, computing languages, operating systems, logic design, digital systems design, computer architecture, interfacing and communications. Students graduating from NJIT with a Bachelor of Science in Computer Engineering and a good academic record will be able to pursue further study leading to advanced degrees in computer engineering, electrical engineering, or computer science.

The curriculum, as described below, is for students entering NJIT as freshmen in the Fall of 2007 or thereafter. Students entering before that date may have a different program and should consult the department to learn which curriculum applies.

## The Mission Statement

The Mission Statement of the Electrical Engineering (EE) Program is to provide EE students a rigorous learning experience and to prepare them for professional careers.

## Program Educational Objectives

In order to meet the Mission of both the institution and the ECE Department, the Department and its Industry Advisory Board have been approved the following Program Educational Objectives:

1. Graduates will succeed in electrical engineering areas or other diverse fields that require analytical and/or professional skills.
2. Graduates will pursue professional development, including continuing or advanced education., relevant to their career plans.
3. Graduates will contribute to their fields or professions and society.

## Electrical Engineering Program Student Outcomes

This program is accredited by the Engineering Accreditation Commission of ABET (http://abet.org) and satisfies ABET a-K Program Students Outcome:

- An ability to apply knowledge of mathematics, science, and engineering;
- An ability to design and conduct experiments, as well as to analyze and interpret data;
- An ability to design a system, component or process to meet desired needs within realistic constrains such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability;
- An ability to function on multidisciplinary teams;
- An ability to identify, formulate, and solve engineering problems;
- An understanding of professional and ethical responsibility;
- An ability to communicate effectively;
- The broad education necessary to understand the impact of engineering solutions in a global economic, environmental, and social context;
- A recognition of the need for, and an ability to engage in, life-long learning;
- A knowledge of contemporary issues;
- An ability to use the techniques, skills and modern engineering tools necessary for engineering practice

## NJIT Faculty

### A

Kam, Moshe, Professor

Akansu, Ali N., Professor

Ansari, Nirwan, Professor

## B

Bar-Ness, Yeheskel, Distinguished Professor Emeritus

## C

Carpinelli, John D., Professor

Carr, William N., Professor Emeritus

Clements, Wayne I., Associate Professor Emeritus

Cornely, Roy H., Professor Emeritus

## F

Feknous, Mohammed, University Lecturer

Frank, Joseph Associate Professor Emeritus

Friedland, Bernard, Distinguished Professor

## G

Ge, Hongya, Associate Professor

Grebel, Haim, Professor

## H

Haddad, Richard A., Professor Emeritus

Haimovich, Alexander M., Professor

Hou, Sui-Hoi Edwin, Associate Professor

Hubbi, Walid, Associate Professor

## K

Kam, Moshe, Professor

Khreishah, Abdallah, Assistant Professor

Klapper, Jacob, Professor Emeritus

Kliewer, Joerg, Associate Professor

Kuo, Marshall C., Professor Emeritus

## L

Levkov, Serhiy P., University Lecturer

## M

Manzhura, Oksana Yu, University Lecturer

Meyer, Andrew U., Professor Emeritus

Misra, Durgamadhab, Professor

## N

Niver, Edip, Professor

## R

Rojas-Cessa, Roberto, Associate Professor

Rosenstark, Solomon, Professor Emeritus

### S

Savir, Jacob, Distinguished Professor

Shi, Yun-Qing, Professor

Simeone, Osvaldo, Associate Professor

Sohn, Kenneth S., Professor Emeritus

Sosnowski, Marek, Professor

Steele, Timothy W., University Lecturer

### T

Tsybeskov, Leonid, Professor

### W

Whitman, Gerald, Professor

### Z

Zhou, Mengchu, Distinguished Professor

Ziavras, Sotirios G., Professor

## Programs

- Computer Engineering - B.S. (p. 492)
- Electrical Engineering - B.S. (p. 495)

- Computer Engineering Minor (p. 497) (not for Electrical Engineering or Computer Science majors)
- Computer Engineering Minor (p. 498) (for Electrical Engineering majors)
- Electrical Engineering Minor (p. 498) (not for Electrical Engineering or Computer Science majors)
- Electrical Engineering Minor (p. 498) (for Computer Engineering majors)

## Electrical and Computer Engineering Courses

**ECE 101. Introduction to Electrical and Computer Engineering. 0 credits, 1 contact hour (1;0;0).**
Familiarize students with various disciplines, career opportunities and curricula in electrical and computer enginneering. Invited speakers include faculty and industrial representatives.

**ECE 231. Circuits and Systems I. 3 credits, 4 contact hours (4;0;0).**
Prerequisites: PHYS 121 and MATH 112 or MATH 133. The basic concepts of electric circuit theory and system analysis. Topics include basic circuit elements, loop and node analysis, network theorems, sinusoidal steady-state analysis, power, resonance, mutual inductance, and ideal transformers.

**ECE 232. Circuits and Systems II. 3 credits, 4 contact hours (4;0;0).**
Prerequisite: ECE 231. Corequisite: MATH 222. A continuation of circuits and systems with special emphasis on transient response. Topics include Laplace transform analysis, transfer functions, convolution, Bode diagrams, and Fourier series.

**ECE 251. Digital Design. 3 credits, 4 contact hours (4;0;0).**
Prerequisites: PHYS 121. The design of combinational and sequential logic circuits used in digital processing systems and computers. Basic register transfer operations are covered. Topics include Boolean algebra, minimization techniques and the design of logic circuits such as adders, comparators, decoders, multiplexers, counters, arithmetic logic units, and memory systems.

**ECE 252. Microprocessors. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 251. An introduction to microprocessor system organization and assembly language programming. The course covers the architecture, instruction set and assembly language of a specific microprocessor. Other topics included are memory organization, input/output interfacing, interrupt processing as well as exception processing. The problems associated with the design of a single board computer are also covered. Students receiving degree credit for CIS 453 cannot receive degree credit for ECE 352. Co-listed as COE 252.

**ECE 271. Electronic Circuits I. 3 credits, 4 contact hours (4;0;0).**
Prerequisite: ECE 231. The electronic devices, junction diodes, bipolar transistors and field-effect transistors, are introduced and studied based on semiconductor physics models. The study then continues with analysis and design of main digital electronic circuits (NMOS and CMOS) inverters and logic gates, MOS memory and storage circuits) and with introduction to analog electronic circuits such as simple one transistor amplifiers.

**ECE 291. Electrical Engineering Laboratory I. 1 credit, 3 contact hours (0;3;0).**
Prerequisites: ECE 231, HUM 101. Corequisites: ECE 232. Laboratory work in the areas covered in ECE 231, ECE 232. Assembling, testing and analysis of basic analog circuits. Emphasis electronic measurement techniques, instrumentation and data analysis. Simulations of dc, ac, and transient circuit response on the personal computer.

**ECE 310. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Restriction: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.

**ECE 321. Random Signals and Noise. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 232 and ECE 333. Random processes occurring in electrical engineering. An introduction to probability and random variables is followed by stochastic processes and noise. Topics include auto- and cross-correlation functions, power spectral density, response of linear systems to random signals, and noise figure calculations.

**ECE 333. Signals and Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, MATH 222. A continuation of circuits and systems. Topics include signal models, system representations and properties, convolution, Fourier transform, sampling, z-transform, and an introduction to IIR and FIR filter design.

**ECE 341. Energy Conversion. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 231. Magnetic materials and their applications including the design of singly- and multiply-excited magnetic circuits and transformers, and the steady-state performance of dc and ac electromechanical energy converters.

**ECE 353. Computer Organization and Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 252. Emphasizes the hardware design of computer systems. Topics include register transfer logic, central processing unit design, microprogramming, ALU design, pipelining, vector processing, micro-coded arithmetic algorithms, I/O organization, memory organization and multiprocessing.

**ECE 354. Digital Test. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: ECE 251 or equivalent, MATH 333 or equivalent. Covers theory and practice related to test technology. Topics include fault modeling, test generation, fault simulation, design for testability, fault diagnosis, built-in self-test, scan design, and many others. Surveys several industrial design for testability structures.

**ECE 361. Electromagnetic Fields I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 231, MATH 213 and MATH 222. Overview of vectors analysis. The study of static electric and magnetic fields, basic laws of electrostatics (Coulomb's and Gauss's laws), scalar electric potential, electrostatic force and energy; basic laws of magnetostatics (Biot–Savart and Ampere's laws), magnetostatic force and energy, vector magnetic potential; fundamental meaning of capacitance, resistance and inductance in terms of electric and magnetic fields; Poisson's and Laplace's equation; characterization of materials (conductors, dielectrics, magnetic materials).

**ECE 362. Electromagnetic Fields II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 361. Maxwell's equations solutions, reflection and refraction of plane waves in dielectric and conducting media, transmission lines; transients and frequency domain solutions in lossy and lossless lines, Smith chart and its applications, parallel plate and rectangular waveguides.

**ECE 368. Signal Transmission. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, ECE 251. This course is not for EE majors. Signal transmission both within and between digital systems. Topics include the telegrapher's equations, wave propagation, lattice diagrams, transients in digital systems, crosstalk, proper termination for high-speed logic, and the transmission characteristics of various interconnecting geometries.

**ECE 372. Electronic Circuits II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, ECE 271. Principles of MOSFET and BJT small signal amplifiers: Q point design, input and output impedance, gain, and signal range limitations for different single stage configurations. Design of analog integrated circuits including differential amplifiers, current sources, active loads. Transistor high frequency models, Miller effect, and frequency response of multistage amplifiers. Feedback in multistage amplifiers. Design and analysis of nonlinear circuits based on comparators. Design and analysis of signal generators.

**ECE 374. Electronic Device I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 271. This course addresses electronic devices on a fundamental level. Topics include semiconductors, structure and properties of p/n junction, Schottky barrier, BJT, MOS, MOS FET, semiconductor optoelectronics.

**ECE 392. Electrical Engineering Laboratory II. 2 credits, 3 contact hours (0;3;0).**
Prerequisite: ECE 271, and ECE 291. Co-requisite ECE 372. Laboratory work in the areas covered in ECE 232, ECE 271 and ECE 372. Design, computer simulation, testing and performance analysis of analog and digital electronic circuits.

**ECE 394. Digital Systems Lab. 1 credit, 3 contact hours (0;3;0).**
Prerequisites: ECE 251, ECE 271 and ECE 291. Experiments emphasize digital design from basic electronic circuits to complex logic. Topics include switching speed, basic sequential circuits, the arithmetic/logic unit, and computer memories.

**ECE 395. Microprocessor Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 291, ECE 252. In this laboratory the students are expected to learn to apply their theoretical knowledge of both the hardware and software aspects of microprocessors. To attain this objective the students are required to construct a microprocessor based single board computer (SBC), with adequate interfacing capabilities to be able to perform some useful control tasks. Programming of the device is done in assembly language. Some of the experiments that follow the construction project deal with software while others deal with the problems of interfacing of microprocessors.

**ECE 405. Electrical Engineering Principles. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 121. (No credit for ECE students.) For non-electrical engineering majors. Topics include basic dc and ac circuits, basic electronics, an introduction to electromechanical energy conversion and control theory.

**ECE 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ECE 310, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. May count as EE or approved elective. Note: Normal grading applies to this COOP Experience.

**ECE 414. Electrical and Computer Engineering Project I. 1 credit, 1 contact hour (1;0;0).**
Prerequistes:In EE program:ECE 321, ECE 341, ECE 372, ECE 392, and ECE 395. In COE: ECE 353, ECE 368, ECE 395 and ECE 394. Student teams prepare and submit technical proposals for the senior design ("capstone") project to be completed the following semester in ECE 416 or ECE 417. Discussion of issues related to the engineering profession, including such topics as: intellectual property, sources of technical information, engineering codes and standards, professional organizations, professional registration. Required of all ECE students.

**ECE 416. Electrical and Computer Engineering Project II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 414. Continuation and completion of the project based on the proposal approved in ECE 414. Progress of the project is monitored by the instructor with demonstrations and presentations at given due dates of the regularly scheduled course. An oral presentation and demonstration of the project by the student team must be given and a written report submitted at the end of the course. Successful projects are approved for the presentation at the Senior Design Project Workshop in the presence of students, faculty and industry representatives.

**ECE 417. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ECE 414. Faculty adviser approval required. Continuation and completion of the project based on the proposal approved in ECE 414 guided by a faculty or a faculty and industrial mentors with meetings scheduled as needed. A formal written report is presented to the faculty advisor at the end of the course. An oral presentation of a successful project is made at the Senior Design Project Showcase attended by students, faculty, and industry representatives.

**ECE 418. Independent Study. 3 credits, 3 contact hours (0;0;3).**
Requirements: senior standing or approval of the associate chairperson for undergraduate studies, a GPA greater than 3.0, and agreement of a faculty advisor. Provides the student with an opportunity to work on a research project under individual guidance of a faculty. The required work and intellectual challenge correspond to at least those of other senior ECE courses. A written report is required for the course completion.

**ECE 421. Digital Data Communications. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232, MATH 333, or ECE 321. This course is not for EE majors. Covers communications basics and some topics in digital communications most germane to data communication. Topics include signal classification, correlation, spectral analysis, energy and power spectral density, white noise, signal transmission through linear systems, sampling and quantization, and principles of digital data transmission.

**ECE 422. Computer Communications Networks. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 321 or MATH 333. Introduction to the fundamental concepts of computer communication networks. Topics include the OSI reference model, the physical, data link, network, and transport layers, TCP/IP, LANs (including token ring, token bus, and ethernet), ALOHA, routing and flow control.

**ECE 423. Data Communications Networking Devices. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 421 or ECE 481. Provides a working knowledge of data communication networking devices, including modems, routers, multiplexers, switches, and concentrators and are used as building blocks in the implementation, modification, or optimization of data communications networks. Emphasizes device design, functionality and physical layer protocols.

**ECE 424. Optical Communication Network. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 232 and either ECE 321 or MATH 333. Focuses on digital optical networks, architecture, modulation techniques, and detection noise. Related topics are wireless communication, infrared link, and CATV. Computer simulations of network systems are done with commercial software packages.

**ECE 425. Wireless Communication Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 481 or ECE 421. Introduction to wireless system design and engineering. Develops an understanding and appreciation of the wireless engineering problems such as cellular layout design, resource allocation, mobility management, capacity and performance and signaling load calculations. Introduces physical layer building blockssuch as modulation, synchronization, coding, diversity, equalization, and spreading.

**ECE 429. Computer Communications Lab. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 422. Experiments with different protocols and standards used in the TCP/IP computer communications, including Ethernet/802.3 standard, Address Resolution Protocol (ARP), Internet Protocol (IP), Transport Control Protocol (TCP), User Datagram Protocol (UDP), and others. Exercises with network measurements and virtualization tools, and configurations of some commercial routers are included.

**ECE 431. Introduction to Feedback Control Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 333. Concept of feedback control. Typical feedback control systems. System dynamics by Laplace transform and state space methods. Stability definition and assessment: Routh-Hurwitx criteria. Graphical stability methods: Root locus, Nyquist and Bode plots. Performance evaluation and simulation. Matlab/Simulink used extensively. A good background in Laplace transform and linear (matrix) algebra highly desirable.

**ECE 432. Control Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 431. A continuation of the study of automatic control systems with emphasis on computer-aided design and problem solving. Topics covered include state feedback control, observers, industrial regulators, linear quadratic regulators, and the analysis of various common system nonlinearities. Implementation techniques on both analog and digital platforms will be addressed.

**ECE 435. Medical Imaging Instrumentation and Data Acquisition Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 231, ECE 252 and ECE 333. Three-Dimensional medical imaging modalities including X-ray Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, and Ultrasound utilizes advanced highly integrated electronic sensors, fast processor-based computers, and advanced signal proessing and reconstruction methods.

**ECE 436. Bio Control Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 431. This course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Real time signal acquisition and processing are also adressed.

**ECE 439. Control Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 431. Laboratory work in the design and synthesis of control systems, closely coordinated with the control systems elective.

**ECE 441. Power Electronics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 373. Electronic devices and circuits used to energize various apparatus and systems. Topics include circuits, freewheeling diodes, thyristors, firing and commutation of silicon-controlled rectifiers, converters, dc choppers, and power supplies.

**ECE 442. Power Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 341. Introduction to power plants and power networks. Topics include transmission line parameters, system modeling, economic operations of power systems, load flow studies, short circuit analysis, and power system stability.

**ECE 443. Renewable Energy Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 231 and ECE 271. This course presents the various sources of renewable energy including wind, solar, and biomass as potential sources of energy and investigates the contribution they can make to the energy profile of the nation. The technology used to harness these resources will be presented. Discussions of economic,environment, politics and social policy are integral components of the course.

**ECE 449. Power Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 494. Corequisite: ECE 442. Laboratory work in the design and synthesis of power systems, closely coordinated with the power systems elective.

**ECE 451. Advanced Computer Architecture. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 353. Focues on dvanced concepts in computer systems design, and the interaction between hardware and software components at various levels (i.e., hardware/_software codesign). Introduces common performance measures used by hardware and software designers to facilitate comparative analysis. Main topics are: advanced pipelining, good instruction sets, CISC and RISC microprocessors, introduction to parallel computing, and a brief historical survey of computer designs.

**ECE 452. Advanced Computer Architecture II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 451 Overview of recent advances and topics of current active research in the field of Computer Architecture. Includes: new computing paradigms such as brain inspired non-von Neumann architectures, stochastic computing, hybrid memory systems and other architectures leveraging emerging memory technologies. Systolic array systems; new interconnect architectures including NoCs; GPU-accelerated computing etc. are also discussed.

**ECE 453. Introduction to Discrete Event Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 251 or CS 251 or equivalent, and MATH 333 or ECE 321 or equivalent. Introduces logical models, timed models, and stochastic timed models of discrete event systems. Applies petri net methodology to the modeling of computer systems, flexible manufacturing systems, communication networks, and robotics. Contrasts the approaches of _simulation, elementary queueing theory, and Markov processes.

**ECE 457. Digital Image Processing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 333. An introduction to the fundamental techniques for digital image processing. Covers human visual sstems, image sensing and acquisition, image sampling and quantization, 1-D and 2-D systems, image enhancement, image restoration, image degradation, features extraction, and image segmentation.

**ECE 459. Advanced Computer Systems Design Lab. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 451, ECE 495. Corequisite: ECE 452. Design laboratory component of the advanced computer systems technical track offered to COE majors in the senior year. Experiments emphasize advanced CPU design concepts, such as RISC approaches and exception handling, multiprocessor and systolic array computers, and FPGAs. Develop software programs to test the capabilities of these hardware designs.

**ECE 461. Microwave and Integrated Optics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 362. The analysis and design of microwave transistor amplifiers and oscillators using scattering parameter techniques. Topics include transmission line theory, scattering parameters, matching networks, signal flow graphs, amplifier design considerations (power gain stability, noise and band width), and negative resistance oscillator design.

**ECE 462. RF/Fiber Optics Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 362. Topics include dielectric waveguides and optical fibers, semiconductor optical sources and detectors; rf/microwave modulation and demodulation of an optical carrier; design concepts in optical transmitters and receivers; and usage of CAD software tools for rf/microwave simulations.

**ECE 463. Optoelectronics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 374. The course addresses electronic and optoelectronics device concepts. Topics include optical materials, semiconductor materials,light propagination in waveguide, solar cell, LED and modulation of light.

**ECE 469. RF/Microwave and Fiber Optics Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Corequisite: ECE 462. Laboratory work in characterization of RF/microwave transmission structures and optical fibers, sources and detectors, spectral and time domain (OTDR) measurements in micro-waves and optics. Experiments in microwave and fiber optic links. Usage of CAD software tools for RF/microwave simulations.

**ECE 472. Pulse Techniques. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 373. Topics in electronics including linear and non-linear operational-amplifier circuits, the frequency compensation of operational-amplifiers, higher-order active filters including switched-capacitor designs, waveform generators, multi-vibrators, timers, waveshapers, converters, and other selected topics.

**ECE 475. VLSI Circuits. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECE 372. Topics include MOSFETs, their characteristics and use in analog and digital circuit design, static and dynamic circuits; memory cells; differential stages; symbolic layout of NMOS and CMOS circuits; fundamentals of silicon processing technology and associated design rules and methodology; calculation of chip performance including power, speed and area; logic arrays.

**ECE 481. Digital Communications Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 321. An introduction to digital communications systems and modulation and techniques, along with simulation experiments of communications systems and techniques in Matlab/Simulink. Description of AM and FM modulations, sampling and digitalization of signals, baseband and carrier-modulated digital transmission, signal detection in noise, inter-symbol interference and equalization, channel capacity, data compression techniques, error detection and correction methods.

**ECE 482. Communications Systems Elective. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECE 481. A continuation of the study of communications systems with selected topics from different areas of communications theory such as sampled-data communications, information theory and noise.

**ECE 489. Communications Systems Laboratory. 2 credits, 4 contact hours (0;4;0).**
Prerequisites: ECE 481. The laboratory experiments are designed using Matlab/Simulink and Software Defined Radio (SDR). The major lab tasks include time and frequency domain analysis of AM and FM signals, generation and detection of digitally modulated waveforms such as BPSK, QPSK, 16QAM and 64QAM which are widely used in wireless communication networks. Through the experiments, students learn how to use Matlab/Simulink to control the SDR, to assess and combat the impairments due to noise and interference, and become familiar with instruments such as spectrum analyzers, audio analyzers and noise generators.

**ECE 494. Electrical Engineering Laboratory III. 2 credits, 3 contact hours (1;2;0).**
Prerequisites: ECE 341, ECE 374, ECE 392. A senior laboratory with experiments in two distinct areas: A) power and energy conversion, and B)semiconductor devices. Part A involves experiments with full size ac and dc electric motors, generators, and transformers. In part B characteristics of diodes, transistors and solar cells are measured using computer controlled instrumentation.

**ECE 495. Computer Engineering Design Lab. 3 credits, 5 contact hours (1;4;0).**
Prerequisites: ECE 353, ECE 394. Preparation for putting into practice the concepts learned in ECE 353. Emphasizes hardware design and debugging. Topics include combinational and sequential logic design using CAD tools, design based upon PLA/PLD devices, computer interface design using hardware and software, and an open-ended design project such as a central processing unit design.

**ECE 498. Special Topics in Electrical and Computer Engineering. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in an area of electrical and computer engineering not regularly covered in any other ECE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course.

# B.S. in Computer Engineering

(129 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 125 | General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design | 2 |

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|---|---|---|
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 115 | Intro. to CS I in C++ | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| ECE 101 | Introduction to Electrical and Computer Engineering | 0 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 116 | Intro. to Computer Science II/C++ | 3 |
| ECE 231 | Circuits and Systems I | 3 |
| ECE 251 | Digital Design | 3 |
| MATH 222 | Differential Equations | 4 |
| Select one of the following English Composition and Cultural History (lower-level) GUR electives: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World (Cultural History) | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 252 | Microprocessors | 3 |
| ECE 271 | Electronic Circuits I | 3 |
| ECE 291 | Electrical Engineering Laboratory I | 1 |
| MATH 213 | Calculus III B | 4 |
| ECON 201 | Economics | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| CS 280 | Programming Language Concepts | 3 |
| ECE 368 | Signal Transmission | 2 |
| ECE 395 | Microprocessor Laboratory | 2 |
| MATH 326 | Discrete Analysis for Computer Engineers | 3 |
| MATH 333 | Probability and Statistics | 3 |
| Select one of the following: [3] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 201 | Understanding Technological Society | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 332 | Principles of Operating Systems | 3 |
| MATH 340 or MATH 337 | Applied Numerical Methods or Linear Algebra | 3 |

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|---|---|---|
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 394 | Digital Systems Lab | 1 |
| PHIL 334 | Engineering Ethics and Technological Practice: Philosophical Perspectives on Engineering [2] | 3 |
| MGMT 390<br>or IE 492 | Principles of Management<br>or Engineering Management | 3 |
| | **Term Credits** | **16** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ECE 354 | Digital Test | 2 |
| ECE 414 | Electrical and Computer Engineering Project I | 1 |
| ECE 495 | Computer Engineering Design Lab | 3 |
| COE Track Elective I | | 3 |
| COE Track Elective II | | 3 |
| Open GUR:ENG, LIT, PHIL, STS, THTR 300 level | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ECE 416<br>or ECE 417 | Electrical and Computer Engineering Project II<br>or Independent Study | 3 |
| COE Track Elective III | | 3 |
| COE Track Laboratory Elective | | 2 |
| Capstone Seminar in Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| ECE Technical Elective | | 3 |
| ECE Technical Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **129** |

[2] Fulfills Humanities and Social Sciences (upper-level) GUR

[3] Students may also take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Computer Engineering Tracks

The computer Engineering technical tracks are designed to provide in-depth study in a specialty area. Students at the fourth year of the curriculum must choose one of the available tracks. Courses are listed below. Students may take alternative courses but must see their academic advisor for approval.

| | |
|---|---|
| Computer Engineering Tracks - Select one of the following: | |
| 1. Advanced Computer Systems Track | |
| ECE 451 | Advanced Computer Architecture |
| ECE 452 | Advanced Computer Architecture II |
| ECE 453 | Introduction to Discrete Event Systems |
| or IS 461 | Systems Simulation |
| ECE 459 | Advanced Computer Systems Design Lab |
| 2. Computer Communications Track | |
| ECE 421 | Digital Data Communications |
| ECE 422 | Computer Communications Networks |
| ECE 425 | Wireless Communication Systems |
| ECE 429 | Computer Communications Lab |

In addition to the above track courses, students in each track take two COE technical elective courses. The COE technical elective must be a 300 or 400 level ECE course or advisor approved upper level engineering, science or mathematics course. Elective courses from other departments cannot cover the same material as ECE courses taken by the student. For example some CS courses may cover similar material as other courses in the COE program and are not allowed as electives. Courses from the Engineering Technology Department are generally not approved as ECE electives.

Refer to the General University Requirements (http://catalog.njit.edu/undergraduate/academic-policies-procedures/general-university-requirements) section of this catalog for further information on electives.

## Co-op

Co-op courses bearing degree credit replace a technical elective or another course approved by the faculty advisor in the student's major department. In Computer Engineering, ECE 310 Co-op Work Experience I is taken for zero credits, and ECE 410 Co-op Work Experience II is taken for 3 degree credits, upon acceptance by the faculty co-op advisor of an approved proposal.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Electrical Engineering

(128 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 125 | General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CS 115 | Intro. to CS I in C++ | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| ECE 101 | Introduction to Electrical and Computer Engineering | 0 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **15** |
| **Second Year** | | |
| **1st Semester** | | |
| ECE 231 | Circuits and Systems I | 3 |
| ECE 251 | Digital Design | 3 |
| MATH 222 | Differential Equations | 4 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World (Cultural History) | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education:GUR Elective | | 1 |
| PHYS 234 | Physics III | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 271 | Electronic Circuits I | 3 |
| ECE 291 | Electrical Engineering Laboratory I | 1 |
| ECE 252 | Microprocessors | 3 |
| MATH 213 | Calculus III B | 4 |
| ECON 201 | Economics | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |

| | | |
|---|---|---|
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| ECE 395 | Microprocessor Laboratory | 2 |
| Select one of the following: [2] | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 201 | Understanding Technological Society | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 374 | Electronic Device I | 3 |
| ECE 392 | Electrical Engineering Laboratory II | 2 |
| PHIL 334 | Engineering Ethics and Technological Practice: Philosophical Perspectives on Engineering | 3 |
| ECE 341 | Energy Conversion | 3 |
| | **Term Credits** | **17** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ECE 414 | Electrical and Computer Engineering Project I | 1 |
| ECE 494 | Electrical Engineering Laboratory III | 2 |
| EE Track Elective I | | 3 |
| EE Track Elective II | | 3 |
| ECE Technical Elective | | 3 |
| Open GUR: ENG, LIT, HIST, PHIL, STS, THEA 300 level | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ECE 416<br>or ECE 417 | Electrical and Computer Engineering Project II<br>or Independent Study | 3 |
| MGMT 390<br>or IE 492 | Principles of Management<br>or Engineering Management | 3 |
| Capstone Humanities and Social Sciences (upper-level) Seminar:GUR Elective | | 3 |
| EE Track Laboratory Elective | | 2 |
| ECE Technical Elective | | 3 |
| ECE Technical Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **128** |

[2] Students may also take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.

## Electrical Engineering Track and Track Laboratory

Students should select one track. Courses are listed below. Students may take alternatives courses but must see their academic advisor for approval.

| | |
|---|---|
| Electrical Engineering Tracks - Select one of the following: | |
| 1. Computer Systems Track | |
| ECE 353 | Computer Organization and Architecture |
| ECE 451 | Advanced Computer Architecture |
| ECE 495 | Computer Engineering Design Lab |
| 2. Controls Track | |
| ECE 431 | Introduction to Feedback Control Systems * |
| ECE 432 | Control Systems Elective |
| ECE 439 | Control Systems Laboratory |

| | |
|---|---|
| 3. Electronic, Microwave and Photonic Devices Track | |
| ECE 461 | Microwave and Integrated Optics |
| ECE 462 | RF/Fiber Optics Systems Elective ** |
| ECE 469 | RF/Microwave and Fiber Optics Systems Laboratory |
| 4. Power Track | |
| ECE 443 | Renewable Energy Systems |
| ECE 442 | Power Systems Elective ** |
| ECE 449 | Power Systems Laboratory |
| 5. Telecommunications & Networking Track | |
| ECE 481 | Digital Communications Systems * |
| ECE 422 | Computer Communications Networks * |
| or ECE 425 | Wireless Communication Systems |
| Telecommunications & Networking Track Lab | |
| ECE 429 | Computer Communications Lab |
| or ECE 489 | Communications Systems Laboratory |

| | |
|---|---|
| * | Prerequisite for track lab |
| ** | Co-requisite for track lab |

## Electrical Engineering Technical Electives - 3 courses

The ECE Elective must be a **300 or 400 level ECE course** or an advisor approved upper level **engineering, science or mathematics** course. Elective courses cannot cover the same material as ECE courses taken by the student. For example Math 333 is not allowed as an elective since ECE 321, covering similar topics, is in the EE curriculum. Similarly ECE 368 and ECE 421 are not electives in the EE program. Courses from the Engineering Technology Department are generally not approved as ECE electives.

## Co-op

Co-op courses bearing degree credit replace an elective or another course approved by the faculty advisor in the student's major department. In electrical engineering, ECE 310 Co-op Work Experience I is taken for zero credits, and ECE 410 Co-op Work Experience II is taken for 3 degree credits.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Computer Engineering Minor

(17 credits)

For all majors except Electrical Engineering.

| | | |
|---|---|---|
| ECE 231 | Circuits and Systems I | 3 |
| ECE 251 | Digital Design | 3 |
| ECE 252 | Microprocessors | 3 |
| ECE 291 | Electrical Engineering Laboratory I | 1 |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 394 | Digital Systems Lab | 1 |
| ECE 495 | Computer Engineering Design Lab | 3 |
| **Total Credits** | | **17** |

# Computer Engineering Minor (for Computer Science majors)

| | | |
|---|---|---|
| ECE 231 | Circuits and Systems I | 3 |
| or ECE 271 | Electronic Circuits I | |
| ECE 291 | Electrical Engineering Laboratory I | 1 |
| ECE 252 | Microprocessors | 3 |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 394 | Digital Systems Lab | 1 |

| | | |
|---|---|---|
| ECE 395 | Microprocessor Laboratory | 2 |
| ECE 495 | Computer Engineering Design Lab | 3 |
| **Total Credits** | | **16** |

# Computer Engineering Minor (for Electrical Engineering majors)

| | | |
|---|---|---|
| CS 116 | Intro. to Computer Science II/C++ | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 394 | Digital Systems Lab | 1 |
| ECE 495 | Computer Engineering Design Lab | 3 |
| **Total Credits** | | **13** |

# Electrical Engineering Minor

Open to all other majors except Electrical Engineering and Computer Engineering majors.

| | | |
|---|---|---|
| ECE 231 | Circuits and Systems I | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 271 | Electronic Circuits I | 3 |
| ECE 291 | Electrical Engineering Laboratory I | 1 |
| Select two of the following: | | 6 |
| ECE 333 | Signals and Systems | |
| ECE 341 | Energy Conversion | |
| ECE 361 | Electromagnetic Fields I | |
| ECE 372 | Electronic Circuits II | |
| ECE 374 | Electronic Device I | |
| **Total Credits** | | **16** |

# Electrical Engineering Minor (for Computer Engineering majors)

| | | |
|---|---|---|
| ECE 333 | Signals and Systems | 3 |
| ECE 341 | Energy Conversion | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| ECE 374 | Electronic Device I | 3 |
| **Total Credits** | | **15** |

# Engineering Technology

Engineering technology is that part of the technological field which requires the application of scientific and engineering knowledge and methods, combined with technical skills, for the implementation and extension of existing technologies. Engineering technology education focuses on preparing engineering technologists for positions that involve product development and improvement, system development, management, manufacturing and engineering operational functions. Graduates also enter the technical sales and customer services field, or continue in graduate work in engineering or management. Placement of graduates has been excellent.

The Engineering Technology Program awards Bachelor of Science in Engineering Technology (BSET) degrees for each of the following degree options: Construction Engineering Technology (CET), Electrical and Computer Engineering Technology (ECET), Mechanical Engineering Technology (MET), Medical Informatics Technology (MIT), Surveying Engineering Technology (SET), and Technology Education (TEED). The department also awards a Bachelor of Science (BS) degree in Concrete Industry Management (CIM).

The options in construction engineering technology, electrical and computer engineering technology, mechanical engineering technology and surveying engineering technology are accredited by the Technology Accreditation Commission of ABET (TAC of ABET) http://abet.org

Many students choose to complete their freshman and sophomore years at a community college or a technical institute, and obtain an associate's degree in applied science from these institutions. It is strongly recommended that students talk to an academic advisor at NJIT while they are still pursuing their associate's degree. The academic advisor will explain the transfer process in detail as well as suggest elective courses that may be beneficial. Contact an advisor by calling the Department of Engineering Technology at (973) 596-3228, or by email at EngineeringTechnology@njit.edu.

After being admitted to NJIT, students must meet with an academic advisor to discuss the curriculum and any special interests the student might have. Students who lack necessary courses will be assigned bridge courses to make up the required prerequisites. Generally, courses taken at the freshman and sophomore level at the community colleges cannot substitute for junior or senior NJIT engineering technology courses.

Engineering technology students are expected to meet with their faculty advisor each semester to schedule courses and review their progress in the program. The advisor must approve all courses, including electives, prior to registration.

## NJIT Faculty

### B

Barnes, William, Associate Professor

Brateris, Daniel J., University Lecturer

### E

English, Robert, Professor Emeritus

### J

Juliano, Thomas, Associate Professor

### K

Khader, Michael, Associate Professor

### L

Lieber, Samuel C., University Lecturer

### M

Mahgoub, Mohamed A., Assistant Professor

Miima, John B., Assistant Professor

### P

Potts, Laramie, Associate Professor

### R

Rabie, Mohammad A., University Lecturer

Rahman, Sahidur, University Lecturer

Rockland, Ronald H., Professor

### S

Sengupta, Arijit, Associate Professor

### W

Washington, David W, Associate Professor

Wiggins, John, Senior University Lecturer

## Programs

- Engineering Technology, Computer Technology (CMPT) - B.S. (p. 510)
- Engineering Technology, Construction Engineering Technology (CET) - B.S. (p. 518)
- Engineering Technology, Construction Management Technology (CMT) - B.S. (p. 521)
- Engineering Technology, Electrical and Computer Engineering Technology (ECET) - B.S. (p. 524)

- Engineering Technology, Manufacturing Engineering Techology (MNET) - B.S. (http://catalog.njit.edu/undergraduate/newark-college-engineering/technology/manufacturing-engineering-technology)
- Engineering Technology, Mechanical Engineering Technology (MET) - B.S. (p. 528)
- Engineering Technology, Medical Informatics Technology (MIT) - B.S. (p. 531)
- Engineering Technology, Surveying Engineering Technology (SET) - B.S. (p. 533)
- Engineering Technology, Technology Education (TEED) - B.S. (p. 536)
- Engineering Technology, Telecommunications Management Technology (TMT) - B.S. (p. 539)

- Concrete Industry Management (CIMT) - B.S. (p. 513)

Manufacturing Engineering Technology Minor (http://catalog.njit.edu/undergraduate/newark-college-engineering/technology/manufacturing-engineering-technology-minor)

## Engineering Technology Courses

**CET 225. Soil Mechanics. 3 credits, 0 contact hours (0;0;0).**

**CET 233. Structural Analysis in Construction. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MET 237. This course will cover the aspects of the design and construction of structural steel and reinforced concrete for construction engineering technology students. This will include the design of beams, slabs and columns as well review of the connection of these structural members as encountered in practice.

**CET 313. Construction Procedures I. 3 credits, 3 contact hours (3;0;0).**
Corequisite: CET 317. An introduction to heavy construction practices. Emphasis is on construction equipment, site preparation, earthmoving, compaction, dewatering, piles, drilling and blasting, and tunnelling. Case studies in heavy construction are used.

**CET 314. Construction Procedures II. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313, CET 317. An introduction to building construction practices and building materials. Emphasis is on structural systems, construction materials and detailed finishing operations required to make a serviceable structure. Case studies in building construction are used.

**CET 317. Construction Computing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 106 Application of available software to construction-related computing problems, including: strength of materials, structural analysis, fluids/ hydraulics, surveying, scheduling, cost estimating, and computerized drafting (CAD).

**CET 322. Construction Codes and Regulations. 3 credits, 3 contact hours (3;0;0).**
An introduction to the New Jersey Uniform Construction Code, the BOCA National Building Code, NJ DOT Standard Specifications and the CSI specification format. A code analysis of a typical construction project is undertaken.

**CET 323. Construction Safety. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313 and CET 314 This course will address the safety issues encountered in construction as mandated by the Occupational Safety and Health Act (OSHA)and other similar regulations.

**CET 331. Structural Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CET 233. Study of types and behavior of modern structures using both analytical and intuitive techniques. Examples include beam and column, one- and two-way slab systems, wood and masonry systems, and wind and seismic analysis.

**CET 341. Soils and Earthworks. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MET 237 A study of the significant soil types and tests. Problems are investigated relating to soil mechanics, soil supported foundations for engineering structures. Appropriate field trips are made.

**CET 411. Cost Estimating. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313, CET 314, CET 317. Take off of quantities of materials from typical building and highway projects. Pricing for labor, materials, and equipment. Crew sizes, productivity and manpower leveling. Computerized cost estimating and take off methods. Prepare a complete bid estimate for a construction project.

**CET 413. Environmental Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CET 313, CET 314, CET 431. An introduction to construction-related environmental science topics, including basic environmental chemistry, geology, ground water hydrology, basic air quality, surface water run-off, erosion and sedimentation control, indoor air quality, and vibration analysis. Case studies cover various construction activities with respect to their effect on the environment and the manner in which they can be controlled.

**CET 415. Construction Project Management. 3 credits, 3 contact hours (3;0;0).**
Restriction: Senior standing in construction enginerring technology or contruction management technology. An introduction to construction management and administration methods and procedures including the design and construction process, project organizational structure, construction planning, contract administration, records and reports, financial management, risk analysis, manual and computerized GANTT and CPM scheduling, change orders and extra work, claims and disputes, cost accounting and document tracking.

**CET 416. Senior Construction Project. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: CET 415; second semester senior standing in construction engineering technology or construction management technology. Simulates the methods and procedures used to successfully manage a construction project. Provides familiarization with constructability analysis, value engineering, productivity improvement, quality control, advanced field and office administration techniques, problem solving, and construction auto-mation. Extensive use of construction-related computer software. Written submittals and oral presentations required.

**CET 421. Construction Contracts. 3 credits, 3 contact hours (3;0;0).**
Legal aspects of the various types of construction contracts and specifications. Scope, format, and use of various types of contracts such as owner-contractor and contractor-sub-contractor.

**CET 431. Construction Testing. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET237 Exposure to a variety of construction-related field tests and field testing equipment. Includes concrete mix design, concrete testing, soil density and compaction, asphalt tests, load testing of wood, mortar analysis and testing, brick and CMU testing, and quality control methods and procedures for finishes.

**CET 435. Design of Temporary Structures. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CET 331. Analysis of loadings on, and design of, temporary structures required in construction. Formwork, shoring and scaffolding systems, temporary bridges, trenching, and temporary retaining walls are among the subjects covered. Construction safety associated with temporary structures is stressed.

**CET 460. Forensics in Construction. 3 credits, 3 contact hours (3;0;0).**
Restriction: Senior standing in construction engineering technology. Construction failure, in its many forms, are both interesting and instructive and in the context of this course students will study construction failures in their many forms.

**CET 490. Special Project. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Senior standing in construction engineering technology. The student works on one or more individually selected projects guided by the department staff. The project must be construction related and may include planning, research (library or lab), engineering report, and statistical, analytical, or field investigation. Any of these may follow class-inspired direction, or the students may branch out on their own. The project(s) of each student must be completed and professionally presented by assigned due date for appropriate review and recording of accomplishments.

**CET 491. Special Project. 1 credit, 1 contact hour (1;0;0).**
Restriction: Senior standing in construction engineering technology. The student works on an individually selected project guided by the department staff. The project may be design- or construction-related and may include research, engineering design, technical report, or field investigation. Requirements will include a written submittal.

**CET 492. Special Project. 2 credits, 2 contact hours (0;0;2).**
Restriction: Senior standing in construction engineering technology. The student works on a selected project guided by the department staff. The project may be design or construction related and may include research, engineering design, technical report or field investigation. Requirements will include a written submittal.

**CET 493. Special Projects. 3 credits, 3 contact hours (3;0;0).**

**CET 497. Co-op Work Experience. 3 credits, 3 contact hours (0;0;3).**
Restriction: Approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.Note: Normal grading applies to this COOP Experience.

**CIMT 101. Introduction to Concrete. 3 credits, 3 contact hours (3;0;0).**
This course is an overview of the concrete industry including historical aspects, the chemistry, properties and uses of concrete, production and delivery, and management of production facilities. Students will also be introduced to concrete construction and contracting, environmental concerns, professionalism, and career opportunities in the concrete industry.

**CIMT 205. Concrete Properties and Testing. 3 credits, 4 contact hours (2;2;0).**
The effects of concrete-making materials (aggregates, cements, admixtures, etc.) on the properties of fresh and hardened concrete will be studied and analyzed from an applications point of view. Concrete mixture proportioning calculations, statistical analysis of strength tests, and the economics of various concrete mixes will also be discussed.

**CIMT 210. Concrete Applications I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CIMT 101 and CIMT 205. This course is the first of two courses designed to provide a detailed study of the many applications of concrete in the construction of buildings, pavements, and other facilities as they relate directly to the concrete industry. Emphasis will be placed on the advantages, disadvantages and unique problems facing the concrete industry and suppliers of materials used in the manufacture of concrete products.

**CIMT 305. Concrete Applications II. 3 credits, 3 contact hours (3;0;0).**
This course is a continuation of CIMT 210 and focuses on codes, specifications and industry standards as well as the production and delivery issues related to traditional and unique concrete applications.

**CIMT 310. Concrete Products and Delivery. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CIMT 210 Concrete Applications I. This course will provide the student with a basic understanding of managing the order and delivery process common to all concrete products. An emphasis will be given to planning, organizing and controlling at both the management level as well as the supervisory level.

**CIMT 315. Concrete Construction Methods. 3 credits, 3 contact hours (3;0;0).**

**CIMT 405. Advanced Concrete Testing and Quality Assurance. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CIMT 205. This course will focus on advanced concrete testing techniques and quality assurance procedures currently used in the industry for traditional and specialty applications.

**CIMT 410. Senior Project in CIM. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Senior standing in Concrete Industry Management. The student works on one or more individually selected projects guided by the department staff. The project must be concrete industry related and may include planning, research (library or lab), engineering report and statistical, analytical, or field investigation. Any of these may follow class-inspired direction, or the students may branch out on their own. The project(s) of each student must be completed and professionally presented by assigned due date for appropriate review and recording of accomplishments.

**CIMT 491. Special Project in CIM. 1 credit, 1 contact hour (1;0;0).**

**CIMT 492. Special Project in CIM. 2 credits, 2 contact hours (2;0;0).**

**CIMT 493. Independent Study. 3 credits, 3 contact hours (0;0;3).**

**CIMT 497. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.Note: Normal grading applies to this COOP Experience.

**CIMT 498. Coop Work Experience II. 3 credits, 3 contact hours (0;0;3).**

**CMT 332. Structural Systems for Construction Management. 3 credits, 3 contact hours (3;0;0).**
Study of the types and behavior of building structural systems using qualitative analysis techniques. Systems to be covered will include those involving structural steel, reinforced concrete, wood and timber, and plain and reinforced masonry. The effect of wind and seismic events on these systems is reviewed.

**CMT 414. Environmental Science for Construction Management. 3 credits, 3 contact hours (3;0;0).**
An introduction to construction-related environmental topics, including environmental chemistry, geology, ground water hydrology, outdoor air quality, surface water run-off, erosion and sedimentation control, indoor air quality, asbestos abatement, radon remediation, and noise and vibration.

**CMT 436. Temporary Structures for Construction Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CMT 332. Study of the types of the various temporary systems and structures used in field construction activities, including concrete forming and falsework, sheeting and shoring for excavations, scaffolding, barricades, ladders, and temporary bridges and ramps. Construction safety with respect to the systems is covered.

**CMT 452. Mechanical and Electrical Systems for Construction. 3 credits, 3 contact hours (3;0;0).**
Study of the different types of water supply, plumbing, fire protection, heating, ventilation, air conditioning and electrical systems commonly employed in residential and commercial buildings. Case studies include an overview of the design of these systems and their installation in the field.

**CPT 310. Computer Design Fundamentals for Computer Technology. 3 credits, 4 contact hours (2;2;0).**
Restriction: enrolled in the computer technology option. Boolean algebra, gates, combinational and sequential logic. Memory, microprocessor, and I/O control IC's. Sequential bus architecture.

**CPT 315. Computer Architecture for Computer Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 310. Computer design fundamentals for computer technology, Von Neumann computer architecture: processor, memory and I/O. Processor organization: registers, ALU, and control. Memory organization and memory bus, I/O organization: I/O bus, memory mapped I/O. Number representations and ALU designs. Fundamentals of assembly language, lab exercises in assembly language are used throughout to illustrate concepts.

**CPT 325. Medical Informatics Technology. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior standing. Medical Informatics (MI) professionals use information technology to benefit the health and human services industry. One of the main challenges is to develop an integrated medical record/information system that links doctors, pharmacists, medical imaging facilities and hospitals. In addition, MI professionals will also develop skills to design and develop suport technology for seniors to maintain independent life styles. This includes remote monitoring systems linked to medical professionals, software for support services, and home automation technology.

**CPT 330. Software Web Applications for Engineering Technology I. 3 credits, 4 contact hours (2;2;0).**
Common software applications using software objects. The use of software objects in the management of programming projects. Projects illustrate concepts.

**CPT 335. Networks Applications for Computer Technology I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: C++, Visual Basic, UNIX utilities. Covers common gateway interface (CGI), servers, network protocols, network administration, server and network per-formance.

**CPT 341. Visual Basic.NET for Engineering Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Previous programming experience. Creation of windows with text, controls, menus and graphics, events detection, files and objects management, object oriented techniques.

**CPT 373. Web App Development for Mobile. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: A basic programming course, in addition is recommended an introductory web programming course. Mobile platforms are becoming ubiquitous and software development for these devices is becoming an essential skill for technical professionals. This software/App development course integrates software and web skills with cross platform open source tools that allow developers to write apps for multiple platforms. Course topics will include PhoneGap and open course development software, App layout, CSS (styling) and navigation (transition animations), JavaScript and native functions, geolocation listeners and Asynchronous JavaScript and XML (AJAX) skills. A class project will incorporate skills introduced in this course. Medical informatics majors will design and build an Electronic Medical records Apps. Other projects will be tailored to the interest of other majors.

**CPT 395. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: Approval of the department and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**CPT 401. Senior Project. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: MIS 345. Restriction: senior standing in computer technology. Project management and development, scheduling, proposal writing, documentation of software projects, technical presentations. The successful completion of the project consists of research on a recent computer software and/or hardware product, and the application of the findings to the development of a project, which must include a software component. The senior project may be replaced by a cooperative education experience course, subject to advisor's approval.

**CPT 425. Medical Informatics Technology II. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 325. Restriction: Senior standing. Advanced topics, builds on the core competencies introduced in Medical Informatics I. This course focuses on: Management of Information in Healthcare Organizations/Cost Benefit Analysis, Health and Financing, Consumer Health and Telehealth and Wireless Patient-Monitoring Systems. Cutting edge technologies that will impact on future healthcare delivery.

**CPT 430. Software Web Applications for Engineering Technology II. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 330. Common applications using software objects. The use of software objects in the management of programming projects. Projects are used to illustrate concepts.

**CPT 435. Networks Applications for Computer Technology II. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 335. Network security. Database implementations. Scaling.

**CPT 440. Visual Basic Applications for Engineering Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 340. PC-based control techniques, embedded systems. Database control. Real-time control. Network data acquisition. Man-machine interface and ergonomics considerations.

**CPT 450. Computer Graphics for Computer Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: Calculus II, knowledge of the programming language used in the course, check with the instructor. Drawing shapes, curves and text. Colors and areas, point of light, shading. Masking, 2-D drawings and transformations, 3-D drawings and transformations. Animation. Introduction of a popular graphics package. Lab exercises are used throughout to illustrate concepts.

**CPT 491. Special Projects in Computer Technology. 1 credit, 1 contact hour (1;0;0).**
Restriction: Senior standing in computer technology. The student works on selected projects guided by the department staff.

**CPT 492. Special Projects in Computer Technology. 2 credits, 2 contact hours (2;0;0).**
See CPT 491.

**CPT 493. Special Projects in Computer Technology. 3 credits, 3 contact hours (3;0;0).**
See CPT 492.

**ECET 201. Circuits I. 3 credits, 4 contact hours (2;2;0).**
This first course in Electrical Circuits introduces the student to both DC and AC Circuit Theory. It includes Ohm's and Kirchoff's Laws for analysis of series and parallel circuits. Series-parallel, ladder and bridge networks are analyzed. Resonance and frequency response are included along with an introduction to AC circuits. Circuit simulations and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 202. Circuits II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 201 or ECE 231 and Math 138 or Math 111 This second course in Electrical Circuits expands on Circuit Theory introduced in ECET 201. It includes Ohm's and Kirchhoff's Laws for analysis of series and parallel AC circuits. Series-parallel, ladder and bridge networks are analyzed using AC signals. Resonance and frequency response are included. The basic theory and operation of diodes and transistors, including dc biasing are studied. Circuit simulation and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 205. Fundamentals of Analog Electronics. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 202 or ECE 232 This course introduces students to the active components used in electronics circuits. It covers the physics, the characteristics, and some applications of semiconductor diodes and transistors. The applications will include amplifiers, rectifiers, op amps, oscillators, and timers. Circuit simulation and laboratory experiments are designed to support the theory and provide measurement skills.

**ECET 210. Intro. to Microprocessors and Computer Architecture. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: None This is an introductory course in computer architecture and microprocessor applications for students who already have basic knowledge of digital circuit principles. Computer hardware architecture is analyzed, and assembly-language programs are written and run. Computer architecture concepts are applied through the use of assembly software programs for a popular microprocessor family. Theoretical ideas are reinforced by building and testing realistic experimental systems in the laboratory.

**ECET 214. Introduction to Communications. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 202 or ECE 232. Corequisite: ECET 205 A study of amplitude modulation, frequency modulation, and pulse modulation systems of transmission and reception, including applications of these systems in radio, television and telemetry. Introduces the latest digital communications theory and applications. Computer simulation and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 215. Introduction to Digital Electronics. 3 credits, 4 contact hours (2;2;0).**
The first course in digital electronics develops the fundamentals of the binary system, circuit implementation from Boolean functions and map minimization. Course includes study of combinational logic, sequential logic circuits, flip-flops, counters, and shift register. Computer simulation and laboratory experiments are designed to support the theory and obtain measurement skills.

**ECET 300. Circuit Analysis: Transform Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ECET 303 or ECE 232 and MATH 238 or Math 112. Corequisite: MATH 322 or MATH222. The principles, theorems and techniques of circuit analysis are reviewed. The technique of waveform and circuit transforms is introduced. Laplace transforms are studied and applied in the solution of circuit problems with a variety of input functions. Fourier analysis also is introduced. Extensive use of computer simulation software.

**ECET 303. Circuit Measurements. 2 credits, 4 contact hours (1;3;0).**
Prerequisite: ECET 205 or ECE 271 and MATH 238 or MATH 112. Lecture and laboratory sessions are designed to develop techniques for the measurement of various circuit parameters as well as the theoretical prediction of these parameters. Extensive use of computer simulation software.

**ECET 305. Integrated Circuit Applications. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 303 and MATH 238 or MATH 112. Corequisite: ECET 300. Provides a working knowledge of the characteristics and applications of integrated circuits. Topics include how linear ICs work, the most common circuit configurations in which ICs are used, and how to design the most commonly needed circuits with ICs, using manufacturers specification sheets.

**ECET 310. Microprocessors I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Courses in digital logic and introduction to microprocessors (AAS level). Develops a working knowledge of the characteristics and applications of microprocessors. Emphasis is put on the architecture and instruction set of an advanced microprocessor. Representative data handling problems are studied and tested in the laboratory.

**ECET 311. Embedded Systems I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CPT 315 or ECE 251 and ECET 215. Develops a working knowledge of the characteristics and applications of devices used in embedded systems such as microcontrollers. Emphasis is put on the architecture, instruction sets, and assemblers. Representative data handling problems and interfacing are studied and tested in the laboratory using state-of-the art hardware.

**ECET 314. Communication Systems. 3 credits, 4 contact hours (2;2;0).**
Corequisite: ECET 300. A study of amplitude modulation, frequency modulation, and pulse modulation systems of transmission and recep-tion, including applications of these systems in radio, television, and telemetry. Introduces the latest digital communications theory and applications. Perform appropriate laboratory exercises and projects.

**ECET 319. Electrical Systems and Power. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Physics I and Calculus (AAS level). Restriction: For non-ECET majors only. The fundamentals of ac and dc circuit theory are studied. Transistor and diode theory and their applications in amplifiers and filters are investigated. Electrical machines are also included in this course. Computer simulation as well as appropriate laboratories are required.

**ECET 329. Analog and Digital Electronics. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 201 or ECE 231. For MET majors only. Building on ECET 201, a study of more advanced topics in electronics including AC circuit analysis, op-amps, transistors, digital logic and microcontrollers. Computer simulation as well as laboratories are required.

**ECET 344. Numerical Computing for Engineering Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CS 101 or CS 100 or CS 106, or CS 115 and MATH 238 or MATH 112. Corequisite: MATH 309. An introduction to the use of a computer to analyze and solve problems common in engineering.Using computers and the application language students will confront a variety of tasks that will promote an object oriented programming structure. The goal of this course is to understand and program routines commonly used in the design of computer algorithms for computer-based problems. Practical applications as well as mathematical programming are stressed.

**ECET 350. Computerized Industrial Controls. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CPT 315 and ECET 311. This course introduces students to the theory and application of computerized control systems and technologies used in industry today. The course focuses on the hands-on development and integration of programmable logic controllers (PLCs), motor controllers (drives), and supervisory software.

**ECET 365. Digital Logic and Circuit Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ECET 215 or ECE 251 Develops the mathematics and minimization techniques together with the circuit implementation for the design of combinational and sequential digital solid-state logic circuits. Studies decoders, mulitplexers, counters, registers, and PLDs. Computer and communications circuits are used as examples. Projects employ computer simulation of digital circuits.

**ECET 395. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Restriction: Completion of Freshman year and Approval of the department and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**ECET 401. ECET Senior Project I. 2 credits, 2 contact hours (2;0;0).**
Prerequisites: ECET 344, ECET 305, ECET 411 and ENG 352. The first course in a two-course sequence comprised of Senior Project 1 (ECET 401) and Senior Project 2 (ECET 402). Project management, concurrent engineering, proposal development, library research, and computer usage are stressed. Students develop a formal proposal, technical specifications, Gantt chart, and design specifications for the senior project to be implemented in ECET 402.

**ECET 402. ECET Senior Project II. 1 credit, 2 contact hours (0;2;0).**
Prerequisite: ECET 401 (The previous semester) Apply technical knowledge to implement, build, and test the project approved in ECET 401.Complete library research, design specifications, computer analysis, simulation, and time and cost estimates. Purchase and build a working prototype of the design. Complete formal testing procedures to verify that the prototype meets design specifications. Submit formal written documentation and present the project during an oral presentation to a design review board and other students in the class.

**ECET 406. Control Systems and Transducers. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: ECET 305. Class and laboratory study of analog and digital automatic control. Using Laplace transforms, principles of analysis and design of control systems are introduced. Transducer characteristics and their application in instrumentation and control are investigated. Several experiments are implemented using Programmable Logic Controllers (PLCs).

**ECET 410. Microprocessors II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 310 and ECET 365. Covers the operations, bread boarding, and interfacing of devices peripheral to microcom-puters. Emphasizes embedded applications of microprocessers to systems requiring both hardware and software development. Advanced topics include programmable peripheral I/O controllers, interrupts and local ISA, PCI and USB buses.

**ECET 411. Embedded Systems II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: ECET 311 and ECET 365. This course is the second of two embedded systems courses. The primary objective is to prepare students in the ECET curriculum to design embedded systems as part of senior project and also in industry. The design of embedded systems is investigated at the hardware and software level with an emphasis on processor and system architecture. The C language is used for programming.

**ECET 412. Power Generation and Distribution. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 205 or ECE 271 Electrical generation, transmission, and distribution systems with an emphasis on 3 phase analysis, design, short circuit currents due to symmetrical faults, and reliability considerations of the electric power system. The laboratory portion includes hands on activities and experiments that align electric power theory with application. Design considerations for inside / outside plant, worker safety, system interconnection and protection, while focusing on reliability and cost considerations are covered.

**ECET 415. Fundamentals of Telecommunications. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 214. The focus of this course is on network data communication systems and related protocols. Main topics include transmission media including coax, twisted pair, fiber optics, wired, and wireless media. The Transmission Control Protocol/Internet Protocol (TCP/IP) model as well as the Open System Interface (OSI) model are discussed with emphasis on the details of the TCP/IP model. Additional topics such as wired and wireless LAN, backbone networks, wide area networks, The Internet, networking security, and networking design are covered.

**ECET 416. Networking Applications. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 344. Introduces students to the technology of networking with a particular focus on local area networks and the protocols associated with network communication. Comprised of two components: concept/theory and hands-on/applications in the laboratory. Topics include: an overview of network communication systems, networking concepts, network protocols, network standards, wide area networks, local area networks, enterprise networks, network topology, media access control, transport control protocol, internet protocol, and routing. Students learn to analze traffic flow on network links and how to write network based software applications.

**ECET 418. Transmission Systems. 3 credits, 4 contact hours (2;2;0).**
Prerequisites:ECET 214. A study of wireless and terrestrial transmission systems with an emphasis on fiber optics and the latest wireless techniques. The lectures examine the technologies as well as the advantages and disadvantages of the various transmission techniques. The laboratories are a mixture of fiber optic, microwave, and wireless experiments providing hands-on experience in these important areas.

**ECET 440. Clinical Internship. 3 credits, 3 contact hours (3;0;0).**
By Advisement". Consists of 200 hours of experience in the clinical engineering department of a hospital. The student is under the supervision, and is evaluated by, the director of clinical engineering at the hospital. A final report is submitted to and graded by the NJIT faculty advisor.

**ECET 444. Technology Applications of Object-Oriented Programming. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: ECET 344. Brings together prior software knowledge and applies it to develop modern software applications. Comprised of theory and hands-on applications in the lab. Concepts in modular/structured design and object-oriented design will be combined to develop modern internet and database connected applications. Examine several case studies during the last few weeks. Design, construct, and test a practical software project.

**ECET 491. Special Projects in ECET. 1 credit, 3 contact hours (3;0;0).**
By Advisement". Special projects course for ECET students with subject matter to be arranged by instructor and approved by program coordinator.

**ECET 492. Special Projects in ECET. 2 credits, 3 contact hours (3;0;0).**
By Advisement". See ECET 491.

**ECET 493. Special Projects in ECET. 3 credits, 3 contact hours (0;0;3).**
By Advisement". See ECET 491.

**ECET 495. Co-op Work Experience II. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: ECET 395. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.

**ET 101. Introduction to Engineering Technology. 0 credits, 2 contact hours (2;0;0).**
This course introduces the student to engineering technology. Also included is an introduction to the various engineering technology options: Construction, Electrical and Computer, and Mechanical Engineering Technologies as well as Concrete Industry Management.

**MET 103. Engineering Graphics and Intro. to CAD. 2 credits, 3 contact hours (1;2;0).**
A first course in Computer Aided Design (CAD), includes lab work using AutoCAD software. Topics include fundamentals of engineering graphics, AutoCAD command structure, setting units and limits, drafting primitives, layering, use of editing tools; grid, snap, and axis commands. Upon successful completion of this course, students should be able to effectively produce two-dimensional drawings using the AutoCAD software program.

**MET 105. Applied Computer Aided Design. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: MET 103. A second course in Computer Aided Design (CAD), additional AutoCAD topics include blocks, move and copy, array, mirror, text, text styles, 3D and isometric modes. Upon successful completion of this course, students should be able to use advanced AutoCAD commands to quickly and efficiently produce 2D and 3D drawings, and also be able to modify the AutoCAD environment (e.g., menues, macros, etc.) to boost productivity.

**MET 205. Advanced Computer Aided Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET 105. This course introduces advanced CAD applications, including attribute and attribute extraction, external reference files, solid modeling, surface rendering and animation. Upon successful completion of this course, students should be able to use a CAD software package to develop animations consisting of 3D models with rendered surfaces.

**MET 235. Statics for Technology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: PHYS 102 and MATH 238. Provides an understanding of equilibrium of particles and rigid bodies subject to concentrated and distributed forces. Upon successful completion of this course, the students should be able to analyze problems involving the equilibrium of particles and rigid bodies, including simple machines, trusses, and frictional forces.

**MET 236. Dynamics for Technology. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: MET 235 or MECH 235. Provides an understanding of the mathematics of the motion of particles and rigid bodies, and of the relation of forces and motion of particles. Upon successful completion of this course, the students should be able to describe the motion of particles and rigid bodies as functions of time and position, develop their equations of motions due to applied forces, and determine post impact behavior.

**MET 237. Strength of Materials for Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET 235 or MECH 235. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structured problems, and an understanding of the mechanical behavior of materials under various load conditions. The laboratory experience is integrated within the course. Upon successful completion of this course, the students should be able to determine stresses and deformations for a variety of simple structural problems.

**MET 301. Analysis and Design of Machine Elements I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Elementary strength of materials, calculus (AAS level), Physics I, C++ or BASIC. The principles of strength of materials are applied to mechanical design. Topics include theory of failure, stress concentration factors and fatigue, the design and analysis of shafts subjected to static and dynamic loadings, and critical speed of a rotating shaft.

**MET 302. Analysis and Design of Machine Elements II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MET 301. A continuation of MET 301, including analysis and design of power screws, brakes, clutches, belts, chain drives, gears, gear trains, bearings, and other machine elements.

**MET 303. Applied Thermodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Calculus (AAS level), C++ or BASIC, Physics II. Basic principles of thermodynamics and their applications to internal combustion engines, turbines, compressors, power generating and refrigeration systems.

**MET 304. Applied Fluid Mechanics. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MATH 238 or MATH 112, PHYS 103 or PHYS 121. An introduction to fluid statics and the basic laws of fluid flow; conservation of mass, momentum and energy. Applications of the basic laws to internal and external incompressible flow, including specific topics in pipe flow systems, centrifugal pumps and fans, streamlining, and fluid flow meters.

**MET 307. Plastics Technology. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MET junior standing. An introduction to the basic concepts of plastics conversion, resin classification, processing techniques and significant engineering properties.

**MET 308. Plastics Processing Techniques. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MET junior standing, MET 307. A study of the various processing techniques for both thermoset and thermoplastic materials. Topics include extrusion, injection molding, blow molding, compression moldings, and casting processes.

**MET 314. Dynamics of Machinery. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Dynamics or kinematics (mechanisms), calculus (AAS level), C++ or BASIC. Acquaints students with motion and forces in machines. Topics include velocity and accelerations in linkages, gears, cam and gear trains, static and dynamic forces, and torques in linkages.

**MET 395. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of freshmen year. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**MET 401. Mechanical Design Project I. 2 credits, 2 contact hours (2;0;0).**
Prerequisites:MET 302, MET 303, MET 304, MET 314, ECET 329, ENG 352. Project and lecture applies the principles learned in all technical courses to more advanced design situations. Proposal of a typical mechanical engineering system is presented by an individual or by small groups. The proposal must meet the approval of course instructor. A formal proposal is required.

**MET 403. Applied Thermodynamics II. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MATH 309, MET 303 or its equivalent, MET 304. Builds on a first course on thermodynamics and covers thermodynamic properties of steam, first and second law of thermodynamics. Topics include power and refrigeration cycles, psychrometric chart and combustion.

**MET 404. Applied Heat Transfer. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MATH 309, MET 303, MET 304. An introduction to the fundamental theories and applications of heat transfer. Emphasizes understanding and practical problem solving in covering the three fundamental modes of heat transfer: conduction, convection, and radiation.

**MET 407. Structural Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: C++ or BASIC, elementary strength of materials. Acquaints students with the fundamentals of structural design. Topics include analysis and design of structural members due to various loadings (tension, compression, bending, torsion, and shear), deflections of structural members, truss analysis, stress analysis of weldment.

**MET 409. AirConditioning and Refrigeration. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MET 303, MET 304. Calculation of building cooling and heating loads, psychrometric charts, air distribution and duct design. Topics also include compression and absorption refrigeration cycles, automatic control of refrigeration systems, and building energy management.

**MET 415. Automatic Control Systems. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MET senior standing. Introduction to programmable logic controllers (PLC) as a tool for industrial controls of machines and process. Includes selections of hardware and software, ladder logic programming, wiring methods, maintenance and trouble shooting of.

**MET 448. Mechanical Design Project II. 1 credit, 2 contact hours (2;0;0).**
Prerequisite: MET 401. Continuation of project MET 401. Oral presentation and formal written report are required.

**MET 491. Special Projects in MET. 1 credit, 3 contact hours (3;0;0).**
One-credit special project course for MET students. Must have an instructor agreeing to sponsor the project. Approval by program coordinator is required.

**MET 492. Special Projects in MET. 2 credits, 3 contact hours (3;0;0).**
Two-credit special project course for MET students. Must have an instructor agreeing to sponsor the project. Approval by program coordinator is required.

**MET 493. Special Projects in MET. 3 credits, 3 contact hours (3;0;0).**
Three-credit special project course for MET students. Must have an instructor agreeing to sponsor the project. Approval by program coordinator is required.

**MET 495. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: MET 395. Approval of the department, and permission of the Office of Cooperative Education and Internships. Full-time work experience for approximately one semester. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project.

**MIT 326. Electronic Medical Record Design. 3 credits, 4 contact hours (2;2;0).**
This course will prepare students to manage medical records and related information in different medical settings like individual/group medical practices, health care organizations, long-term care settings, insurance companies, health-care software consulting companies, and/or government agencies. This course will also enable Medical Informatics student interns to become well versed in technology used during their internships. This course has two main objectives; first planning for Electronic Medical Record (EMR) adoption and implementation, and second, practical techniques of implementing and customizing Electronic Medical Records.

**MIT 360. Introduction to Gerontology. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: Junior level standing. R920 201 or R830 101. Introduction to Gerontology is an introduction to the field of human aging. The course of study will include a multidisciplinary examination of the way in which human aging is viewed and how we perceive the process of growing older and how society responds to the issues of aging. The class will look at aging from multiple perspectives that include the social, political and biological sciences, arts and humanities, care giving and social services. This proposed course will provide students with an understanding of the unique challenges individuals experience as they age. Second it provides some basic hands/labs covering assistive technologies and personal and mobile sensors.

**MIT 362. Geriatric Engineering I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: MIT 360 and (CS 106 or CS 113 or CS 115 or CPT 341) and (MATH 305 or MNET 315.) This course will first provide students with an understanding of the unique challenges individuals experience as they age. It introduces system design techniques to facilitate assistive technologies that foster independent living. The course provides a labs for the emerging field of designing assistive technologies and personal and mobile sensors. Labs will incorporate A hands low-power small footprint computing devices for sensor monitoring. Students will explore the feasibility of using, for example Raspberry Pi, and Arduino platforms, to monitor vital signs and export data to Electronic Health Record (EHR) platforms. Big Data challenges will be explored in preparation for meaningful use applications required by all EHR systems.

**MIT 440. Clinical Internship. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: Junior Level Standing, CPT 325 and permission MIT program coordinator. During the course of a semester the student gains 100 hours of experience in the IT or Network and Security department of a hospital. The student is under the supervision, and is evaluated by, the director of the corresponding program at the hospital. A final report is submitted to and graded by the BS, MIT Program Advisor at NJIT.

**MNET 300. Concepts In Machining. 3 credits, 3 contact hours (3;0;0).**
Applications in the machining of various materials. Topics include speeds and feeds calculations, tooling concepts, gaging techniques and prototype construction.

**MNET 303. Advanced Techniques in CAD/CAM. 3 credits, 4 contact hours (2;2;0).**
Applications including hands-on experience with CAD/CAM systems. Emphasis is on understanding how displayed objects are represented and manipulated on the computer. Laboratory experiences contribute to an understanding of the advantages and limitations of CAD/CAM systems.

**MNET 315. Industrial Statistics. 3 credits, 4 contact hours (2;2;0).**
Introduction to statistics covering data collection, analysis and presentation. Specialized topics include probability, control charts, correlation, regression, hypothesis testing, and -experimentation.

**MNET 318. Mnfg Process Design. 3 credits, 4 contact hours (2;2;0).**
A development of the principles of production, methodology and economics in view of production requirements with respect to materials, tolerances and finish. Production processes are matched to the product requirements. Laboratory work supports the lecture. Computer problem solving is incorporated in the course.

**MNET 395. Coop Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience.

**MNET 405. Numc Control Machn Tools. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MNET 300 or equivalent. Fundamental concepts of numerical control systems. Assignments include mill and lathe programming techniques, sheet metal processing, and CNC economics.

**MNET 414. Industrial Cost Analysis. 3 credits, 3 contact hours (3;0;0).**
An introduction to general costing techniques. Time value of money concepts are introduced to decision-making matters such as equipment justification, design selection and fabrication costs.

**MNET 416. Production Scheduling. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MNET 315. A study of manual and computerized methods for setting schedules. Gantt charts, CPM, PERT, PERT/COST, and Line of Balance are some of the topics treated. Problems of line balancing and machine loading are discussed.

**MNET 420. Quality Systems. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: Basic statistics. Introduction in quality control that emphasizes design quality, total quality management and statistical process control. Additional topics include quality economics, ISO, reliability, service quality, measurement and acceptance sampling.

**MNET 421. Contracts & Specs. 3 credits, 3 contact hours (3;0;0).**

**MNET 422. Tool Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: MNET 300 and MNET 303. Introduction to the design of cutting tools with emphasis on speeds, feeds, and power requirements. Covers design of jigs, fixtures, punch and dies, gaging and inspection tooling with emphasis on current industrial practices.

**MNET 423. Motion & Time Study Tech. 3 credits, 4 contact hours (2;2;0).**
A study of the basic principles of motion study concerning workplace design and related techniques involving process analyses, man-machine charts and micromotion study. Covers stopwatch time study techniques as well as predetermined time standards, work sampling and wage incentive system.

**MNET 426. Manufacturing Project. 2 credits, 4 contact hours (1;3;0).**
Prerequisite: Senior standing. A capstone project requiring a formal written report and oral presentation.

**MNET 495. Cooperative Experien II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MNET 395 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and/or project.

**SET 200. Introduction to Geomatics. 3 credits, 6 contact hours (3;3;0).**
Plane surveying with angle and distance measurements; leveling; topographic mapping; traverse and area computations; horizontal and vertical curves; cross sections; triangulation; state plane coordinates; 3-D surveying using global positioning system (GPS), Geographic Information Systems (GIS) and remote sensing technology for surveying and mapping applications. Emphasis is on the use of the computer for solving typical field and office problems. Field exercises in conjunction with the classroom exercises in SET 200 utilizing classical and electronic instruments and COGO/CAD software.

**SET 207. Evidence and Procedures for Property Surveys. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 200. Introduction to surveying law and to the concept of evidence related to boundary locations as discoverable on the ground and through deeds or other written records. Understanding of the principles of property law, titles, land ownership, transfer of land ownership, deed descriptions, evidence recovery and conflict resolutions.

**SET 280. Marine Surveying. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: CE 200 or SET 200. Marine Surveying builds on the core competencies introduced in "Introduction to Geomatics":. This course focuses on computer generated solutions for nautical charts and water boundary delineations using imaging, optical, LiDAR, and acoustic observations via marine, airborne, and space-based platforms; to understand marine surveying technology for solutions on environmental problems; develop skills and techniques to enhance, interpret, and analyze acoustic measurements using computer-based methods.

**SET 301. Route Surveying (Surveying III). 4 credits, 6 contact hours (3;3;0).**
Prerequisites: CE 200 or equivalent. Horizontal and vertical curves computation and layout with regard to highway design. Special emphasis on complex curves. Topics include control, positioning, error analysis, highway design problems, and layout. Also included is a review of the concepts of right-of-way surveys.

**SET 302. Geodetic Control Surveying (Surveying IV). 4 credits, 6 contact hours (3;3;0).**
Prerequisites: CE 200 or equivalent. A study of the higher order methods and techniques of surveying such as Global Positioning System (GPS) with observations of HARNs, 1st, 2nd and 3rd Orders of Accuracy along with the requisite computations to reduce these observations to measurements and the applications of these measurements to the State Plane Coordinate systems and the geoid.

**SET 303. Photogrammetry and Aerial Photo Interpretation. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: CE 200 or equivalent. A review of the principles of photography, including the physical science of optics as related to the use of aerial photos, to engineering and land surveying projects. Includes the necessary mathematics of photogrammetry and the process of designing and establishing the required data for proper acquisition of photogrammetric information.

**SET 304. Adjustment Computations I. 4 credits, 4 contact hours (4;0;0).**
Prerequisites: Calculus I or equivalent. A course designed to give the student the necessary knowledge to reduce survey observations to measurements; to analyze the data to determine the relationship of adjusted measurements to the observations; to verify that the mathematical constraints have been met; and to introduce approximate and least squares adjustments of surveying observations.

**SET 307. Boundaries and Adjacent Properties. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: SET 207. A course on legal principles regarding boundaries and the constructive solutions of the problems of boundary surveying by a consideration of deed descriptions and examples of their application to surveying.

**SET 360. Digital Surveying Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: SET 200 or MET 205 or equivalent, or instructor permission. Digital surveying methods focus on skills using robotic and digital geospatial data collection technologies for mapping using CAD methods. Topics include digital data collection, data preparation, reductions, and data processing for coordinate computations. Topics in CAD focus preparing as-built site plans, plat or survey diagram, Digital Elevation Model (DEM) or a Digital Surface Model (DSM) development. Students will experience "hands on" exercises in the practice of geospatial data collection, handling instrumentation, data processing and data representation.

**SET 401. Fundamentals of Geodesy (Surveying V). 3 credits, 3 contact hours (3;0;0).**
Prerequisite: SET 302 and SET 303. Geodesy and its relation to surveying and other disciplines. Topics include geometric, physical and satellite geodesy. Also includes the concept of map projection.

**SET 403. Remote Sensing Principles for Geomatics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CE 200 or SET 200. Principles of remote sensing for Geomatics application build on the core competencies introduced in Introduction to Surveying. This course focuses on computer generated solutions from technologies used for the acquisition and production of geospatial data via terrestrial, airborne, and space-based platforms; to understand remote sensing technology for solutions on scientific environmental problems; develop skills and techniques to enhance, interpret, and analyze digital imagery using computer-based methods.

**SET 404. Adjustment Computations II. 4 credits, 4 contact hours (4;0;0).**
Prerequisite: SET 304. Introduction to the concepts of observations and models. A continuation of the theory of least squares and the mathematical weighting of observations. Also includes the statistical evaluation of least square results.

**SET 407. Boundary Line Analysis. 4 credits, 6 contact hours (3;3;0).**
Prerequisite: SET 307. Develops the analytical synthesis of real property law, land surveying procedures, and scenario development compatible with current case law decisions for the development of most probable scenarios of boundary location for the court's consideration.

**SET 420. Geographic/Land Information Systems. 4 credits, 6 contact hours (3;3;0).**
Prerequisites: SET 307 or MET 205 or permission of instructor. Geographic/Land Information System builds on the core competencies that were introduced in the course "Introduction to Surveying". This course focuses on understanding the fundamentals of Geographic/Land Information Systems (GIS/LIS) and Multi-Purpose Cadastres. Topics on LIS emphasize issues relating to the design, implementation, and maintenance of land records. Topics on GIS emphasize GIS data models (vector versus raster) and database development for applications in diverse fields like criminal justice, economics, and infrastructure. Students will learn practical skills on web-based mapping and GIS.

**SET 440. Land Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: SET 207 and CE 321 or equivalent. Understanding the process of development of land through the study of land use law, federal, state and municipal land use regulations, federal and state regulations regarding environmental issues and the administrative and statutory laws governing the preparation of land surveys; impart the ability to prepare a land survey from initial contact and the proposal phase to preliminary and final plan approval through a class project designed to cover all of these phases.

**SET 490. Senior Project in Surveying. 2 credits, 2 contact hours (2;0;0).**
Prerequisite: Senior standing. The student works on an individual surveying project guided by the department staff. The project should concentrate on a specific aspect of surveying, not necessarily on field measurements. Project includes library research, written report and oral presentation of findings.

**SET 491. Special Projects in Surveying. 1 credit, 1 contact hour (0;0;1).**
This course provides students with research experience in Geomatics/Surveying at the undergraduate level. Course content and scope of study will be approved by the coordinator of the SET program. Topics can include GPS data processing, marine surveying for bathymetric modeling and generalization, and geophysical surveying using gravity and topography data. Course outcomes include knowledge of advanced data processing, data analysis, and interpretation at the undergraduate level.

**SET 492. Special Projects in Surveying. 2 credits, 2 contact hours (0;0;2).**
This course provides students with research experience in Geomatics/Surveying at the undergraduate level. Course content and scope of study will be approved by the coordinator of the SET program. Topics can include GPS data processing, marine surveying for bathymetric modeling and generalization, and geophysical surveying using gravity and topography data. Course outcomes include knowledge of advanced data processing, data analysis, and interpretation at the undergraduate level.

**SET 493. Special Projects in Surveying. 3 credits, 3 contact hours (0;0;3).**
This course provides students with research experience in Geomatics/Surveying at the undergraduate level. Course content and scope of study will be approved by the coordinator of the SET program. Topics can include GPS data processing, marine surveying for bathymetric modeling and generalization, and geophysical surveying using gravity and topography data. Course outcomes include knowledge of advanced data processing, data analysis, and interpretation at the undergraduate level.

**TMT 301. Digital Electronics for Telecommunications. 3 credits, 4 contact hours (2;2;0).**
Studies the fundamentals of digital electronics including combinational and sequential logic. Emphasizes those signals and configurations commonly employed in telecommunication systems. Theory is reinforced in hardware and simulation laboratory exercises.

# B.S. in Engineering Technology, Computer Technology

Computer Technology (CMPT) is an interdisciplinary program which combines courses mainly in Engineering Technology, Computer Science and Management. The program also provides a background in mathematics and science which is sufficient to allow students to go on to graduate school. It is designed as a continuation of an associate's degree program in computer science, computer programming, computer networking, or computer software. This program prepares the student for careers as a computer application programmer, database administrator, computer system manager, computer network manager, software specialist, Management Information Systems (MIS) manager, customer support engineer, computer sales representative or educator and trainer in the field of computer applications.

Students who wish to enter the program as a transfer student are typically students with an associate's degree in a program of computer studies, such as computer science, computer technology, computer software or computer networking.

A maximum of 64 semester hour credits may be transferred into this program, and students need most of the following courses: Calculus I, Science such as biology, botany, chemistry, geology or physics, Communications, Economics / Accounting , Physical Education , Introduction to Programming, Data Structures / Advanced High Level Language Programming, Operating Systems (DOS, Windows, Unix) and Database Concepts with SQL (Access, dBase, Visual Basic).  Students are expected to have some knowledge of C++ or another object oriented language.Students with less than 64 credits or with deficiencies in the above subject areas are considered on a case by case basis.

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| Science Elective - Phys/Chem/Biol/A&P | | 3 |
| Science Lab Elective | | 1 |
| MATH 138<br>or MATH 135 | General Calculus I<br>or Calculus for Business | 3 |
| FRSH SEM | Freshman Seminar | 0 |

| | | |
|---|---|---|
| CS 106 | Roadmap to Computing Engineers | 3 |
| | **Term Credits** | **13** |
| **2nd Semester** | | |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Science Elective - Phys/Chem/Biol/A&P | | 3 |
| Science Lab Elective | | 1 |
| CS 113<br>or CS 115 | Introduction to Computer Science<br>or Intro. to CS I in C++ | 3 |
| IT 201 | Information Design Techniques | 3 |
| Specialization/Technical Elective 1 | | 3 |
| ET 101 | Introduction to Engineering Technology | 0 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| EPS 202 | Society, Technology, and the Environment (or Rutgers Equivalent Elective) | 3 |
| Free Elective | | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| IT 202 | Internet and Applications | 3 |
| IT 120 | Introduction to Network Technology | 3 |
| Specialization/Technical Elective 2 | | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| Free Elective | | 3 |
| ECON 201 | Economics | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| Specialization/Technical Elective 3 | | 3 |
| Specialization/Technical Elective 4 | | 3 |
| Specialization/Technical Elective 5 | | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| CPT 310 | Computer Design Fundamentals for Computer Technology | 3 |
| CPT 330 | Software Web Applications for Engineering Technology I | 3 |
| CPT 341 | Visual Basic.NET for Engineering Technology | 3 |
| ENG 352 | Technical Writing | 3 |
| Select one of the following: | | 3-4 |
| MATH 112 | Calculus II | |
| MATH 346 | Mathematics of Finance I | |
| Specailization/Technical Elective 6 | | |
| MIS 245 | Introduction to Management Information Systems | 3 |
| | **Term Credits** | **18-19** |
| **2nd Semester** | | |
| CPT 315 | Computer Architecture for Computer Technology | 3 |
| CPT 335 | Networks Applications for Computer Technology I | 3 |
| MATH 305 | Statistics for Technology | 3 |
| MNET 414<br>or FIN 315 | Industrial Cost Analysis<br>or Fundamentals of Corporate Finance | 3 |
| MRKT 330 | Principles of Marketing | 3 |

| | | |
|---|---|---|
| Humanities and Social Sciences (high-level):GUR Humanities Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CPT 401 | Senior Project | 2 |
| CPT 430 | Software Web Applications for Engineering Technology II | 3 |
| CPT 440 | Visual Basic Applications for Engineering Technology | 3 |
| MGMT 480<br>or MRKT 360 | Managing Technology and Innovation<br>or Internet Marketing | 3 |
| OM 375 | Management Science | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CPT 435 | Networks Applications for Computer Technology II | 3 |
| CPT 450 | Computer Graphics for Computer Technology | 3 |
| Elective - Science course in Physics or Chemistry | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **12** |
| | **Total Credits** | **130-131** |

## GUR Electives

Refer to the **General University Requirement** section of this catalog for further information on GUR electives.

## CMPT Specializations - Select one specialization from the list below.  Students must complete a combination of 6 courses in specialization and technical electives.

## IT Security Specialization:

| | |
|---|---|
| Complete the following 2 courses: | |
| CPT 335 | Networks Applications for Computer Technology I |
| CPT 435 | Networks Applications for Computer Technology II |
| **Technical Electives** | |
| Select four of the following: | |
| IT 220 | Wireless Networks |
| IT 330 | Computer Forensic |
| IT 331 | Privacy and Information Technology |
| IT 332 | Digital Crime |
| IT 430 | Ethical Hacking for System Administrators |
| CS 434 | Advanced Database Systems |
| CS 608 | Cryptography and Security |
| CS 639 | Elec. Medical Records: Med Terminologies and Comp. Imp. |
| R120 102 | General Biology |
| R120 142 | Anatomy & Physiology |

## Medical Informatics Specialization:

| | |
|---|---|
| Complete the following 4 courses: | |
| CPT 325 | Medical Informatics Technology |
| CPT 425 | Medical Informatics Technology II |
| MIT 326 | Electronic Medical Record Design |
| R120 141 | Anatomy & Physiology |
| **Techincal Electives:** | |
| Select two of the following: | |
| IT 220 | Wireless Networks |
| IT 330 | Computer Forensic |

| | |
|---|---|
| IT 331 | Privacy and Information Technology |
| IT 332 | Digital Crime |
| IT 430 | Ethical Hacking for System Administrators |
| CS 434 | Advanced Database Systems |
| CS 608 | Cryptography and Security |
| CS 639 | Elec. Medical Records: Med Terminologies and Comp. Imp. |
| R120 102 | General Biology |
| R120 142 | Anatomy & Physiology |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Concrete Industry Management

The Concrete Industry Management (CIM) program is designed to train and educate the student in the field of concrete industry by exposing the student to a multidisciplinary program which draws on management and technology to produce a well-rounded graduate who is able to enter a career in the concrete industry. The four-year Bachelor of Science degree program focuses on science, technology, management and production as well as the mandatory university courses in English, history and the humanities. The concrete industry is a $931 billion dollar industry which is eager to employ graduates, who are educated and trained, to manage, develop and own concrete industry businesses.

The objective of this program is to produce graduates grounded in the basics of concrete's production techniques and its use in a multitude of construction applications. In addition, graduates acquire a minor in business administration.

The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in Civil or Construction Engineering Technology and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. Students in other majors, such as Business, may have taken many of the required courses. In the case of all students, both four-year and transfer, a minimum of 126 credits is required for graduation.

(128)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| CS 106 | Roadmap to Computing Engineers | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ACCT 117 | Survey of Accounting | 3 |
| Technical Elective (100-200 level) | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| CIMT 101 | Introduction to Concrete | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| ACCT 215 | Managerial Accounting I | 3 |
| MGMT 290 | Business Law I | 3 |
| CIMT 205 | Concrete Properties and Testing | 3 |
| ECON 201 | Economics | 3 |
| MIS 245 | Introduction to Management Information Systems | 3 |

| | | |
|---|---|---|
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CHEM 301 | Chemical Technology | 3 |
| Technical Elective (100-200 level) | | 3 |
| CIMT 210 | Concrete Applications I | 3 |
| MATH 305 | Statistics for Technology | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| MNET 420 | Quality Systems | 3 |
| CET 313 | Construction Procedures I | 3 |
| CIMT 305 | Concrete Applications II | 3 |
| ENG 352 | Technical Writing | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| CET 323 | Construction Safety | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CET 314 | Construction Procedures II | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| CIMT 310 | Concrete Products and Delivery | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Technical Elective (300-400 level) | | 3 |
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CET 411 | Cost Estimating | 3 |
| CET 415 | Construction Project Management | 3 |
| CIMT 405 | Advanced Concrete Testing and Quality Assurance | 3 |
| CIMT 497 | Co-op Work Experience I | 3 |
| Technical Elective (300-400 level) | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Capstone Seminar Humanities and Social Sciences (upper-level) GUR | | 3 |
| CET 413 | Environmental Science | 3 |
| MNET 414 | Industrial Cost Analysis | 3 |
| CIMT 410 | Senior Project in CIM | 3 |
| CIMT 315 | Concrete Construction Methods | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **128** |

## Electives

| | |
|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** [1] | |
| Select one of the following 300-level courses: | |
| ENG 3XX | English course |
| HIST 3XX | History course |
| LIT 3XX | Literature course |

| | | |
|---|---|---|
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

[1] The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Free Electives

Consult the program coordinator. Students transferring into this program with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

## Co-op

Co-op is a required course in this program, and must be approved by the faculty advisor and Career Services.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Concrete Industry Management

The Concrete Industry Management (CIM) program is designed to train and educate the student in the field of concrete industry by exposing the student to a multidisciplinary program which draws on management and technology to produce a well-rounded graduate who is able to enter a career in the concrete industry. The four-year Bachelor of Science degree program focuses on science, technology, management and production as well as the mandatory university courses in English, history and the humanities. The concrete industry is a $931 billion dollar industry which is eager to employ graduates, who are educated and trained, to manage, develop and own concrete industry businesses.

The objective of this program is to produce graduates grounded in the basics of concrete’s production techniques and its use in a multitude of construction applications. In addition, graduates acquire a minor in business administration.

The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in Civil or Construction Engineering Technology and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. Students in other majors, such as Business, may have taken many of the required courses. In the case of all students, both four-year and transfer, a minimum of 126 credits is required for graduation.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |

| | | |
|---|---|---|
| PHYS 102A | General Physics Laboratory | 1 |
| CS 106 | Roadmap to Computing Engineers | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ACCT 117 | Survey of Accounting | 3 |
| Technical Elective (100-200 level) | | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| CIMT 101 | Introduction to Concrete | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| ACCT 215 | Managerial Accounting I | 3 |
| MGMT 290 | Business Law I | 3 |
| CIMT 205 | Concrete Properties and Testing | 3 |
| ECON 201 | Economics | 3 |
| MIS 245 | Introduction to Management Information Systems | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CHEM 301 | Chemical Technology | 3 |
| Technical Elective (100-200 level) | | 3 |
| CIMT 210 | Concrete Applications I | 3 |
| MATH 305 | Statistics for Technology | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| MNET 420 | Quality Systems | 3 |
| CET 313 | Construction Procedures I | 3 |
| CIMT 305 | Concrete Applications II | 3 |
| ENG 352 | Technical Writing | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| CET 323 | Construction Safety | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| CET 314 | Construction Procedures II | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| CIMT 310 | Concrete Products and Delivery | 3 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Technical Elective (300-400 level) | | 3 |
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |

| | | |
|---|---|---|
| CET 411 | Cost Estimating | 3 |
| CET 415 | Construction Project Management | 3 |
| CIMT 405 | Advanced Concrete Testing and Quality Assurance | 3 |
| CIMT 497 | Co-op Work Experience I | 3 |
| Technical Elective (300-400 level) | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Capstone Seminar Humanities and Social Sciences (upper-level) GUR | | 3 |
| CET 413 | Environmental Science | 3 |
| MNET 414 | Industrial Cost Analysis | 3 |
| CIMT 410 | Senior Project in CIM | 3 |
| CIMT 315 | Concrete Construction Methods | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **128** |

## Electives

| | |
|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** [1] | |
| Select one of the following 300-level courses: | |
| ENG 3XX | English course |
| HIST 3XX | History course |
| LIT 3XX | Literature course |
| PHIL 3XX | Philosophy course |
| STS 3XX | Science, Technology, and Society course |
| SS 3XX | Social Science course |
| THTR 3XX | Theater course |
| ARCH 382 | History of Architecture IV |
| RUTG 3XX | Approved 300-level course at Rutgers-Newark |
| **Humanities and Social Sciences (upper-level) GUR** | |
| Select one of the following 300-level courses: | |
| LIT 3XX | Literature course |
| HIST 3XX | History course |
| PHIL 3XX | Philosophy course |
| STS 3XX | Science, Technology, and Society course |
| RUTG 3XX | 300-level course at Rutgers-Newark approved by the Humanities department |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | |
| Take one of the following. Honors College students take honors section: | |
| HSS 403 | Humanities Senior Seminar - Literature |
| HSS 404 | Humanities Senior Seminar - History |
| HSS 405 | Humanities Senior Seminar - Philosophy |
| HSS 406 | Humanities Senior Seminar - English |
| HSS 407 | Humanities Senior Seminar - Theater |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society |
| HSS 409 | Humanities Senior Seminar - Social Science |

[1] The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Free Electives

Consult the program coordinator. Students transferring into this program with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

## Co-op

Co-op is a required course in this program, and must be approved by the faculty advisor and Career Services.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Engineering Technology, Construction Engineering Technology

The construction industry is an interesting and dynamic career that combines the elements of technical knowledge, management skills and creativity to breathe life into a set of plans, turning them into a real structure. The Construction Manager needs the technical ability to successfully interface with design professionals such as architects and engineers as well as the management skills to work with the talented trades persons that perform the actual work of construction.

These skills are acquired in the classroom as well as through internships and co-op education programs and in all phases of the construction industry such as building construction as well as heavy/highway and utility construction. These internship and co-op opportunities are supported by our industry partners.

The students in NJIT's Construction Engineering Technology (CET) program acquire a broad set of technical skills as well as business, communication and management knowledge in order to successfully enter the construction management field. Graduates of our program are successful contractors, construction managers, project executives, project managers and construction inspectors.

This program is accredited by the Engineering Accreditation Commission of ABET, http://abet.org.

Graduates of this program are eligible to sit for the Professional Engineer's examination in New Jersey with the appropriate experience, as determined by the New Jersey Board of Professional Engineers and Land Surveyors. (http://www.njconsumeraffairs.gov/pels/). Graduates of the program are also eligible to pursue graduate degrees in civil engineering, management or related areas and students may participate in the BS/MS Program (http://www.njit.edu/graduatestudies/program-options/bs-ms/index.php).

The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in Civil or Construction Engineering Technology and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of 129 credits is required for graduation.

## Program Educational Objectives

- Graduates of our program will attain positions of responsibility within the various aspects of the construction industry.
- Graduates of our program will have the necessary skills to avail themselves of the opportunities for lifelong learning and professional development.

## Student Outcomes

- An ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities; and,
- An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies; and,
- An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes; and,
- An ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives; and,
- An ability to function effectively as a member or leader on a technical team; and,
- An ability to identify, analyze, and solve broadly-defined engineering technology problems; and,
- an ability to apply written, oral, and graphical communication in both technical and nontechnical environments; and an ability to identify and use appropriate technical literature; and,
- An understanding of the need for and an ability to engage in self-directed continuing professional development; and,
- An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity; and,
- A knowledge of the impact of engineering technology solutions in a societal and global context; and,
- A commitment to quality, timeliness, and continuous improvement; and,
- Producing and utilizing design, construction and operations documents; and,
- Performing economic analyses and cost estimates related to design, construction and maintenance of systems in the construction technical specialties; and,

- An ability to select appropriate construction materials and practices; and,
- An ability to apply principles of construction law and ethics; and,
- An ability to apply basic technical concepts to the solution of construction problems involving hydraulics and hydrology, geotechnics, structures, construction scheduling and management and construction safety, and
- An ability to perform standard analysis and design in at least one recognized technical specialty within construction engineering technology that is appropriate to the goals of the program.

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| CS 106 | Roadmap to Computing Engineers | 3 |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 238 | General Calculus II | 3 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MET 105 | Applied Computer Aided Design | 2 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MET 235 | Statics for Technology | 3 |
| CET 313 | Construction Procedures I | 3 |
| ECET 201 | Circuits I | 3 |
| ACCT 117 | Survey of Accounting | 3 |
| CE 200 | Surveying | 3 |
| CE 200A | Surveying Laboratory | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MET 237 | Strength of Materials for Technology | 3 |
| CET 314 | Construction Procedures II | 3 |
| Select one of the following: | | 3 |
| HIST 213 | The Twentieth-Century World | |
| HUM 212 | The Modern World | |
| ECON 201 | Economics | 3 |
| ENG 352 | Technical Writing | 3 |
| MET 304 | Applied Fluid Mechanics | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| CET 233 | Structural Analysis in Construction | 3 |
| CET 317 | Construction Computing | 3 |
| CET 322 | Construction Codes and Regulations | 3 |
| MATH 305 | Statistics for Technology | 3 |

| | | |
|---|---|---|
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CET 323 | Construction Safety | 3 |
| CET 341 | Soils and Earthworks | 3 |
| CET 331 | Structural Systems | 3 |
| MNET 414 | Industrial Cost Analysis | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| MET 303 | Applied Thermodynamics | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CET 411 | Cost Estimating | 3 |
| CET 415 | Construction Project Management | 3 |
| CET 431 | Construction Testing | 3 |
| CET 435 | Design of Temporary Structures | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CET 413 | Environmental Science | 3 |
| CET 421 | Construction Contracts | 3 |
| CET 416 | Senior Construction Project | 2 |
| Management Elective | | 3 |
| Technical Elective | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **131** |

## Electives

| | | |
|---|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** [1] | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |

| | |
|---|---|
| HSS 406 | Humanities Senior Seminar - English |
| HSS 407 | Humanities Senior Seminar - Theater |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society |
| HSS 409 | Humanities Senior Seminar - Social Science |

1 The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Suggested Technical Electives

| | | |
|---|---|---|
| CET 460 | Forensics in Construction | 3 |
| MNET 420 | Quality Systems | 3 |
| CE 321 | Water Resources Engineering | 3 |
| CE 342 | Geology | 3 |
| CE 350 | Transportation Engineering | 3 |
| CE 406 | Remote Sensing | 3 |
| CE 450 | Urban Planning | 3 |
| CE 461 | Professional Practice in CEE | 3 |
| CE 465 | Green and Sustainable Civil Engineering | 3 |

## Free Electives

Consult the program coordinator. Students transferring into this program with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## Minors

Minors are available in several programs of study:

- Computer Science which is offered by the CIS Department
- Professional Communications offered by the Humanities Department
- Business offered by the School of Management

The exact requirements for each of these programs are established by each of the departments offering the Minor. Students seeking information regarding the requirements for minors should consult that department.

# B.S. in Engineering Technology, Construction Management Technology

The construction industry is an interesting and dynamic career that combines the elements of technical knowledge, management skills and creativity to breathe life into a set of plans, turning them into a real structure. The Construction Manager needs the technical ability to successfully interface with design professionals such as architects and engineers as well as the management skills to work with the talented trades persons that perform the actual work of construction. These skills are acquired in the classroom as well as through internships and co-op education programs and in all phases of the construction industry such as building construction as well as heavy/highway and utility construction. These internship and co-op opportunities are supported by our industry partners.

The students in NJIT's Construction Management Technology (CMT) program acquire a broad set of management skills as well as business, management, communication, and technical knowledge in order to successfully enter the construction management field. Graduates of our program are successful contractors, construction managers, project executives, project managers and construction inspectors. Graduates of the program are eligible to pursue graduate degrees in civil engineering, management or related areas and students may participate in the BS/MS Program (http://www.njit.edu/graduatestudies/program-options/bs-ms/index.php). The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in Civil or Construction Engineering Technology and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of 129 credits is required for graduation.

(129 credits)

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| CS 106 | Roadmap to Computing Engineers | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| ET 101 | Introduction to Engineering Technology | 0 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 238 | General Calculus II | 3 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| MET 105 | Applied Computer Aided Design | 2 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| CIMT 101 | Introduction to Concrete | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **19** |
| **Second Year** | | |
| **1st Semester** | | |
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| MGMT 290 | Business Law I | 3 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| ECON 201 | Economics | 3 |
| CE 200 | Surveying | 3 |
| CE 200A | Surveying Laboratory | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ACCT 215 | Managerial Accounting I | 3 |
| MIS 245 | Introduction to Management Information Systems | 3 |
| CIMT 205 | Concrete Properties and Testing | 3 |
| ENG 352 | Technical Writing | 3 |
| Humanities and Social Sciences (upper-level) Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 305 | Statistics for Technology | 3 |
| CET 313 | Construction Procedures I | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| CET 317 | Construction Computing | 3 |
| CET 322 | Construction Codes and Regulations | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CET 314 | Construction Procedures II | 3 |
| CMT 332 | Structural Systems for Construction Management | 3 |
| HRM 301 | Organizational Behavior | 3 |
| CET 323 | Construction Safety | 3 |

| | | |
|---|---|---|
| Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CET 411 | Cost Estimating | 3 |
| CET 415 | Construction Project Management | 3 |
| MNET 414 | Industrial Cost Analysis | 3 |
| CMT 452 | Mechanical and Electrical Systems for Construction | 3 |
| CET 421 | Construction Contracts | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CET 413 | Environmental Science | 3 |
| CMT 436 | Temporary Structures for Construction Management | 3 |
| CET 416 | Senior Construction Project | 2 |
| MGMT 390 | Principles of Management | 3 |
| Technical or Mgmt. Elective | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| | **Total Credits** | **128** |

## Electives

| | | |
|---|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** [1] | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

1 The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Free Electives

Consult the program coordinator. Students entering with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

## Suggested Management Electives

| | | |
|---|---|---|
| HRM 303 | Human Resources Management | 3 |
| HRM 310 | Managing Diversity in Organizations | 3 |
| MGMT 316 | Business Research Methods | 3 |
| MGMT 480 | Managing Technology and Innovation | 3 |
| MGMT 492 | Business Policy | 3 |
| MGMT 491 | International Business | 3 |

## Suggested Technical Electives

| | | |
|---|---|---|
| MNET 420 | Quality Systems | 3 |
| CE 342 | Geology | 3 |
| CE 350 | Transportation Engineering | 3 |
| CE 406 | Remote Sensing | 3 |
| CE 450 | Urban Planning | 3 |
| CE 465 | Green and Sustainable Civil Engineering | 3 |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register.  A full-time credit load is 12 credits.  First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## Minors

Minors are available in several programs of study:

- Computer Science which is offered by the CIS Department
- Professional Communications offered by the Humanities Department
- Business offered by the School of Management

The exact requirements for each of these programs are established by each of the departments offering the Minor. Students seeking information regarding the requirements for minors should consult that department.

| | | |
|---|---|---|
| CET 323 | Construction Safety | 3 |
| CET 490 | Special Project | 3 |
| CET 491 | Special Project | 1 |
| CET 492 | Special Project | 2 |

## Suggested Management Electives

| | | |
|---|---|---|
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| CS 103 | Computer Science with Business Problems | 3 |
| HRM 303 | Human Resources Management | 3 |
| HRM 310 | Managing Diversity in Organizations | 3 |
| MGMT 480 | Managing Technology and Innovation | 3 |
| MGMT 492 | Business Policy | 3 |

# B.S. in Engineering Technology, Electrical and Computer Engineering Technology

The Electrical and Computer Engineering Technology (ECET) program emphasizes the application of electrical/electronics principles and devices and computer hardware and software. Graduates of the ECET program are involved in product development and improvement, system development, management, manufacturing and engineering operational functions, in a wide variety of companies in the computer, telecommunications, medical electronics and other technical fields. Graduates also have positions in technical sales and customer service, and a significant percentage continue their studies and earn graduate degrees in engineering or management.

The placement of graduating students has been excellent. This program is accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET), http://abet.org.

Graduates of this program are eligible to sit for the Professional Engineer's examination in New Jersey with the appropriate experience, as determined by the New Jersey Board of Professional Engineers and Land Surveyors (http://www.njconsumeraffairs.gov/pels/). Graduates of the program are also eligible to pursue graduate degrees in biomedical engineering, electrical and computer engineering, engineering management, management or related areas and students may participate in the BS/MS Program (http://www.njit.edu/graduatestudies/program-options/bs-ms/index.php). The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in Electrical Engineering Technology and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of 129 credits is required for graduation.

## Program Educational Objectives

- Our graduates will establish productive careers in technology-based organizations in such diverse positions as design, manufacturing, teaching, management, system engineering and sales.
- Our graduates will participate in lifelong learning activities including graduate school and other professional education.

## Student Outcomes

- an ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities
- an ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies
- an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes
- an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives
- an ability to function effectively as a member or leader on a technical team
- an ability to identify, analyze, and solve broadly-defined engineering technology problems
- an ability to apply written, oral and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;
- an understanding of the need for and an ability to engage in self-directed continuing professional development
- an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity
- a knowledge of the impact of engineering technology solutions in a societal and global context
- a commitment to quality, timeliness, and continuous improvement
- the application of digital and analog circuit design, computer software, and embedded systems to the development of electrical and computer systems;
- the ability to analyze and develop communications, control, computer, or power systems
- the ability to apply project management techniques to computer and electrical systems.
- the ability to utilize statistics/probability, transform methods and differential equations in support of electrical and computer systems

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| CS 106 | Roadmap to Computing Engineers | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| ET 101 | Introduction to Engineering Technology | 0 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 238 | General Calculus II | 3 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| ECET 201 | Circuits I | 3 |

| | | |
|---|---|---|
| ECET 215 | Introduction to Digital Electronics | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| ECET 202 | Circuits II | 3 |
| Technical Elective (200 level or higher) | | 3 |
| CPT 315 | Computer Architecture for Computer Technology | 3 |
| EPS 202 | Society, Technology, and the Environment (or Rutgers Equivalent GUR Elective) | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| ECET 205 | Fundamentals of Analog Electronics | 3 |
| ECET 214 | Introduction to Communications | 3 |
| Technical Elective (200 level or higher) | | 3 |
| ECON 201 | Economics | 3 |
| Free Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| ECET 303 | Circuit Measurements | 2 |
| ECET 311 | Embedded Systems I | 3 |
| ECET 365 | Digital Logic and Circuit Design | 3 |
| ENG 352 | Technical Writing | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 322 | Differential Equations for Applications | 3 |
| ECET 411 | Embedded Systems II | 3 |
| ECET 300 | Circuit Analysis: Transform Methods | 3 |
| ECET 305 | Integrated Circuit Applications | 3 |
| ECET 344 | Numerical Computing for Engineering Technology | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ECET 401 | ECET Senior Project I | 2 |
| MATH 305<br>or MNET 315 | Statistics for Technology<br>or Industrial Statistics | 3 |
| MGMT 390 | Principles of Management | 3 |
| PHIL 334 | Engineering Ethics and Technological Practice: Philosophical Perspectives on Engineering | 3 |
| ECET Technical Elective | | 3 |
| ECET Technical Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 301 | Chemical Technology | 3 |
| ECET 402 | ECET Senior Project II | 1 |

| | | |
|---|---|---|
| MNET 414 | Industrial Cost Analysis | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Technical Elective (300 level or higher) | | 3 |
| Technical Elective (300 level or higher) | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **129** |

## Focus Areas

The following groups of courses are designed to focus on specific areas of industry. Students are not required to declare a focus area.

## Biomedical Focus

| | | |
|---|---|---|
| ECET 440 | Clinical Internship | 3 |
| BME 302 | Mechanical Fundamentals of Biomedical Engineering | 3 |
| BME 489 | Medical Instrumentation | 3 |
| Select one of the following: | | 3 |
| ECET 415 | Fundamentals of Telecommunications | |
| ECET 416 | Networking Applications | |
| ECET 418 | Transmission Systems | |

## Communications Focus

| | | |
|---|---|---|
| ECET 415 | Fundamentals of Telecommunications | 3 |
| ECET 416 | Networking Applications | 3 |
| ECET 418 | Transmission Systems | 3 |

## ECET Technical Electives

ECET electives are 300 and 400 level courses offered by the ECET program that are not previously required courses within the program. All ECET students are required to take at least two of these courses for their degree. ECET elective courses taken in addition to the two required can fill any of the elective requirements.

| | | |
|---|---|---|
| ECET 350 | Computerized Industrial Controls | 3 |
| ECET 412 | Power Generation and Distribution | 3 |
| ECET 415 | Fundamentals of Telecommunications | 3 |
| ECET 416 | Networking Applications | 3 |
| ECET 418 | Transmission Systems | 3 |
| ECET 440 | Clinical Internship | 3 |
| ECET 444 | Technology Applications of Object-Oriented Programming | 3 |

## Technical Electives

Technical electives can be satisfied only bt courses with a technical subject matter; this excludes humanities, history, economics, social sciences, literature, and any other non-technical subject. In general, the following subjects qualify as technical: BME, BIOL, CPT, CS, IT, MATH, PHYS, R120, R460, MNET. Except CPT 310 Computer Design Fundamentals for Computer Technology or CPT 315 Computer Architecture for Computer Technology or MATH 305 Statistics for Technology or MATH 309 Mathematical Analysis for Technology or MATH 322 Differential Equations for Applications or CHEM 301 Chemical Technology or MNET 315 Industrial Statistics or MNET 414 Industrial Cost Analysis.

## Free Electives

Free electives may be satisfied by any course offered at the university. The ECET program contains two free electives, one at the 200 or higher level and one at the 300 or higher level.

## Co-op Work Experience (Internship)

Co-op Work Experience is not required as part of the ECET program, although it is highly recommended. Students can participate in a sixteen-week paid internship at a variety of local companies. Students who pass Co-op can use the credit to fulfill any of the six non-ECET required electives.

To apply for Co-op students must first visit the Career Development Services office at NJIT and fill out a Co-op application. The application will be sent to your academic advisor for approval and you will be notified of the decision.

## Co-op Classes

The ECET Co-op classes are ECET 395 Co-op Work Experience I and ECET 495 Co-op Work Experience II. Sudents may take up to two Co-op courses; however only the first Co-op counts for course credit towards a degree. ECET 395 Co-op Work Experience I is three credits. ECET 495 Co-op Work Experience II is zero credits and is used for a students second Co-op.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Engineering Technology, Mechanical Engineering Technology

The Mechanical Engineering Technology (MET) program prepares graduates with knowledge, problem solving ability, and hands-on skills to enter careers in the design, installation, manufacturing, testing, evaluation, technical sales, or maintenance of mechanical systems. Our graduates typically have strengths in the analysis, applied design, development, implementation, or oversight of advanced mechanical systems and processes.

The MET program emphasizes hands-on experience and the use of state-of-the-art computer software in the fields of mechanical design, automatic controls, power generation, CAD/CAM, HVAC, and engineering sales. The program also provides a background in mathematics and science, which is sufficient to allow students to go on to graduate school, and also obtain a professional engineering license. This program is accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET), http://abet.org.

Graduates of this program are eligible to sit for the Professional Engineer's examination in New Jersey with the appropriate experience, as determined by the New Jersey Board of Professional Engineers and Land Surveyors. (http://www.njconsumeraffairs.gov/pels/). Graduates of the program are also eligible to pursue graduate degrees in mechanical engineering, management or related areas and students may participate in the BS/MS Program (http://www.njit.edu/graduatestudies/program-options/bs-ms/index.php). The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in Mechanical Engineering Technology and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of 128 credits is required for graduation.

## Program Educational Objectives

- Our graduates will possess the strengths to obtain and advance in positions that require analysis, applied design, development, implementation, or oversight of mechanical systems and processes.
- Our graduates will have the knowledge, problem solving ability, and hands-on skills to be successful in careers in the design, installation, manufacturing, testing, evaluation, technical sales, or maintenance of mechanical systems.
- Our graduates will have the foundation to take advantage of opportunities for life-long learning and professional development.

## Student Outcomes

- an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;
- an ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
- an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;
- an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives;
- an ability to function effectively as a member or leader of a technical team;
- an ability to identify, analyze, and solve broadly-defined engineering technology problems;
- an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;
- an understanding of the need for and an ability to engage in self-directed continuing professional development;
- an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity;
- a knowledge of the impact of engineering technology solutions in a societal and global context;
- a commitment to quality, timeliness, and continuous improvement;
- technical expertise in dynamics, fluid mechanics, and thermodynamics;
- technical expertise having added technical depth in mechanical design, solid mechanics, and electro-mechanical devices and controls.

(128 credits)

| First Year | | |
|---|---|---|
| **1st Semester** | | **Term Credits** |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| CS 106 | Roadmap to Computing Engineers | 3 |
| ET 101 | Introduction to Engineering Technology | 0 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MATH 238 | General Calculus II | 3 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| MET 105 | Applied Computer Aided Design | 2 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| EPS 202 | Society, Technology, and the Environment (or Rutgers Equivalent:GUR Elective) | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MET 235 | Statics for Technology | 3 |
| Technical Elective | | 3 |
| ECET 201 | Circuits I | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| CHEM 301 | Chemical Technology (or Technical Elective for Transfer Students) | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MET 236 | Dynamics for Technology | 2 |
| MET 237 | Strength of Materials for Technology | 3 |
| ME 215 | Engineering Materials and Processes | 3 |
| Free Eelctive | | 3 |
| ECON 201 | Economics | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **17** |
| **Third Year** | | |
| **1st Semester** | | |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| MET 301 | Analysis and Design of Machine Elements I | 3 |
| MET 303 | Applied Thermodynamics | 3 |
| MET 314 | Dynamics of Machinery | 3 |
| ENG 352 | Technical Writing | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MET 302 | Analysis and Design of Machine Elements II | 3 |
| MET 304 | Applied Fluid Mechanics | 3 |
| ECET 329 | Analog and Digital Electronics | 3 |

| | | |
|---|---|---|
| CHEM 301 | Chemical Technology (or Technical Elective for Transfer Students) | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MET 401 | Mechanical Design Project I | 2 |
| MET 415 | Automatic Control Systems | 3 |
| MNET 414 | Industrial Cost Analysis | 3 |
| Humanities and Social Sciences (upper-level) :GUR Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MGMT 390 | Principles of Management | 3 |
| MET 448 | Mechanical Design Project II | 1 |
| MNET 315 | Industrial Statistics | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Technical Elective | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **128** |

## Electives

| | | |
|---|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

## Free Electives

Consult the program coordinator. Students entering with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

## Suggested Technical Electives

| | | |
|---|---|---|
| MET 205 | Advanced Computer Aided Design | 3 |
| MET 307 | Plastics Technology | 3 |
| MET 308 | Plastics Processing Techniques | 3 |
| MET 395 | Co-op Work Experience I | 3 |
| MET 403 | Applied Thermodynamics II | 3 |
| MET 404 | Applied Heat Transfer | 3 |
| MET 407 | Structural Design | 3 |
| MET 409 | AirConditioning and Refrigeration | 3 |
| MET 495 | Co-op Work Experience II | 3 |
| MNET 303 | Advanced Techniques in CAD/CAM | 3 |
| MNET 420 | Quality Systems | 3 |
| CPT 330 | Software Web Applications for Engineering Technology I | 3 |
| CPT 341 | Visual Basic.NET for Engineering Technology | 3 |

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## Co-op

Co-op courses must be approved by the faculty advisor in the student's major department. For the B.S.E.T. option in Mechanical Engineering Technology, MET 395 Co-op Work Experience I may be taken as a technical elective, and may, with the approval of the department and Career Services, be taken in the sophomore year. MET 495 Co-op Work Experience II, which is the second co-op course, may be taken as zero credits.

# B.S. in Engineering Technology, Medical Informatics Technology

Medical Informatics is an interdisciplinary program which combines courses from Information Systems, Biology and Management. The program also provides a background in mathematics and science which is sufficient to allow students to go onto graduate school. It is the study of how health data is collected, stored and communicated, how data is used for administration and clinical decision making and how computers and telecommunications can be applied to support those processes.

The areas of study in Medical Informatics are; Medical Records, Tele-monitoring, Expert Systems, Security, CT-MRI & PET scan data analysis and storage and Medical Sensors. The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.S. degree Computer Science or Medical Informatics, and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of 128 credits is required for graduation.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| R120 101 | General Biology | 4 |
| MATH 138<br>or MATH 135 | General Calculus I<br>or Calculus for Business | 3 |
| CS 106 | Roadmap to Computing Engineers | 3 |
| IT 120 | Introduction to Network Technology | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| ET 101 | Introduction to Engineering Technology | 0 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| BME 111 | Introduction to Physiology | 3 |
| CS 113 | Introduction to Computer Science | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Technical Elective 1 | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 115 | Intro. to CS I in C++ | 3 |
| IT 201 | Information Design Techniques | 3 |
| IT 220 | Wireless Networks | 3 |
| ENG 200 | Communicating in Organizations | 3 |
| EPS 202 | Society, Technology, and the Environment (or Rutgers Equivalent:GUR Elective) | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| IT 202 | Internet and Applications | 3 |
| Technical Elective 2 | | 3 |
| MATH 305<br>or MNET 315 | Statistics for Technology<br>or Industrial Statistics | 3 |
| R920 201<br>or R830 101 | Intro Sociology I<br>or Principles Of Psychology I | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| CPT 325 | Medical Informatics Technology | 3 |
| CPT 310 | Computer Design Fundamentals for Computer Technology | 3 |
| CPT 330 | Software Web Applications for Engineering Technology I | 3 |
| ENG 352 | Technical Writing | 3 |
| MGMT 390 | Principles of Management | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CPT 425 | Medical Informatics Technology II | 3 |
| CPT 341 | Visual Basic.NET for Engineering Technology | 3 |
| CPT 335 | Networks Applications for Computer Technology I | 3 |
| MIT 326 | Electronic Medical Record Design | 3 |
| IT 230 | Computer and Network Security | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| CPT 401 | Senior Project | 2 |
| CS 431<br>or IS 331 | Database System Design and Management<br>or Database Design Management and Applications | 3 |
| MIT 360 | Introduction to Gerontology | 3 |
| IT 330<br>or IT 430 | Computer Forensic<br>or Ethical Hacking for System Administrators | 3 |
| 300 level HIST/Phil/STS | | 3 |

| | | |
|---|---|---|
| Technical Elective 3 | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| MIT 362 | Geriatric Engineering I | 3 |
| Technical Elective 4 | | 6 |
| CPT 373 | Web App Development for Mobile | 3 |
| Capstone Seminar in Humanities and Social Sciences (upper-level) GUR | | 3 |
| Technical Elective 5 | | 3 |
| | **Term Credits** | **18** |
| | **Total Credits** | **128** |

## GUR Electives

Refer to the **General University Requirement** section of this catalog for further information on GUR electives.

## Technical Electives

| | | |
|---|---|---|
| IT 220 | Wireless Networks | 3 |
| IT 330 | Computer Forensic | 3 |
| IT 331 | Privacy and Information Technology | 3 |
| IT 332 | Digital Crime | 3 |
| IT 430 | Ethical Hacking for System Administrators | 3 |
| CS 434 | Advanced Database Systems | 3 |
| CS 608 | Cryptography and Security | 3 |
| CS 639 | Elec. Medical Records: Med Terminologies and Comp. Imp. | 3 |
| MIT 440 | Clinical Internship | 3 |
| R120 102 | General Biology | 4 |
| R120 142 | Anatomy & Physiology | 4 |

1 The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Engineering Technology, Surveying Engineering Technology

Surveying involves activities such as mapping the earth above and below sea level; determining the position of the boundaries of public or private land including national and international boundaries; providing geospatial information necessary for the construction of private and public works; designing, establishing and administering of land and geographic information systems (LIS/GIS) and the integration of the data within those systems; positioning and monitoring of physical features, structures and engineering works; planning, development and re-development of property whether urban or rural; determining facts about the size, shape and gravity field of the earth; conducting hydrographic surveys for marine and coastal infrastructure development; and conducting high precision measurements for worldwide control networks and for industrial applications and scientific studies. The surveyor utilizes a wide variety of techniques and equipment on the job. Some of the equipment is terrestrial-based, other equipment is air- and space-borne.

The Surveying Engineering Technology (SET) curriculum stresses the technical, theoretical and legal aspects of surveying. Technical surveying courses include theory and application of Global Position Systems (GPS) and Geographic Information Systems (GIS). Law or Law-related courses are integrated into the program in order to impart to students the legal knowledge and legal responsibility of a land surveyor.

This program is accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET), http://abet.org. Graduates of this program are eligible to sit for the Professional Engineer's examination in New Jersey with the appropriate experience, as determined by the New Jersey Board of Professional Engineers and Land Surveyors. (http://www.njconsumeraffairs.gov/pels/). Graduates of the program are also eligible to pursue graduate degrees in Geodesy, Remote Sensing, and Mapping and students may participate in the BS/MS Program (http://www.njit.edu/graduatestudies/program-options/bs-ms/index.php).

The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an AAS. degree in Civil or Construction Engineering Technology or Computer Science and should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of **128 credits is required for graduation**.

## Program Educational Objectives

- Graduates will become licensed surveyors and/or GIS specialists.
- Graduates will be able to take on supervisory roles in their firms. Some graduates will start their own surveying practice.
- Graduates will be able to apply and expand upon their undergraduate-level surveying preparation. This will be accomplished through continuing education and becoming involved in regional and national professional societies such as NJSPLS and ACSM.

## Student Outcomes

- an ability to select and apply the knowledge, techniques, skills, and modern tools of their disciplines to broadly-defined engineering technology activities
- an ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies
- an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes
- an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives
- an ability to function effectively as a member or leader on a technical team
- an ability to identify, analyze, and solve broadly-defined engineering technology problems
- an ability to apply written, oral and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;
- an understanding of the need for and an ability to engage in self-directed continuing professional development
- an understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity
- a knowledge of the impact of engineering technology solutions in a societal and global context
- a commitment to quality, timeliness, and continuous improvement
- an ability to utilize modern measurement technologies to acquire spatial data,
- an ability to utilize industry-standard software to solve technical problems,
- an ability to apply technical concepts to the design and implementation of measurement systems to meet project requirements,
- an ability to design and implement procedures, and analyze data for conformance with precision and accuracy requirements, and
- an ability to carry out or supervise surveying activities and processes such as measurements, positioning, mapping, boundary determination, and geographic/land information systems.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 113 | Introduction to Computer Science | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| Introduction to Information /Technology Elective | | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CE 200 | Surveying | 3 |
| CE 200A | Surveying Laboratory | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| MET 103<br>or CE 260 | Engineering Graphics and Intro. to CAD<br>or Civil Engineering Methods | 2 |
| | **Term Credits** | **17** |
| **Second Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| SET 301 | Route Surveying (Surveying III) | 4 |
| MGMT 290 | Business Law I | 3 |
| Math Elective [1] | | 3 |
| English Composition and Cultural History (lower-level) | | 3 |
| Physical Education | | 1 |
| Concentration Elective: | | 3 |
| CS 114 | Introduction to Computer Science II | |
| Technology/Engineering Elective | | |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| SET 207 | Evidence and Procedures for Property Surveys | 3 |
| MATH 305 | Statistics for Technology | 3 |
| ECON 201 | Economics | 3 |
| English Composition and Cultural History (lower-level) | | 3 |
| CAD Application Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| SET 304 | Adjustment Computations I | 4 |
| SET 307 | Boundaries and Adjacent Properties | 3 |
| CE 321 | Water Resources Engineering | 3 |
| ENG 352 | Technical Writing | 3 |
| Concentration Elective: | | 3 |
| CS 431 | Database System Design and Management | |
| Technology/Engineering Elective | | |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| SET 407 | Boundary Line Analysis | 4 |
| SET 404 | Adjustment Computations II | 4 |
| SET 420 | Geographic/Land Information Systems | 4 |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Science Elective [2] | | 3 |
| | **Term Credits** | **18** |
| **Fourth Year** | | |
| **1st Semester** | | |
| SET 302 | Geodetic Control Surveying (Surveying IV) | 4 |
| SET 303 | Photogrammetry and Aerial Photo Interpretation | 4 |
| Technical Elective | | 3 |
| Open Elective | | 3 |
| | **Term Credits** | **14** |
| **2nd Semester** | | |
| SET 401 | Fundamentals of Geodesy (Surveying V) | 3 |
| SET 440 | Land Development | 3 |
| SET 490 | Senior Project in Surveying | 2 |
| Mangement:GUR Elective | | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **129** |

[1] MATH 337 Linear Algebra is recommended. Other acceptable electives are MATH 213 Calculus III B, MATH 226 Discrete Analysis, MATH 240 Numerical Mathematics Laboratory, or MATH 337 Linear Algebra.

[2] Geology, Chemistry, or Biology

## Electives

| | | |
|---|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** [1] | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

[1] The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Suggested Technical Electives

| | | |
|---|---|---|
| SET 280 | Marine Surveying | 4 |
| SET 403 | Remote Sensing Principles for Geomatics | 3 |

## Other Technical/Engineering Elective

Civil/Environmental/Engineering, Construction Engineering Technology, Computer courses

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# B.S. in Engineering Technology, Technology Education

There is a great need for highly qualified teachers of science and technology at the secondary school level. Nationwide, middle and high schools are facing a shortage of technology teachers. The Technology Education (TEED) program is a partnership between NJIT and Rutgers University, Newark, offering a degree in Engineering Technology and an instructional certification with the Teacher of Technology Education (1810) endorsement.

The technology education curriculum provides an in-depth knowledge of various engineering technology disciplines in addition to the required education courses. Students will take a core group of technical courses, and have an ability to concentrate in one or more of the Engineering Technology options. Students will also complete their degree with a 6 credit student teaching course.

The full four-year curriculum for the program is shown below. Students who wish to enter the program as a transfer student are typically students with an A.A.S. degree in an Engineering Technology program or an A.S. program in a technical discipline. These students should have completed most or all of the courses, or their equivalents, in the first two years of the program as shown below. In the case of all students, both four-year and transfer, a minimum of 131 credits is required for graduation.

(131 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CS 106 | Roadmap to Computing Engineers | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| MATH 138 | General Calculus I | 3 |
| MET 103 | Engineering Graphics and Intro. to CAD | 2 |
| ET 101 | Introduction to Engineering Technology | 0 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 238 | General Calculus II | 3 |
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| ECET 201 | Circuits I | 3 |
| MET 105 | Applied Computer Aided Design | 2 |
| Physical Education | | 1 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MET 235 | Statics for Technology | 3 |
| CHEM 301 | Chemical Technology | 3 |
| R300 292 | Social Foundation [1] | 3 |
| Free Elective | | 3 |
| ECET 215 | Introduction to Digital Electronics | 3 |
| R300 295 | Urban Adol Psych | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| MET 237 | Strength of Materials for Technology | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| R300 298 | 21st Century Urban Educator | 3 |
| ME 215 | Engineering Materials and Processes | 3 |
| IE 224 | Production Process Design | 3 |
| R300 390 | Understand Ed Eval | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **21** |
| **Third Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| CET 313 | Construction Procedures I | 3 |
| STS 310 | Technology and Human Values | 3 |
| R300 410 | Ict In Secondary Sch | 3 |
| CPT 325 | Medical Informatics Technology | 3 |
| R300 388 | Curriculum& Instruct | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Culture Elective (see list) | | |
| MGMT 390 | Principles of Management | 3 |
| MATH 305<br>or MNET 315 | Statistics for Technology<br>or Industrial Statistics | 3 |
| R300 386 | Methods of Teaching Sec School | 3 |
| | **Term Credits** | **9** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Humanities and Social Sciences (upper-level) Capstone Course | | 3 |
| IE 355 | Human Factors | 3 |
| CET 317 | Construction Computing | 3 |
| Technical ET Elective (3xx or 4xx) | | 3 |
| Technical Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| CET 314 | Construction Procedures II | 3 |
| Technical ET Elective (3xx or 4xx) | | 3 |
| Technical Elective | | 3 |
| R300 418 | Secondary Practicum [2] | 2 |
| R300 419 | Clinical Practice | 1 |
| | **Term Credits** | **12** |
| **Fifth Year** | | |
| **1st Semester** | | |
| R300 487 | Student Teaching & Seminar | 3 |
| R300 488 | Clinical II: St Teaching Exp | 3 |
| | **Term Credits** | **6** |
| | **Total Credits** | **128** |

[1] Replaces EPS 202 Society, Technology, and the Environment as GUR.

[2] Praxis must be taken prior to taking this class.

## Electives

| | |
|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR [1]** | |
| Select one of the following 300-level courses: | |
| ENG 3XX | English course |
| HIST 3XX | History course |
| LIT 3XX | Literature course |
| PHIL 3XX | Philosophy course |
| STS 3XX | Science, Technology and Society course |
| SS 3XX | Social Science course |
| THTR 3XX | Theater course |
| ARCH 382 | History of Architecture IV |
| 3XX | Approved 300-level course at Rutgers-Newark |
| **Humanities and Social Sciences (upper-level) GUR** | |

| | | |
|---|---|---|
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

[1] The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Free Electives

Consult the program coordinator. Students transferring into this program with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

# B.S. in Engineering Technology, Telecommunications Management Technology

The objective of the Telecommunications Management Technology (TMT) program is to provide students with the skills required to work with, administer and manage telecommunications networks and systems. Graduates of this program will have the technical knowledge to design, implement and procure telecommunications networks and the management skills to maximize the financial returns on these systems. This program prepares the student for such careers as telecommunications manager, network administrator, telecommunications sales representative, e-commerce developer and customer support representative.

The coursework provides the technical background to understand the underlying network architecture, protocols, and technology with a special emphasis on case studies and industrial implementations. The benefit/cost analysis of these networks and their impact on the business environment is studied in depth. Students who wish to enter the program as a transfer student are typically students with A.A.S. in Electrical Engineering Technology, but can also have their A.S. in Business.

A maximum of 64 semester hour credits may be transferred into this program, and students need most of the following courses: Oral and Written Communications, Calculus I, Physical Science, Computer Programming Language and Applications, Social Science/Humanities, Physical Education, Telecommunications, Networking, Business and Finance. Students with less than 64 credits or with deficiencies in the above subject areas are considered on a case by case basis.

(131 credits)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| MATH 138 | General Calculus I | 3 |
| PHYS 102 | General Physics | 3 |
| PHYS 102A | General Physics Laboratory | 1 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| IT 101 | Introduction to Information Technology | 3 |
| ET 101 | Introduction to Engineering Technology | 0 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 238 | General Calculus II | 3 |

| | | |
|---|---|---|
| PHYS 103 | General Physics | 3 |
| PHYS 103A | General Physics Laboratory | 1 |
| MIS 245 | Introduction to Management Information Systems | 3 |
| ECET 201 | Circuits I | 3 |
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| | **Term Credits** | **19** |
| **Second Year** | | |
| **1st Semester** | | |
| CS 113 | Introduction to Computer Science | 3 |
| ECET 215 | Introduction to Digital Electronics | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| ACCT 117 | Survey of Accounting | 3 |
| IT 120 | Introduction to Network Technology | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| IT 420 | Computer Systems and Networks | 3 |
| ECET 202 | Circuits II | 3 |
| FIN 218 | Financial Markets and Institutions | 3 |
| Physical Education | | 3 |
| MIS 363 | Project Management for Managers | 3 |
| | **Term Credits** | **18** |
| **Third Year** | | |
| **1st Semester** | | |
| MGMT 390 | Principles of Management | 3 |
| ECET 365 | Digital Logic and Circuit Design | 3 |
| ENG 352 | Technical Writing | 3 |
| ECET 344 | Numerical Computing for Engineering Technology | 3 |
| MATH 305 | Statistics for Technology | 3 |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| | **Term Credits** | **18** |
| **2nd Semester** | | |
| ECET 415 | Fundamentals of Telecommunications | 3 |
| ECET 214 | Introduction to Communications | 3 |
| ECET 416 | Networking Applications | 3 |
| MNET 414 | Industrial Cost Analysis | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ECET 444 | Technology Applications of Object-Oriented Programming | 3 |
| ECET 418 | Transmission Systems | 3 |
| MGMT 480 | Managing Technology and Innovation | 3 |
| Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| IT 430 | Ethical Hacking for System Administrators | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |

| | | |
|---|---|---|
| ECET 418 | Transmission Systems | 3 |
| Technical Elective | | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level) Elective | | 3 |
| ECET 493 | Special Projects in ECET | 3 |
| 3XX or 4XX Business/Management Elective | | 3 |
| | **Term Credits** | **18** |
| | **Total Credits** | **135** |

## Electives

| | | |
|---|---|---|
| **Open Elective in Humanities and Social Sciences (upper-level) GUR** [1] | | |
| Select one of the following 300-level courses: | | |
| ENG 3XX | English course | |
| HIST 3XX | History course | |
| LIT 3XX | Literature course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| SS 3XX | Social Science course | |
| THTR 3XX | Theater course | |
| ARCH 382 | History of Architecture IV | |
| 3XX | Approved 300-level course at Rutgers-Newark | |
| **Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following 300-level courses: | | |
| LIT 3XX | Literature course | |
| HIST 3XX | History course | |
| PHIL 3XX | Philosophy course | |
| STS 3XX | Science, Technology and Society course | |
| 3XX | Approved 300-level course at Rutgers-Newark approved by the Humanities department | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Take one of the following. Honors College students take honors section: | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |
| HSS 409 | Humanities Senior Seminar - Social Science | |

1 The department recommends telecommunications management technology option majors take ENG 352 Technical Writing to fulfill this requirement.

## Free Electives

Consult the program coordinator. Students transferring into this program with fewer than 9 credits in humanities/social science must take an appropriate humanities/social science course to fulfill the NJIT GUR.

## Economics/Management Electives

See the advisor.

## Marketing/Management Electives

Any 300- to 400-level MGMT or MRKT course.

## Technical Electives

Any 300-level or 400-level ECET or CIS course.

# Mechanical and Industrial Engineering

Mechanical Engineering is concerned with the design, development, manufacture, and operation of a wide variety of energy conversion and machine systems. Mechanical engineers employ their knowledge of materials, system design and control, production methods, and mechanics to design traditional systems (such as aircraft, automobiles, engines, robots, energy-generation plants, pumps and valves, machines and household appliances), as well as systems utilizing new technologies (such as biomedical and nano devices), to meet design specifications for performance, economy, and ease of use while complying to safety and environmental protection requirements.

The mechanical engineering program strives to develop mechanical engineering graduates who can achieve fulfilling careers in the areas of engineering practice, professional growth and service. The expectations of the accomplishments and characteristics of their career in these areas are the objectives of the ME program.

The educational preparation necessary for attainment of these objectives can only be realized through the curriculum, the instructional process and related activities of the educational program.The first two years of the curriculum provide a foundation in mathematics and science for the mechanical engineering courses offered in the third year.

The fourth year utilizes the knowledge acquired during the first three years to develop professional skills in applied areas such as thermal and fluid engineering, and systems design and control. Project courses are offered in the fourth year. CAD/CAM systems are used extensively throughout the curriculum.

The mechanical engineering curriculum prepares the student for professional work as well as graduate study in engineering or in other areas such as science, mathematics, management, medicine, law and business.

The curriculum as described below is for students entering NJIT in the fall of 2006 or after that date. Students entering before that date generally have a different program and should consult the department to learn which curriculum applies.

The Industrial Engineering curriculum prepares engineers to design, improve, install, and operate the integrated systems of people, materials, and facilities needed by industry, commerce, and society. Industrial engineers solve problems which arise in the management of systems by applying the principles of engineering science, product and process design, work analysis, human factors principles, and operations research. Industrial engineering leads to a wide variety of professional opportunities in manufacturing, service, research and development and public service enterprises, and to graduate study in industrial engineering, engineering management, business administration, law and other fields.

The industrial engineering curriculum combines three professional areas of practice: product and production process design, work analysis, and engineering management science. Students are also offered exposure to the more specialized areas of automated manufacturing systems, information systems, quality assurance, and safety engineering. In the freshman and sophomore years, the program concentrates on mathematics, physical science, and engineering science, an adequate background in these being essential to the courses presented in the later years. The courses stress fundamental principles and concepts which develop gradually and eventually culminate in a system design dealing with real engineering and management situations in an industrial commercial or public service enterprise.

The curriculum as described here is for students entering NJIT as freshmen in the fall of 2007 or after that date. Students entering before that date may have a different program and should consult the department to learn which curriculum applies.

## Missions

### The Mission of Mechanical Engineering

To educate mechanical engineering graduates to help the state and the country in general to stay competitive at the cutting edge of technology, to serve the profession of engineering, to become leaders in business, academia, industry, and the community and to engage in a lifetime of learning and achievement to benefit mankind.

### The Mission of Industrial Engineering

The mission of the department is to

- provide for all our students an environment conducive to learning and personal growth;
- educate a diverse undergraduate and graduate student body for successful employment in industry and the pursuit of advanced studies;
- prepare students, both undergraduate and graduate, for future managerial and leadership roles;
- engage in research to support the advanced education of graduate students, maintain the intellectual vitality of the faculty, and expand the frontiers of knowledge in areas of importance to the state and nation;
- serve our profession through membership and leadership on national and international societies, and editorial boards, and
- serve our community by offering our expertise to industries, state and local constituencies, and pre-college students and teachers.

# Educational Objectives

## Mechanical Engineering Program Educational Objectives

The objectives are our expectations of the accomplishments and characteristics of the careers of our graduates in the areas of engineering practice, professional growth and service. The current Mechanical Engineering (ME) program objectives are:

1. ME graduates are successfully engaged in mechanical engineering design processes and the practical application of engineering theory, methods and practices into various fields including alternative energy systems, manufacturing, controls, robotics, materials, and biomedical systems and devices.
2. ME graduates advance their professional growth and development through activities such as graduate study in engineering, professional registration, and continuing education, with some graduates transitioning into other professional fields.
3. ME graduates are effectively engaged in service to their professional societies, as well as their local, national or global communities.

## Industrial Engineering Program Educational Objectives

1. Program graduates use the fundamental principles and major areas of Industrial Engineering in their professional practice.

2. Program graduates are life-long learners, pursuing graduate education, and professional growth in Industrial Engineering and related fields.

3. Program graduates pursue diverse career paths in a variety of industries.

# Program Outcomes

## Mechanical Engineering Program Outcomes

Graduates of the Mechanical Engineering program will have:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

This program is accredited by Engineering Accreditation Commission of ABET, http://abet.org

## Industrial Engineering Program Outcomes

Graduates of the Industrial Engineering program will have:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multi-disciplinary teams
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- A recognition of the need for, and the ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The undergraduate Industrial Engineering Program is accredited by the Engineering Accreditation Commission of ABET, http://abet.org

# NJIT Faculty

## A

Abdel-Malek, Layek, Professor

Abdou, George, Associate Professor

## B

Bengu, Golgen, Associate Professor

Bladikas, Athanassios, Associate Professor

## C

Cai, Wenbo, Assistant Professor

Caudill, Reggie J, Professor

Chen, Rong-Yaw, Professor Emeritus

Chester, Shawn A., Assistant Professor

## D

Das, Sanchoy K., Professor

Droughton, John V., Professor Emeritus

## F

Fenster, Saul K., Professor Emeritus

Fischer, Ian S., Professor

Florio, Pasquale J., Associate Professor

## H

Harnoy, Avraham, Professor

Hatch, C., Richard, Professor Emeritus

## J

Ji, Zhiming, Associate Professor

## K

Kirchner, Robert P., Professor Emeritus

Koplik, Bernard, Professor

Kountouras, Harry V., Senior University Lecturer

## L

Lee, Eon Soo, Assistant Professor

Linden, Martin J., Professor Emeritus

## M

Mani, Balraj Subra, University Lecturer

McDermott, Kevin J., Associate Professor

## N

Nadimpalli, Siva P.V., Assistant Professor

Narh, Kwabena A., Professor

### R

Rao, I. Joga, Professor

Rosato, Anthony D., Professor

### S

Samardzic, Veljko, University Lecturer

Singh, Pushpendra, Professor

Sodhi, Rajpal Singh, Professor

Surjanhata, Herli, Senior University Lecturer

### T

Tricamo, Stephen J., Professor

### W

Wilson, Charles E., Professor Emeritus

Wolf, Carl, Professor Emeritus

### Z

Zhu, Chao, Professor

## Programs

- Industrial Engineering - B.S. (p. 550)
- Mechanical Engineering - B.S. (p. 552)

- Industrial Engineering Minor (p. 555)
- Materials Engineering Minor (p. 555)

## Mechanical and Industrial Engineering Courses

**IE 101. Introduction to Industrial Engineering. 1 credit, 2 contact hours (1;1;0).**
An Introduction to the field of Industrial Engineering, the functions performed by industrial engineers, career paths and opportunities in the field, introduction to the student and senior professional societies, and initiation of a mentoring program.

**IE 203. Applications of Computer Graphics in Industrial Engineering. 2 credits, 3 contact hours (1;2;0).**
Restriction: sophomore standing. Methods, tools and technologies of networked, graphical/visual communication systems with an industrial engineering focus. Lean and sustainable green enterprise, product, process, service and shop floor level visual factory management systems. Provides analytical and practical knowledge of computer graphics in IE, including graphical standards necessary to meet the requirements of today?s practice. Introduction of modern web-based software tools and systems.

**IE 224. Production Process Design. 3 credits, 4 contact hours (2;2;0).**
Restriction: sophomore standing. Introduction to the theory and practice of manufacturing processes. Study covers the fabrication of metallic, plastic, and electrical products, operation of NC and other automatic equipment, and economics of the design and production process.

**IE 310. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Restriction: junior standing, approval of co-op faculty advisor, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their aca-demic program. Work assignments facilitated by the co-op office and approved by the co-op faculty advisor. Mandatory participation in seminars and completion of a report.

**IE 331. Applied Statistical Methods. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 211. A presentation of statistical analysis techniques and their applications. Topics include the statistical measures describing data, frequency distributions, probability distributions, sampling parameter estimation, hypothesis testings, regression analyses, and analyses of variance. Special emphasis on their application to industrial fields.

**IE 334. Engineering Economy and Capital Investment. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing. Introduction to the principles of engineering economics for utilization and evaluation of capital investments, including time value of money, depreciation, cost of capital, life cycle cost, net present value, and payback. Consideration of decisions involving multiple choice replacement, uncertainty, and risk.

**IE 335. Engineering Cost Analysis and Control. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing. The tools and techniques applicable for cost analysis and control including standard costs, variance analysis, cost volume relationships, cost estimation, and utilization of accounting data for control of operations.

**IE 339. Work Measurement and Standards. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: IE 203, IE 224. Emphasizes the measurement and evaluation of existing work methods and how improvement can be achieved. Topics include visual and micro-motion study techniques, motion economy, time study, and work sampling. The development and use of standard data and computerized techniques. Also, hands-on experience through a series of laboratory experiments.

**IE 355. Human Factors. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior standing. Human-machine systems analysis including study of workplace layout, measurement of employee efficiency and productivity, criteria for tool and fixture design or selection, industrial fatigue, environmental influences on performance including the effects of illumination, noise, vibration, thermal, and other atmospheric factors. Basic ideas of industrial hygiene; the impact of OSHA; and special techniques for experimenting with human subjects, via demonstrations and supervised experiments.

**IE 411. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: IE 310. Restriction: approval of co-op faculty advisor and permission of the Office of Cooperative Education and Internships. Full-time work experience of approximately one semester's duration. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and an oral presentation to IE faculty. Note: Normal grading applies to this COOP Experience.

**IE 436. Cost Analysis and Engineering Economics. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. Not open to industrial engineering majors. Focuses on the economic factors of concern to manufacturing engineers. Major topics include justification of proposed capital expenditures, equipment retirement and replacement decisions, cost determination, profitability studies, and manufacturing budget construction and utilization for cost control.

**IE 439. Deterministic Models in Operations Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 222 or equivalent. The deterministic techniques of operations research. Topics include the applications of linear, nonlinear, integer, and dynamic programming methods and network flows analysis to solve industrial and systems engineering problems.

**IE 440. Stochastic Models in Operations Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IE 331, MATH 222 or their equivalent. Probabilistic techniques of operations research. Topics include the applications of Markov chains, queueing and inventory control models to analyze and evaluate systems performance.

**IE 441. Information and Knowledge Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. Introduction to recent advances in the application of computers in industrial engineering and database structures, both sequential and random. Description of methods for organizing data, database modeling, information storage and retrieval. Also, applications of expert systems concepts and techniques.

**IE 443. Senior Project I. 2 credits, 4 contact hours (1;3;0).**
Restriction: senior standing. Introduction to senior design project. Selection of specific system design for the project, establishment of initial contacts, preliminary collection and analysis of system data. Concepts of system design analysis emphasizing simulation modeling and analysis, model verification, and model validation.

**IE 444. Senior Project II. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: IE 443. Senior design project, in which the concepts of industrial engineering systems, principles, and procedures are integrated and applied in industrial projects or case studies.

**IE 445. Idustrial Simulation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 101, IE 331 or equivalent. Introduction to the application of simulation modeling for the analysis of complex industrial and manufacturing service systems. Examples are chosen from real-life situations such as warehousing, material handling, robotics, transportation, and hospital emergency rooms. Verification/validation as well as statistical analysis of both input/output data are introduced.

**IE 447. Legal Aspects of Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. Familiarization with the U.S. system of case law, statutes and regulations applicable to professional relationships involving the engineer. Includes contracts, property, product liability and other torts, governmental regulatory bodies such as OSHA, EPA, and NRC, professional liability, and role of codes and standards.

**IE 449. Industrial Robotics. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CS 101, PHYS 121, junior or senior standing. Robotics in manufacturing systems. The field of robotics is studied with emphasis given to the role of programmable robots in manufacturing. Hands-on experience with hardware and software necessary for various industrial robot systems through laboratory experience.

**IE 450. Product Engineering Standards. 3 credits, 3 contact hours (3;0;0).**
Restriction: senior standing. Developing and using standards in the design, manufacturing, and use of products. Topics include economics of parts standardization, drawing and assembly techniques, and use of national and international standards. Review of the role of standards-setting bodies and methods for the development of product testing standards used in industry and commerce.

**IE 451. Industrial Measuring Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 331. Reviews contemporary measuring systems and provides a basic under-standing of the various methods, their accuracy, reliability, and relative costs to perform. Includes measuring methods needed for compliance evaluation in accordance with occupational and safety legislation, industrial processes, and product design.

**IE 453. Computer Integrated Manufacturing. 3 credits, 4 contact hours (2;2;0).**
Restriction: junior or senior standing. Examines the components of computer integrated manufacturing (CIM) including the design of information frameworks and network protocols required to orchestrate full manufacturing automation. Study of CAD, CAPP, robotics, NC, CNC, computer interfacing, and database systems in the context of a CIM environment. Exposure to state-of-the-art CIM software and hardware.

**IE 455. Robotics and Programmable Logic Controllers. 3 credits, 4 contact hours (2;2;0).**
Restriction: junior or senior standing. Introduction to the design and implementation of programmable logic controllers for use in industry in the areas of automotive assembly, pharmaceutical manufacturers, the chemical industry, and others. Includes ladder logic, input/output ports, continuous process control, timing and counting functions, chaining sequences, and digital gate logic.

**IE 456. Introduction to Industrial Hygiene. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 355. Analysis of the effects of various environmental stressors on people at work, including their interference with performance and the development of acute and chronic health problems. Study of how numerous airborne contaminants, noise, thermal extremes, ionizing and nonionizing radiation, etc., affect workers alone and in combination. Topics include measurement and evaluation techniques, TLVs, control methodologies, legal requirements for employers.

**IE 459. Production Planning and Control. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IE 221, IE 439, junior or senior standing. A study of the components and functioning of integrated production, planning, and control systems. Forecasting, aggregate planning, scheduling, and recent models of production and inventory control for optimizing continuous and intermittent manufacturing operations. MRP basics. Introduction to using a computer to apply scheduling models.

**IE 460. Measuring Techiniques and Quality Control. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: understanding of basic probability. Not open to industrial engineering majors; intended for other engineers, inspection supervisors, and management. Various types of control charts and acceptance sampling systems and procedures. These techniques are used widely in industry to improve product quality and reduce costs.

**IE 461. Product Quality Assurance. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 331. Methods used to achieve higher product quality, to prevent defects, to locate chronic sources of trouble, to measure process capability, and to use inspection data to regulate manufacturing processes are emphasized. Preparation of statistical control charts and selection of suitable sampling plans.

**IE 463. Invention and Entrepreneurship. 3 credits, 3 contact hours (3;0;0).**
Restriction: Junior or Senior standing or permission of instructor. This course will teach students the process of developing new products. It takes students from the art of creativity through product design and concludes with the formulation of a business plan for marking and production. If the new product satisfies the requirements of novelty, usefulness and nonobviousness, a patent application may be filed.

**IE 466. Material Handling and Facilities Layout. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: IE 439. Analysis of organized human activities typified by industrial and office operations. Recent methods are applied to optimize location and layout of facilities. Introduction to modern material handling systems, expert systems in plant layout, logistics of motion of people and materials, flow analysis, plant layout, and material handling techniques.

**IE 469. Reliability in Engineering Systems. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: IE 331 or equivalent, senior standing. Emphasizes the determination of systems reliability from a knowledge of characteristics and reliability of individual system components. Topics include reliability concepts, failure rates, systems analysis, optimization, maintenance, etc. Covers techniques for the formulation and evaluation of reliability models.

**IE 472. Product Liability Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. The techniques available to the engineer to minimize the hazards of design and manufacturing that result in product liability cases. The effect of legal precedents on design, manufacturing, advertising, marketing, and using a product within developing technical disciplines such as: reliability prediction and analysis methods, assuring the quality of manufactured products, loss control systems, safety engineering precepts, human factors principles and design review. Review of government regulations for safety and protection.

**IE 473. Safety Engineering. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. The principles and practices of safety engineering in product and facilities design. Safe practices and hazard control, safety standards and codes, inspection procedures, the role of insurance, governmental regulations, and safety statistics. Participation in current safety engineering research studies. The Occupational Safety and Health Act and related legislation.

**IE 480. Special Studies in Industrial Engineering for Non-Majors. 3 credits, 3 contact hours (3;0;0).**
Restriction: permission of the IE faculty advisor. Not open to industrial engineering majors. Individual investigations under faculty guidance through consultation, readings, and visits with recognized authorities and institutions, dealing with specialized industrial engineering problems. Explore in depth an area of interest and give a report in a seminar setting, and submit a written project report.

**IE 481. Investigations in Industrial Engineering I. 3 credits, 3 contact hours (0;0;3).**
Restriction: junior or senior standing, per-mission of the IE faculty advisor. Individual investigation under faculty guidance through consultation, readings, and visits with recognized authorities and institutions, dealing with specialized industrial engineering design problems. Explore in depth an area of interest and give a report in a seminar setting, and submit a written project report.

**IE 482. Investigations in Industrial Engineering II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: IE 481, permission of the IE faculty advisor. Further individual investigations, a continuation of IE 481.

**IE 492. Engineering Management. 3 credits, 3 contact hours (3;0;0).**
Restriction: junior or senior standing. An introduction for engineering majors to the fundamentals of engineering economics and the management process for engineering and development. Major topics include capital investment justification methods, project organization, scheduling and control techniques, legal, quality, and staffing issues.

**ME 215. Engineering Materials and Processes. 3 credits, 4 contact hours (2;2;0).**
Prerequisite: CHEM 126 or CHEM 122. Students also must register for the lab component. Combined lecture and laboratory relating to the study of engineering materials. Processes of formation from liquid and particle state, plastic forming, molding deformation, and metal removal. Effects of heat treatment on material properties. Laboratory exercises involve basic machine tools and computer-controlled equipment.

**ME 231. Kinematics of Machinery. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 101, MECH 234. Design, selection, and evaluation of mechanisms for various applications. Topics include displacement, velocity, and acceleration analysis of planar linkages, synthesis of function generators and motion generators, design of cams, gear-tooth geometry and analysis of gear trains.

**ME 304. Fluid Mechanics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 236, ME 311. Introduction to the basic principles of conservation of mass, momentum, and energy as they apply to engineering systems which utilize fluids. Some of the topics are dimensional analysis, theoretical and empirical analysis of one-dimensional compressible and incompressible flow, empirical analysis of external and internal flows, and elementary boundary layer theory.

**ME 305. Introduction to System Dynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, MECH 236, ME 231. Principles of dynamic system modeling and response with emphasis on mechanical, electrical, and fluid systems. Application of computer simulation techniques.

**ME 310. Co-op Work Experience I. 0 credits, 0 contact hours (0;0;0).**
Prerequisites: completion of freshman year, approval of department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report.

**ME 311. Thermodynamics I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211, PHYS 111. Thermodynamic fundamentals. Topics are the first and second laws of thermodynamics, physical properties of pure substances, entropy, ideal and real gases, and gaseous mixtures.

**ME 312. Thermodynamics II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ME 311. A continuation of ME 311 including studies of irreversibility and combustion. Thermodynamic principles are applied to the analysis of power generation, refrigeration, and air-conditioning systems. Introduction to solar energy thermal processes, nuclear power plants, and direct energy conversion.

**ME 315. Stress Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, MECH 237, ME 215. Problems related to mechanical design. Topics include two-dimensional elasticity, transformation of stress and strain, plane stress problems, axisymmetric members, buckling criteria, and failure theories.

**ME 316. Machine Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 231, ME 315. Aspects of the design process and design of machine elements. Mini-projects are used to introduce engineering design procedures.

**ME 339. Fundamentals of Mechanical Design. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MECH 234. For industrial engineering majors. Topics include kinematics of mechanisms, machine components, and a brief intro-duction to mechanical vibrations. Students gain the ability to deal with design problems from the viewpoint of a non-specialist.

**ME 343. Mechanical Laboratory I. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: EE 405, MATH 279 or Math 333 and MECH 236. Students also must register for the lab component. Laboratory and lecture in instrumentation and measurement for mechanical engineering students. Applications for the sensing of such variables as pressure, tem-perature, mass flow, and displacement. Particular attention to the applicability and sensitivity of instruments.

**ME 403. Mechanical Systems Design I. 3 credits, 3 contact hours (2;1;0).**
Prerequisites: ME 304, ME 305, ME 312, ME 316. Lectures and projects covering problem solving methodology in the design, analysis, and synthesis of mechanical and thermal systems. The student's academic background combines with engineering principles and topics to serve as a foundation for broad engineering projects. Emphasis on creative thinking and the engineering design process in projects involving the optimal conversion of resources.

**ME 405. Mechanical Laboratory II. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: ME 343, ME 312. Laboratory emphasizing the use of fundamental principles and instrumentation systems for the analysis and evaluation of mechanical components within a system.

**ME 406. Mechanical Laboratory III. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: ME 405, ME 407. Laboratory covering the testing and evaluation of complete mechanical systems.

**ME 407. Heat Transfer. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 222, ME 304, ME 311. A study of the three fundamental modes of heat transfer: conduction, convection, and radiation. A physical interpretation of the many quantities and processes in heat transfer using numerical methods. Theory is applied to the analysis and design of heat exchangers and other applications. Where appropriate, computer simulation is used.

**ME 408. Mechanical Systems Design II. 2 credits, 3 contact hours (1;2;0).**
Prerequisite: ME 403, ME 407. A continuation of ME 403 from a more integrated viewpoint, with lectures on special topics. Concepts in optimization and computer simulation are considered in the design and synthesis of mechanical engineering systems. The projects are more comprehensive, emphasizing creative design, and requiring design decisions of a more sophisticated nature.

**ME 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ME 310, approval of the department, and permission of the Office of Cooperative Education and Internships. Full-time work experience of approximately one semester's duration. Provides major related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and project. Note: Normal grading applies to this COOP Experience.

**ME 425. Finite Element Method in Mechanical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: CIS 101, Math 222, and Mech 237. Introduction to central ideas underlying the finite element method in mechanical engineering and its computer implementation. Fundamental concepts such as interpolation functions for one- and two-dimensional elements, bar element method, Galerkin's method, discretization of a model, methods of assembling global matrices, and the final solution techniques for obtaining nodal values. Specific applications to mechanical engineering problems in trusses, beams, torsion, heat transfer, fluid flow, plane stress, and plane strain.

**ME 430. Introduction to Computer-Aided Design. 3 credits, 4 contact hours (2;2;0).**
Prerequisites: CS 101, FED 101 and Math 222. Introduction to basic concepts of computer-aided design as applied to mechanical engineering design problems. Topics include numerical techniques, computer graphics, geometric modeling, design optimization, and databases for design. The laboratory uses current CAD software packages for mechanical design. Projects involve applications of the basic principles using student's own as well as available software.

**ME 431. Introduction to Robotics and Automation. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CS 101, MECH 236. Introduction to mechanics and control of robotic manipulators. Topics include spatial transformations, kinematics, dynamics, trajectory generation, actuators and control, and relations to product design and flexible automation.

**ME 432. Principles of Air Conditioning and Refrigeration. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 304, ME 312; Corequisite: ME 407. A course in the fundamentals of air conditioning and refrigeration. Topics covered are psychometrics, cooling and heat load calculations, air distribution systems, duct design, vapor compression and absorption systems, and the principles of cooling towers.

**ME 433. Vibration Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 236, MATH 222. An introduction to the fundamental theory of mechanical vibrations. Undamped and damped systems with single and multiple degrees of freedom, transient vibration, vibrations of continuous media, and analog and numerical methods.

**ME 435. Thermodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 211, PHYS 111. Intended for non-mechanical engineering students of all disciplines. Topics include the basic laws of thermodynamics, properties of fluids and solids, analysis of open and closed systems, gas and vapor power cycles, refrigeration and air conditioning, and an introduction to heat transfer. Cannot be taken for credit by mechanical engineering students.

**ME 437. Structural Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ME 315. Fundamentals of structural analysis. Consideration of stresses and deflections of beams as well as the design of beams, columns, trusses, and structural connections of steel, reinforced concrete, and timber structures.

**ME 438. Introduction to Physical Metallurgy. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126 or CHEM 122, and ME 215. Introduction to metallic microstructures, solid solutions and the mechanical properties of metals and alloys. Physical understanding of diffusion processes is emphasized in covering the relationship between the nature of metals and different heat treating processes.

**ME 439. Principles of Tribology. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: CHEM 126, MECH 237. An introduction to the principles of wear resistance of machine parts and tribology. Physical understanding of different mechanisms of wear and friction and methods of increasing durability.

**ME 441. Computer Simulation and Analysis in Mechanical Engineering. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 430. This course covers various topics in Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE). The course provides an in-depth understanding and skill of constructing 2-D drawings using well-known commercial CAD package, and integrating 3-D solid modeling techniques into simulation, and analysis animation of new designs using commercial CAD/CAE software. The students will have hands-on experience to analyze Structure, Heat Transfer, and Computational Fluid Dynamics problems by using several different software packages. The course also focuses on CAD Product Data Exchange using both Direct Database conversion and International Standards based conversion methods between major CAD/CAE systems. Typical industrial applications will be illustrated.

**ME 451. Introduction to Aerodynamics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 304, ME 311. Introduction to the basic principles and properties of fluid flow around immersed bodies. Topics include the kinematics and dynamics of fluid fields, the thin airfoil, finite wing theory, and one-dimensional compressible flow.

**ME 452. Dynamics of Space Flight. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MECH 236, MATH 222. An introduction to the mechanics of space flight. After a brief introduction to the physics of the solar system, the dynamics of space flight are developed from the Newtonian viewpoint. Covers the performance and propulsion methods of rocketry.

**ME 455. Automatic Controls. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ME 305. Introduction to the principles of automatic controls. Emphasis on systems, considering their mechanical, hydraulic, pneumatic, thermal, and displacement -aspects. First and second order linear systems. Introduction to system analysis techniques such as Nyquist and Bode diagrams and applications in system design.

**ME 470. Engineering Properties of Plastics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 215, MECH 237. A study of the physical properties of the various commerical thermosetting and thermoplastic resins. An introduction to linear viscoelastic theory and its relationship to measurable mechanical properties of plastics. Also, engineering properties such as flammability, chemical resistance, and electrical properties.

**ME 471. Introduction to Polymer Processing Techniques. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ME 304, ME 407. A study of the various plastics processing techniques, including extrusion, injection molding, blow molding, compression molding, thermoforming, rotational molding, casting, etc. The relationship between product design and choice of process will be presented.

**ME 490. Mechanical Engineering Project A. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: departmental approval required. One or more individually selected projects. Projects usually require library research, design, cost analysis, planning of testing. Also involves an engineering report and a technical presentation.

**ME 491. Mechanical Engineering Project B. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: ME 490 and departmental approval required. One or more selected projects. Projects usually require library research, design, cost analysis, planning of testing. Also involves an engineering report and a technical presentation.

# B.S. in Industrial Engineering

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| Physical Education:GUR Elective | | 1 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| IE 203 | Applications of Computer Graphics in Industrial Engineering | 2 |
| MATH 211 | Calculus III A | 3 |
| MECH 320 | Statics and Strength of Materials | 3 |
| ECON 201<br>or ECON 265 | Economics<br>or Microeconomics | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |

| | | |
|---|---|---|
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| IE 224 | Production Process Design | 3 |
| MECH 236 | Dynamics | 2 |
| MATH 222 | Differential Equations | 4 |
| IE 331 | Applied Statistical Methods | 3 |
| Physical Education:GUR Elective | | 1 |
| ENG 340 | Oral Presentations | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| IE 355 | Human Factors | 3 |
| IE 335 | Engineering Cost Analysis and Control | 3 |
| IE 439 | Deterministic Models in Operations Research | 3 |
| ME 339 | Fundamentals of Mechanical Design | 3 |
| Open Elective in Humanities and Social Sciences (upper-level):GUR | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ECE 405 | Electrical Engineering Principles | 3 |
| IE 334 | Engineering Economy and Capital Investment | 3 |
| IE 339 | Work Measurement and Standards | 3 |
| IE 440 | Stochastic Models in Operations Research | 3 |
| IE 445 | Idustrial Simulation | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| IE Technical Elective 1 | | 3 |
| IE 443 | Senior Project I | 2 |
| IE 461 | Product Quality Assurance | 3 |
| IE 492<br>or MGMT 390 | Engineering Management<br>or Principles of Management | 3 |
| ME 435 | Thermodynamics | 3 |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| IE 444 | Senior Project II | 2 |
| IE 459 | Production Planning and Control | 3 |
| IE 466 | Material Handling and Facilities Layout | 3 |
| IE Technical Elective 2 | | 3 |
| IE Technical Elective 3 | | 3 |
| | **Term Credits** | **14** |
| | **Total Credits** | **128** |

**Industrial Engineering Technical Elective-**

Students in industrial engineering select 9 credits of technical electives. With the undergraduate advisor's approval, upper level courses from other departments may be used as technical electives. Select three courses from the following list:

| | | |
|---|---|---|
| IE 441 | Information and Knowledge Engineering | 3 |
| IE 447 | Legal Aspects of Engineering | 3 |

| | | |
|---|---|---|
| IE 449 | Industrial Robotics | 3 |
| IE 453 | Computer Integrated Manufacturing | 3 |
| IE 455 | Robotics and Programmable Logic Controllers | 3 |
| IE 456 | Introduction to Industrial Hygiene | 3 |
| IE 463 | Invention and Entrepreneurship | 3 |
| IE 469 | Reliability in Engineering Systems | 3 |
| IE 473 | Safety Engineering | 3 |

Refer to the **General University Requirements** (p. 550) section of this catalog for further information on electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

## Co-op

Two co-op courses taken in sequence replace a technical elective. In industrial engineering, In INdustrial Engineering, IE 310 Co-op Work Experience I is taken without credit, and IE 411 Co-op Work Experience II is taken for degree credit, with IE 310 Co-op Work Experience I as a prerequisite.

# B.S. in Mechanical Engineering

(130 credit minimum)

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| HIST 213 | The Twentieth-Century World | 3 |
| MATH 211 | Calculus III A | 3 |
| MATH 279<br>or MATH 333 | Statistics and Probability for Engineers<br>or Probability and Statistics | 2-3 |
| MECH 234 | Engineering Mechanics | 2 |
| ME 215 | Engineering Materials and Processes | 3 |
| EPS 202 | Society, Technology, and the Environment | 3 |
| Physical Education: GUR Elective | | 1 |
| | **Term Credits** | **17-18** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| ME 231 | Kinematics of Machinery | 3 |
| MECH 236 | Dynamics | 2 |
| MECH 237 | Strength of Materials | 3 |
| ECON 201 | Economics | 3 |
| | **Term Credits** | **15** |
| **Third Year** | | |
| **1st Semester** | | |
| ECE 405 | Electrical Engineering Principles | 3 |
| ME 305 | Introduction to System Dynamics | 3 |
| ME 311 | Thermodynamics I | 3 |
| ME 315 | Stress Analysis | 3 |
| PHIL 334 | Engineering Ethics and Technological Practice: Philosophical Perspectives on Engineering | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ME 304 | Fluid Mechanics | 3 |
| ME 312 | Thermodynamics II | 3 |
| ME 316 | Machine Design | 3 |
| ME 343 | Mechanical Laboratory I | 3 |
| ME 430 | Introduction to Computer-Aided Design | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| ME 403 | Mechanical Systems Design I | 3 |
| ME 405 | Mechanical Laboratory II | 2 |
| ME 407 | Heat Transfer | 3 |
| Open Elective in Humanities and Social Sciences (upper-level):GUR | | 3 |
| Technical Elective 1 [1] | | 3 |
| Technical Elective 2 [1] | | 3 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| ME 406 | Mechanical Laboratory III | 2 |
| ME 408 | Mechanical Systems Design II | 2 |
| Technical Elective 3 [1] | | 3 |
| Technical Elective 4 [1] | | 3 |
| MGMT GUR:Select one of following: [2] | | 3 |
| MGMT 390 | Principles of Management | |
| IE 492 | Engineering Management | |
| Capstone Seminar Humanities and Social Sciences (upper-level): GUR Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **130-131** |

1 ME/Technical Electives see list below.

2 ROTC students can substitute AS 333.

**ME/Technical Electives**-Students must select 4 course from the list below. In special cases, other ME/Technical Electives may be taken with departmental approval. BS/MS student may subsitute ME 600-700 level courses with approval of the Mechanical Engineering Department.

| | |
|---|---|
| CHEM 243 | Organic Chemistry I [1] |
| CHEM 244 | Organic Chemistry II [1] |
| CHEM 473 | Biochemistry [1] |
| ENTR 410 | New Venture Management [2] |

| | |
|---|---|
| ENTR 420 | Financing New Venture [2] |
| ENTR 440 | Lean Startup Accelerator [2] |
| FIN 315 | Fundamentals of Corporate Finance [2] |
| IE 331 | Applied Statistical Methods [3] |
| IE 335 | Engineering Cost Analysis and Control |
| IE 447 | Legal Aspects of Engineering |
| IE 449 | Industrial Robotics |
| IE 453 | Computer Integrated Manufacturing |
| IE 455 | Robotics and Programmable Logic Controllers |
| IE 473 | Safety Engineering |
| MATH 331 | Introduction to Partial Differential Equations |
| MATH 333 | Probability and Statistics [3, 4] |
| MATH 335 | Vector Analysis |
| MATH 336 | Applied Abstract Algebra |
| MATH 337 | Linear Algebra |
| MATH 340 | Applied Numerical Methods [5] |
| MATH 371 | Physiology and Medicine [5] |
| MATH 372 | Population Biology [5] |
| ME 410 | Co-op Work Experience II [6] |
| MIS 363 | Project Management for Managers [3] |
| MRKT 330 | Principles of Marketing [3] |
| OM 375 | Management Science [3] |
| R120 101 | General Biology [1] |
| R120 102 | General Biology [1] |
| ME 425 | Finite Element Method in Mechanical Engineering |
| ME 431 | Introduction to Robotics and Automation |
| ME 432 | Principles of Air Conditioning and Refrigeration |
| ME 433 | Vibration Analysis |
| ME 437 | Structural Analysis |
| ME 438 | Introduction to Physical Metallurgy |
| ME 439 | Principles of Tribology |
| ME 441 | Computer Simulation and Analysis in Mechanical Engineering |
| ME 451 | Introduction to Aerodynamics |
| ME 452 | Dynamics of Space Flight |
| ME 455 | Automatic Controls |
| ME 470 | Engineering Properties of Plastics |
| ME 471 | Introduction to Polymer Processing Techniques |
| ME 490 | Mechanical Engineering Project A [7] |
| ME 491 | Mechanical Engineering Project B [7] |

[1] Only for those students who are Pre-Med.

[2] Students cannot receive credit for both IE 331 and Math 333. Only one can be taken for degree credit.

[3] Only for those students who have declared a minor in Business.

[4] When Math 333 is used instead of Math 279, it cannot also be used as a ME/Technical Elective.

[5] Only for those students who have declared a minor in Math.

[6] Students must take ME 310 AND Me 410 to receive 3 credits for ME 410 toward the degree requirements as a ME/Technical Elective.

[7] Me 490/491 require departmental approval if used as ME/Technical electives.

Refer to the **General University Requirement**s section of this catalog for further information on electives.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Industrial Engineering Minor

| | | |
|---|---|---|
| IE 339 | Work Measurement and Standards | 3 |
| IE 355 | Human Factors | 3 |
| IE 439 | Deterministic Models in Operations Research | 3 |
| IE 461 | Product Quality Assurance | 3 |
| IE 466 | Material Handling and Facilities Layout | 3 |
| **Total Credits** | | **15** |

# Materials Engineering Minor

Minor in Materials Science and Engineering (Student must select 5 courses for a total of 15 credits).

| | | |
|---|---|---|
| ME 215 | Engineering Materials and Processes [1] | 3 |
| ME 438 | Introduction to Physical Metallurgy | 3 |
| ME 470 | Engineering Properties of Plastics | 3 |
| ME 490 | Mechanical Engineering Project A | 3 |
| BME 479 | BioMicroElectroMechanical Systems | 3 |
| MTSE 301 | Principles of Material Science and Engineering | 3 |
| EVSC 325 | Energy and Environment | 3 |

1 Except for students majoring in ME.

# Engineering Science

The complexity of modern engineering, physical and life sciences problems often requires a team effort that can involve professionals from several other disciplines. For students interested in interdisciplinary problem solving, the engineering science programs offer challenging educational opportunities. Students must consult with the program advisor before undertaking a course of study in any engineering science option.

## B.S. in Engineering Science

(127 credit minimum)

A minimum of 127 credits is required for the B.S. in Engineering Science. Of those 127 credits, at least 30 credits are in an option.

Options consist of advanced undergraduate courses that show a progression in depth of knowledge in a given area of study, culminating with a senior project or undergraduate thesis. Option courses may be from different departments, but they must comprise a coherent program of study. Specific courses required by the engineering science curriculum may be counted among the 30 credits if appropriate. An option need not be one in which NJIT offers a B.S. degree. The specific course of study for any particular option will be developed with the approval of the program director.

Courses in biological sciences are available at the adjacent Newark Campus of Rutgers University. Students who demonstrate exceptional ability may choose from offerings at the graduate level at NJIT, Rutgers-Newark, or RBHS.

- Engineering Science - B.S. (p. 556)

## Engineering Science Courses

**ESC 310. Work Experience I. 3 credits, 3 contact hours (0;0;3).**

**ESC 491. Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in engineering science. Provides the student with an opportunity to work on a research project under the individual guidance of a program faculty member.

**ESC 491H. Honors Research and Independent Study I. 3 credits, 3 contact hours (0;0;3).**
Restriction: senior standing in engineering science and enrolled in the Honors College. Same as ESC 491, but projects are more comprehensive and are of greater depth.

**ESC 492. Research and Independent Study II. 3 credits, 3 contact hours (0;0;3).**
Prerequisite: ESC 491. A continuation of ESC 491.

# B.S. in Engineering Science

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| CHEM 121<br>or CHEM 125 | Fundamentals of Chemical Principles I<br>or General Chemistry I | 3 |
| FED 101 | Fundamentals of Engineering Design [1] | 2 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 111 | Calculus I | 4 |
| PHYS 111 | Physics I | 3 |
| PHYS 111A | Physics I Laboratory | 1 |
| FRSH SEM | Freshman Seminar | 0 |
| PE Physical Education | | 1 |
| | **Term Credits** | **17** |
| **2nd Semester** | | |
| CHEM 124 | General Chemistry Laboratory | 1 |
| CHEM 122<br>or CHEM 126 | Fundamentals of Chemical Principles II<br>or General Chemistry II | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| CS 106<br>or CS 115 | Roadmap to Computing Engineers<br>or Intro. to CS I in C++ | 3 |
| MATH 112 | Calculus II | 4 |
| PHYS 121 | Physics II | 3 |
| PHYS 121A | Physics II Laboratory | 1 |
| | **Term Credits** | **18** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 211<br>or MATH 213 | Calculus III A<br>or Calculus III B | 3 |
| ECON 201 | Economics | 3 |
| Cultural History (lower-level):GUR Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| Physical Education | | 1 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| MATH 222 | Differential Equations | 4 |
| MATH 333 | Probability and Statistics | 3 |
| Social Science (lower level) Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| Management: GUR Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Engineering Science Elective | | 3 |

| | | |
|---|---|---|
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineerng Science Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| Capstone Seminar Humanities and Social Sciences (upper-level):GUR Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ESC 491 | Research and Independent Study I | 3 |
| Engineering Science Elective | | 3 |
| Ennginneering Science Elective | | 3 |
| Engineeering Science Elective | | 3 |
| Engineering Science Elective | | 3 |
| | **Term Credits** | **15** |
| | **Total Credits** | **127** |

1 FED 101 Fundamentals of Engineering Design is taken concurrently with either HUM 100 English Composition: Reading, Writing, Speaking II or HUM 101 English Composition: Writing, Speaking, Thinking I

2 Half of the students will take this course in reverse order.

## Electives

| | | |
|---|---|---|
| **English Composition and Cultural History (lower-level) GUR** | | |
| Select two of the following: | | 6 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| 2XX | 200-level history courses at Rutgers-Newark | |
| **Social Sciences (lower-level) GUR** [1] | | |
| Select one of the following Economics courses: | | 3 |
| ECON 201 | Economics | |
| ECON 265 | Microeconomics | |
| ECON 266 | Macroeconomics | |
| STS 201 | Understanding Technological Society | |
| STS 210 | General Psychology | |
| STS 221 | Sociology | |
| Select one of the following: | | 3 |
| EPS 202 | Society, Technology, and the Environment | |
| STS 257 | Technology, Society and Culture: An American View | |
| STS 258 | Technology, Society and Culture: A Global View | |
| **Capstone Seminar in Humanities and Social Sciences (upper-level) GUR** | | |
| Select one of the following. Honors College students select honors section. | | 3 |
| HSS 403 | Humanities Senior Seminar - Literature | |
| HSS 404 | Humanities Senior Seminar - History | |
| HSS 405 | Humanities Senior Seminar - Philosophy | |
| HSS 406 | Humanities Senior Seminar - English | |
| HSS 407 | Humanities Senior Seminar - Theater | |
| HSS 408 | Humanities Senior Seminar - Science, Technology, and Society | |

| | | |
|---|---|---|
| HSS 409 | Humanities Senior Seminar - Social Science | |
| **Physical Education GUR** [2] | | |
| PE 1XX | Physical Education course | 1 |
| Physical Education course | | 1 |
| **Management GUR** | | |
| Select one of the following: [3] | | 3 |
| IE 492 | Engineering Management | |
| MGMT 390 | Principles of Management | |
| AS 333 | Leadership and Management I | |

1. Students also may take approved introductory courses in basic social sciences at Rutgers-Newark to fulfill this requirement.
2. Students are urged to complete the requirement as soon as possible.
3. Acceptable only for students taking the aerospace option. Students enrolled in a dual degree program between architecture and management take HRM 601 Organizational Behavior to fulfill this requirement.

*This curriculum represents the maximum number of credits per semester for which a student is advised to register. A full-time credit load is 12 credits. First-year students are placed in a curriculum that positions them for success which may result in additional time needed to complete curriculum requirements. Continuing students should consult with their academic advisor to determine the appropriate credit load.*

# Martin Tuchman School of Management

The degree programs and research efforts at NJIT's School of Management (SOM) are directed toward understanding the effects of technology and technological change on business. SOM's goal is to prepare a new generation of technology-savvy business leaders who are ready for the challenges of the continuing technological revolution.

SOM is committed to providing a solid foundation in business and management within a hands-on, experiential learning environment. Small class sizes and opportunities to co-op or intern with major corporations throughout the region and to work with startup companies in NJIT's small business incubator allow students to learn first-hand about entrepreneurship and product innovation. Currently, there are over 700 students enrolled in the school's undergraduate and graduate programs. In addition, almost 200 students majoring in engineering, computing, social science, and the applied and design sciences are pursuing a business minor. Joint B.S./M.S. or B.S./M.B.A. options allow students in several departments across the university to accelerate their studies and earn a master's degree in management or an M.B.A. in addition to their undergraduate degree.

SOM offers an undergraduate program leading to the B.S. degree in Business with concentrations in accounting, finance, innovation and entrepreneurship, international business, management information systems, and marketing. At the graduate level, SOM offers three programs leading to M.S. degrees in management (M.S.M.) with a variety of concentration areas, business administration (M.B.A.), and an accelerated Executive M.B.A. (EMBA). The MBA program is available on-campus or online and the E.M.B.A. program is taught on weekends.

- Business - B.S. (p. 571)
- Business Minor (p. 575)
- Innovation and Entrepreneurship Minor (p. 575) (not for IDS students in the Honors College)
- Innovation and Entrepreneurship Minor (p. 575) (for IDS students in the Honors College)

## Programs

- International Business - M.S. (p. 1003)
- Management - M.S. (p. 1003)
- Management of Technology - M.B.A. (p. 1001)

## **Executive Program** (http://catalog.njit.edu/graduate/academic-policies-procedures/executive-program)

- Management of Technology - E.M.B.A. (p. 1000)

## Martin Tuchman School of Management Courses

**ACCT 115. Fundamentals of Financial Accounting. 3 credits, 3 contact hours (3;0;0).**
This is an introductory-level financial accounting course designed to develop fundamentals of financial accounting. This course will help students develop skills in applying financial accounting principles to record basic economic transactions, summarize and present such transactions in financial statements as well as to analyze reported accounting information from a user's perspective to make informed financial decisions. Students will also learn to appreciate accounting as a dynamic, changing discipline rather than an inflexible set of rules.

**ACCT 117. Survey of Accounting. 3 credits, 3 contact hours (3;0;0).**
This is an introductory course designed to develop fundamentals of financial accounting-a process of identifying, recording, and communicating economic events of an organization. This course will provide students with an opportunity to develop skills in applying financial accounting principles to record basic economic transactions, summarize and present such transactions in financial statements as well as analyze reported accounting information by using ratios.

**ACCT 215. Managerial Accounting I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 115 or ACCT 117. This course introduces fundamentals of cost and managerial accounting, including an introduction to job orders and process costing systems, cost allocation, cost behavior, managerial decision models, cost and budgetary planning and control, standard costing, analysis of variance, and responsibility accounting. The course is designed to develop the fundamentals of managerial accounting and provide students with a working knowledge of how accounting data are used by management in planning, decision-making and operational control.

**ACCT 325. Intermediate Accounting I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 215 or ACCT 116. This course provides an in-depth study of generally accepted accounting principles in the classification, presentation and disclosure of assets required by external users of financial statements. Students will learn to complete accounting cycle activities; prepare and evaluate financial statements with data from an accounting information system; apply financial accounting functions and theory to recognize and measure different types of assets; calculate earnings per share; carry out income tax accounting; and understand the nature and effect of accounting errors.

**ACCT 335. Managerial Accounting II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ACCT 215. A study of the concepts and techniques used by cost accountants to assist decision-makers within the organization. In-depth, real-world scenarios will be discussed including process accounting, job-order accounting, measuring quality costs, activity-based costing, and evaluating performance. Students will be introduced to methods currently being used by American businesses, including service firms, as well as manufacturers.

**ACCT 415. Auditing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 435. An examination of current auditing theory and procedures employed in carrying out the audit. The course will cover the life cycle of the audit from accepting an audit, gathering evidence to giving an opinion on a company's financial reports.

**ACCT 425. Tax Accounting I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ACCT 215 or ACCT 116. This course is the first part of the two tax accounting courses, with a focus on federal individual income taxation. It is designed to give the students a comprehensive understanding of personal income tax laws and to able him to prepare personal income tax returns of considerable complexity. Topics covered in this course will include gross income, property transactions, capital gains/losses, itemized deductions employee expenses, depreciation, accounting methods and tax credits, among others.

**ACCT 435. Intermediate Accounting II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ACCT 325. This is the second part of the two intermediate level financial accounting courses designed to review the basic financial required statements and provide accounting students with in-depth study of accounting principles advanced by responsible professional organizations. Topics covered include the classification, presentation and disclosure of assets, liabilities and stockholders' equity for external users of financial information.

**ACCT 490. Independent Study in Acct. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ACCT 325 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**ECON 201. Economics. 3 credits, 3 contact hours (3;0;0).**
The nature of a market economy. Microeconomics, demand theory, production possibilities, cost and price, equilibrium analysis, and applications to decision making in the firm. Macroeconomics, national income accounts, consumption, investment, government monetary and fiscal policy, and problems of employment and price levels. Economic analysis leading to an understanding of current developments in the United States economy and international trade and currency problems. Students who have received credit for ECON 265 or ECON 266 may not subsequently receive credit for ECON 201.

**ECON 265. Microeconomics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 135 or MATH 138 or MATH 111. The theory of price determination and resource allocation under various market structures. The theory of demand, production, costs, factor and product pricing, income distribution, market failure, implications of government intervention in the market, and comparison of the free enterprise and alternative systems. Students who have received credit for SS 201 may not subsequently receive credit for ECON 265.

**ECON 266. Macroeconomics. 3 credits, 3 contact hours (3;0;0).**
The theory of national income determination. The determinants of aggregate production, employment and prices, as well as money and banking, business cycles and monetary and fiscal policy. Students who have received credit for ECON 201 may not subsequently receive credit for ECON 266.

**ECON 485. Special Topics in Economics. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**ENTR 410. New Venture Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Junior standing. Provides an understanding of the process of start up and early stage management of new, technology based, small firms. Emphasis is on recognizing, evaluating and deciding on a new business idea, as well as preparation for and management of the start up process. Preparation and execution of a new business plan.

**ENTR 420. Financing New Venture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: FIN 315 and ENTR 410 The course is organized around three fundamental issues that entrepreneurs need to understand: 1) how innovations evolve over time, 2) how and whys some innovations are successful and some are not and 3) how one manages a new venture that was formed to develop new technologies. It is intended to help students understand the issues associated with a new venture and to develop a business plan to launch a technology based firm.

**ENTR 430. Entrepreneurial Strategy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HRM 301, MRKT 330, MIS 345, FIN 315, ACCT 317, OM 375, MGMT 491. Integrates knowledge of the different aspects of business learned in previous course work. In addition, provides an understanding of the decisions that guide the overall operations of a business organization and how the organization interacts with its markets, competitors, and suppliers. For the student who is considering starting or managing a small business. Combines classroom instruction in business strategy along with case analysis of small firms.

**ENTR 440. Lean Startup Accelerator. 3 credits, 3 contact hours (3;0;0).**
This is a hands-on workshop to help students get their new business idea launched. It utilizes the Lean Startup Methodology where students are expected to interview and acquire actual customers during the course.

**ENTR 485. ST:. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of innovation and entrepreneurship and their application not regularly covered in any other business or entrepreneurship course. The precise topics to be covered, along with prerequisites, are announced in the semester prior ro the offering of the course.

**ENTR 490. Independent Study in ENTR. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ENTR 410 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**FIN 218. Financial Markets and Institutions. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 115 or ACCTt 117, ECON 266 or ECON 201, MATH 105. This course provides an overview of the main features of financial markets and institutions in the United States, including interest rates and rates of return and how they are determined. It also covers securities traded on the U.S. financial markets including bonds, stocks, and derivatives and discusses how financial institutions, especially commercial banks work, along with the role of government in regulating financial markets and institutions.

**FIN 315. Fundamentals of Corporate Finance. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 115, or ACCT 117, ECON 265 or ECON 201, MATH 105. This course focuses on how companies invest in real assets and how they raise the money to pay for those investments. Topics covered include the firm and the financial manager, time value of money, bonds, stocks, and net present value. International finance, risk management, capital structure strategy and case studies of technology-based companies will be introduced.

**FIN 401. Securities in Financial Markets. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: FIN 218 and FIN 315. This course offers a quantitative approach to evaluating fixed income securities and to managing bond portfolios. Specific topics include: modern theory of bond pricing, pricing of high risk bonds, derivatives, and risk management.

**FIN 402. Financial Risk Measurement and Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. This course offers an in-depth analysis of the measurement and management of risk in financial markets. Topics include: assessing overall market risk, credit risk, liquidity risk, settlement risk, volatility risk, measuring portfolio risk, and extreme value risk.

**FIN 403. Financial Statement Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. This course offers comprehensive coverage of analysis of financial statements so that students can: a) evaluate the financial position of a firm; b) assess the firm's inherent value and the value of its securities; c) assess the firm's obligations and its ability to meet them; and d) analyze sources and uses of cash.

**FIN 416. Advanced Corporate Finance. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. Advanced corporate finance with an emphasis on the financial management of technology-based organizations. Case studies are used for comparative analysis. Emphasis is on organizational productivity and profitability.

**FIN 417. Adv Portfolio Analysis. 3 credits, 3 contact hours (3;0;0).**

**FIN 422. International Finance. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. Introduction to the international financial management of the firm with an emphasis on technology-based organizations. Topics covered include hedging currency risk, capital budgeting internationally, raising funds internationally. Global competitiveness is addressed with comparative analysis of the financial management practices of American, European and Japanese firms.

**FIN 423. Risk Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: FIN 315. The management of risk in the business enterprise. Topics include meas-urement of risk and hedging strategies, sources of liability, property and liability insurance, and insurance administration.

**FIN 430. Options and Futures Markets. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: FIN 218, FIN 315, MATH 135 (or MATH 138, MATH 111). This course covers options, forward contracts, futures contracts and swaps, and will give students a working knowledge of how these contracts work, how they are used, and how they are priced. Students will learn how corporations and portfolio managers can hedge different kinds of risks or alter the distribution of returns on their portfolios using various techniques.

**FIN 485. Special Topics in Finance. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**FIN 490. Independent Study in Finance. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: FIN 218, FIN 315 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**HRM 301. Organizational Behavior. 3 credits, 3 contact hours (3;0;0).**
Restriction: upper division standing. A foundation course in individual and group behavior in organizations. Processes such as perception, motivation and leadership are examined with a focus on issues central to technology-based organizations (innovation, creativity, managing technical professionals).

**HRM 303. Human Resources Management. 3 credits, 3 contact hours (3;0;0).**
Covers basic human resources concepts including recruitment, selection, EEO, training, labor relations, and human resources information systems. Human resources management practices in technology-based firms are studied in detail.

**HRM 310. Managing Diversity in Organizations. 3 credits, 3 contact hours (3;0;0).**
Analyzes issues that arise in managing a diverse work force. After examining the demographic environment of contemporary organizations, significant attention is paid to developing strategies to recruit, train, motivate, and retain employees with diverse personal characteristics. While the emphasis is on developing broad-based interpersonal skills, the impact of federal and state laws and regulations is also studied. In addition, students examine the implications of technological developments for managing a diverse population (e.g., the use of new technologies in retaining the differently abled).

**HRM 415. Organizational Design and Development. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HRM 301. Focuses on the design of modern organizations with an emphasis on effectively responding to environmental and technological change. Design issues include analyzing organizational structures, understanding the process of organizational learning, and evaluating organizational cultures. Development issues focus on employee empowerment, vertical and horizontal communication in organizations, and self-managed work teams.

**HRM 485. Special Topics in Human Resource Management. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MGMT 190. Introduction to Business. 3 credits, 4 contact hours (3;0;1).**
Introduction to the School of Management and the Business major. Foundations of the business enterprise and ecosystem. Organizational structures, governance, financial systems, marketing, and government interactions. Economic, political, psychological, and social influences on business. Incorporates freshman seminar topics related to a successful college life, including time management, study skills, interpersonal relationships, wellness, multicultural issues and career decision making. This course is restricted to freshmen BUSINESS majors only except with permission of SOM's undergraduate program director.

**MGMT 216. Business Statistics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 105 or MATH 333. Introduction to business data analysis for application in management decision-making processes. Productivity measures, employment trends, national income data, and consumer price changes. Methods for collection of business and economic data, presentation of data and computer applications, index numbers, historical analysis trend projections, survey sampling, and planning for business research.

**MGMT 290. Business Law I. 3 credits, 3 contact hours (3;0;0).**
The basic principles of common and statutory law applicable to business and professional relationships, emphasizing contracts, negotiable instruments, sales of goods, agency and business organizations.

**MGMT 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of at least 30 credits at NJIT, approval of the school and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.

**MGMT 316. Business Research Methods. 3 credits, 3 contact hours (2;1;0).**
Prerquisites: MGMT 216, MIS 245. This course covers business research methodologies with an emphasis on data collection/mining and data analysis. It offers the knowledge skills to conduct research in all applicable fields from the traditional areas of business, such as, marketing, finance, human resources, operations and service management, as well as web-based e-commerce related research applications. Upon completion, students will be able to: (1) understand business research methodologies, (2) conduct business research studies, (3) present the results, analyses and recommendations to management.

**MGMT 350. Knowledge Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MIS 245. The purpose of this course is to introduce students to Knowledge Management. This term is used to refer to the ways in which organizations create, gather, manage and use the knowledge. Emphasis is placed on the information systems needed to capture and distribute knowledge and how knowledge can be used to gain competitive advantage.

**MGMT 360. Business Law II. 3 credits, 3 contact hours (3;0;0).**
The course will cover concepts required for the CPA Exam. Current cases will illustrate legal principles and how courts make decisions. Topics include corporate information and termination, agency and employment issues and forms of discrimination, comparisons of U.S. laws with those in other countries, the ethical context for business decisions, insider trading, online securities fraud, and disclosure of financial information on corporate blogs and tweets, including the tax consequences.

**MGMT 390. Principles of Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: junior or senior standing. This course explores strategies that allow companies to grow and compete in today's global marketplace, along with skills you will need to turn ideas into action for success in business. You will get an overview of key business processes, and an understanding of how they work together. Learning will be reinforced by real time case studies. A comprehensive project-based learning exercise will allow you to act as a management consultant and relate what you cover in class to a real company.

**MGMT 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MGMT 310 or equivalent, approval of the school, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as a co-op/intern. Mandatory participation in seminar and completion of requirements that include a report and/or project.

**MGMT 480. Managing Technology and Innovation. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Junior standing(57 credits). Introduction to an array of technologies affecting management functions to provide an appreciation and understanding of the importance of new technologies as critical success factors for modern organizations. An integrative approach is taken in analyzing how changes in technology affect individual, group, and organizational effectiveness.

**MGMT 485. Special Topics in Management. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MGMT 490. Independent Study in Managemen. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HRM 301 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**MGMT 491. International Business. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MGMT 190 or MGMT 390 or HRM 301, FIN 315, ECON 266 or ECON 201. A basic understanding of the activities in international business providing a framework for understanding them from the perspective of a company manager. Covers international trade, multinational enterprises, foreign exchange, foreign direct investment, international financial institutions, barriers to international trade, accounting of taxation, industrial relations, multinational enterprise, and world order.

**MGMT 492. Business Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: senior standing. A capstone course in the area of business administration focusing on the integration of concepts taught in various functional courses such as marketing, finance, operations management, accounting, organizational behavior. Issues related to corporate responsibilities and ethical behavior are also incorporated in this course. Emphasis on application of concepts to real life situation is achieved through case discussion and projects. All SOM students need to earn a C or better in MGMT 492 in order to graduate.

**MGMT 499. Senior Seminar: Career Planning and MFT. 1 credit, 1 contact hour (1;0;0).**
A one credit, satisfactory/unsatisfactory course that will allow students to get the career training they need prior to entering work force, as well as review for the Major Fields Test and to actually take the Major Field Test in the course. Corequisite: MGMT 492. This course runs for the first 10 weeks of the semester.

**MIS 245. Introduction to Management Information Systems. 3 credits, 3 contact hours (3;0;0).**
Concepts of information systems, business process, hardware, software, systems analysis, e-commerce, enterprise systems and computer applications in organizations, techniques of systems analysis, systems designs, implementations, and information management (both technical and behavioral)are studied in the organizational context of management information needs.

**MIS 363. Project Management for Managers. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Junior standing (57 credits). This course covers theories, tools, and techniques to manage projects in organizations. Students will learn how to put together a project charter, define project goals, and develop project teams, schedules, and budgets. The course will illustrate the key aspects of project lifecycles (initiation, planning, execution, monitor and control, and closing). It will also emphasize aspects of team, performance, risk, and quality management.

**MIS 445. Decision Support Systems and OLAP. 4 credits, 6 contact hours (2;4;0).**
Prerequisites: MIS 345 and OM 375.Introduces students to the use of decision support systems (DSS) to support management decisions. Topics include: DSS software tools, model management, and DSS design and use.

**MIS 485. Special Topics in Management Information Systems. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MIS 490. Independent Study in MIS. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MIS 245 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**MRKT 330. Principles of Marketing. 3 credits, 3 contact hours (3;0;0).**
Provides an understanding of how environmental factors (political, legal, economy, competition, socio-cultural, and technology) influence the design of product, pricing, promotion and distribution strategies. Topics discussed include strategies to satisfy target markets, market segmentation, buyer behavior, marketing ethics, and an introduction to global marketing issues. Fundamentals of marketing are integrated using cases, videos, and class projects.

**MRKT 331. Consumer and Buyer Behavior. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 105 and MRKT 330. Psychological, social, and economic influences on consumer behavior. The application of consumer behavioral innovation to marketing decisions: research and measurement techniques, individual influences, environmental influences, and consumer information processing and decision making. A field research project will be undertaken.

**MRKT 332. Advertis Theory & Techn. 3 credits, 3 contact hours (3;0;0).**

**MRKT 338. Product Development and Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. The process of product development is studied in detail with specific emphasis on technology-driven innovation. Techniques for getting closer to customers including TQM principles are also covered.

**MRKT 339. Professional Selling. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. Provides an understanding of multifaceted roles salespeople play and prepares students for sales careers in business-to-business firms. Discusses the personal selling process that include prospecting and qualifying, sales call planning, approaching prospects, giving sales demonstrations and presentations, negotiating sales resistance, confirming and closing "win-win" agreements. Places emphasis on building customer relationships and partnerships by providing customer service and to ensure satisfaction and build customer loyalty. Concepts are discussed and integrated using role-playing, experiential exercies, videos, cases and class projects.

**MRKT 360. Internet Marketing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. Provides an overview of fundamental principles of Internet marketing for the contemporary business environment. Topics include Internet marketing strategies, Internet marketing plan, and development of Internet-based marketing programs.

**MRKT 420. Product & Brand Management. 3 credits, 3 contact hours (3;0;0).**
Pre-requisite: MRKT 330. The aim of the course is to equip students with theoretical and practical knowledge necessary for the successful and efficient management of products and brands. It provides the framework for the analysis of the main factors determining success of a brand in the market and introduces techniques and tools necessary for management of products and brands. This course will provide a fundamental understanding of how to build, measure, and manage a brand. The course will also provide an understanding of the role of product management/manager.

**MRKT 430. Marketing Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. The process of marketing research is studied in detail from study design through report preparation. A hands-on, experiential approach is taken with an emphasis on secondary research and multivariate statistical methods. Data analysis is conducted using SAS and/or SPSS.

**MRKT 432. Sales Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 339 This course helps the student to understand the various sales management activities that sales managers are responsible for in their important role as revenue generation managers. Key topics that are discussed within the realm of organizing, managing and controlling the sales force include sales forcasting, budgeting, sales force organization, time and territory management, recruitment, selection and training the salespeople, leadership, motivation, compensation, and sales force performance evaluation. Sales ethics and customer relationship management issues are also addressed.

**MRKT 433. Marketing Channel Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330 This course develops a managerial framework to the field of marketing. Theory, research and practice are integrated to disucss distribution channel decision making implications. Students will understand the role played by the distribution system or network of alliances among agents, wholesalers, distributors and retailers to attain a firm’s distribution of objectives. The course discusses the flow of goods through a distribution channel from the producer to the final consumer. Key topics include marketing channel strategy, channel design, channel management as a well as selecting, motivating, and evaluating the performance of marketing intermediaries. It also discusses the importance of electronic channels that have become prominent in the distribution process.

**MRKT 434. Business to Business Marketing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. Techniques for marketing industrial products to organizations in the manufacturing, service, government, and non-profit sectors are covered within the context of a global marketplace. Emphasis is on the marketing of high technology products using a customer-driven approach.

**MRKT 435. International Marketing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. This course will help students understand how the product, pricing, promotion and distribution elements of the marketing mix are influenced by international forces (cultural, political-legal, economic, competitive, and technological environment). Topics discussed include global market segmentation, marketing ethics, standardization or adaptation of the marketing mix as well as global information systems and market research, segmentation, targeting, and foreign market entry strategies (importing, exporting, licensing, and strategic alliances). Course concepts are integrated using cases, videos, and class projects.

**MRKT 485. Special Topics in Marketing. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MRKT 490. Independent Study in Marketing. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MRKT 330 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**OM 375. Management Science. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MGMT 216. Introduction to statistical and mathematical techniques used in management decision making. Develop the concepts of management science and use its techniques with unrestricted focus. Operations management applications are made in factory settings, health-care and other service industries, education and government agencies.

# Management

## B.S. in Business

The B.S. in Business curriculum is designed to help students understand the many functions involved in operating a successful organization in today's global economy. The School of Management draws upon NJIT's vast resources in science and technology to present a focused program emphasizing the application and management of technology to improve decision-making and competitiveness in organizations, from the multinational conglomerate to the local small business.

The curriculum is cross-disciplinary in approach, emphasizing the intersection of information technologies, business planning, and human behavior in organizations. The program also emphasizes quantitative skills and utilization of current information-age technologies. Students are introduced to multimedia systems, E-commerce and Financial Systems. Students also gain knowledge of current telecommunications technologies and their impact on business operations. Since companies in both domestic and international markets increasingly seek technology-oriented business managers, NJIT business graduates have an advantage.

### Concentrations

The B.S. in Business offers six concentrations: accounting, finance, innovation and entrepreneurship, international business, management information systems, and marketing.

#### Accounting

The accounting concentration offers students who want to become accountants the required course path for getting a CPA license. Courses include managerial accounting, cost accounting, auditing, federal tax and new courses that will be added are forensic and international accounting.

#### Finance

The finance concentration focuses on finance and financial technologies. Courses cover topics such as securities, risk management, financial statement analysis and ERP systems.

#### Management Information Systems

The management information systems concentration focuses on the design of information systems that improve business effectiveness. Coursework includes programming languages, database design, and applications of information technologies to business problems.

#### Marketing

The marketing concentration focuses on business-to-business marketing with a strong emphasis on the marketing of technology-based products and innovations. Courses emphasize selling and promotion, product design and market research, and marketing information systems.

#### Innovation and Entrepreneurship

The innovation and entrepreneurship concentration will help prepare you for careers where you will be commercializing new ideas into new business ventures and new business lines for existing ventures.  In addition to business fundamentals in accounting, economics, marketing, and management, students will learn about New Venture Management and Financing.

#### International Business

The international business specialization emphasizes global business and an understanding of diverse cultures and business environments. Students are strongly encouraged to study abroad at one of our partner universities

# NJIT Faculty

## A

Anandarajan, Asokan, Professor

## B

Bandera, Cesar, Assistant Professor

Bonitsis, Theologos H., Associate Professor

## C

Casal, Jose C., Senior University Lecturer

Chakrabarti, Alok K., Distinguished Professor Emeritus

Chen, Yi, Associate Professor

Chou, Porchiung B., Senior University Lecturer

Cicon, James E., Assistant Professor

Cordero, Rene, Associate Professor Emeritus

## E

Egbelu, Pius J., Distinguished Professor

Ehrlich, Michael A., Associate Professor

## F

Fjermestad, Jerry L, Professor

## G

Gopalakrishnan, Shanthi, Professor

Guilbault, Melodi D., Senior University Lecturer

## K

Kudyba, Stephan P., Associate Professor

## L

Lawrence, Kenneth, D., Professor

## M

Mehta, Rajiv, Professor

## P

Passerini, Katia, Professor

## R

Rapp, William V., Research Professor

Rotter, Naomi G., Professor Emeritus

## S

Schachter, Hindy L., Professor

Schoenebeck, Karen P., Senior University Lecturer

Shi, Junmin, Assistant Professor

Somers, Mark, Professor

Sverdlove, Ronald, Assistant Professor

Sylla, Cheickna, Professor

## T

Thomas, Ellen J., Assistant Professor

## W

Walsh, Diana, Senior University Lecturer

## X

Xu, Wei, Assistant Professor

## Y

Yan, Zhipeng, Associate Professor


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- Economics Minor (p. 575)
- Innovation and Entrepreneurship Minor (p. 575) (not for IDS students in the Honors College)
- Innovation and Entrepreneurship Minor (p. 575) (for IDS students in the Honors College)

- Accounting Concentration (p. 573)
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- International Business Concentration (p. 574)
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- Marketing Concentration (p. 574)


# Management Courses

**ACCT 115. Fundamentals of Financial Accounting. 3 credits, 3 contact hours (3;0;0).**
This is an introductory-level financial accounting course designed to develop fundamentals of financial accounting. This course will help students develop skills in applying financial accounting principles to record basic economic transactions, summarize and present such transactions in financial statements as well as to analyze reported accounting information from a user's perspective to make informed financial decisions. Students will also learn to appreciate accounting as a dynamic, changing discipline rather than an inflexible set of rules.

**ACCT 117. Survey of Accounting. 3 credits, 3 contact hours (3;0;0).**
This is an introductory course designed to develop fundamentals of financial accounting-a process of identifying, recording, and communicating economic events of an organization. This course will provide students with an opportunity to develop skills in applying financial accounting principles to record basic economic transactions, summarize and present such transactions in financial statements as well as analyze reported accounting information by using ratios.

**ACCT 215. Managerial Accounting I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 115 or ACCT 117. This course introduces fundamentals of cost and managerial accounting, including an introduction to job orders and process costing systems, cost allocation, cost behavior, managerial decision models, cost and budgetary planning and control, standard costing, analysis of variance, and responsibility accounting. The course is designed to develop the fundamentals of managerial accounting and provide students with a working knowledge of how accounting data are used by management in planning, decision-making and operational control.

**ACCT 325. Intermediate Accounting I. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 215 or ACCT 116. This course provides an in-depth study of generally accepted accounting principles in the classification, presentation and disclosure of assets required by external users of financial statements. Students will learn to complete accounting cycle activities; prepare and evaluate financial statements with data from an accounting information system; apply financial accounting functions and theory to recognize and measure different types of assets; calculate earnings per share; carry out income tax accounting; and understand the nature and effect of accounting errors.

**ACCT 335. Managerial Accounting II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ACCT 215. A study of the concepts and techniques used by cost accountants to assist decision-makers within the organization. In-depth, real-world scenarios will be discussed including process accounting, job-order accounting, measuring quality costs, activity-based costing, and evaluating performance. Students will be introduced to methods currently being used by American businesses, including service firms, as well as manufacturers.

**ACCT 415. Auditing. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 435. An examination of current auditing theory and procedures employed in carrying out the audit. The course will cover the life cycle of the audit from accepting an audit, gathering evidence to giving an opinion on a company's financial reports.

**ACCT 425. Tax Accounting I. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ACCT 215 or ACCT 116. This course is the first part of the two tax accounting courses, with a focus on federal individual income taxation. It is designed to give the students a comprehensive understanding of personal income tax laws and to able him to prepare personal income tax returns of considerable complexity. Topics covered in this course will include gross income, property transactions, capital gains/losses, itemized deductions employee expenses, depreciation, accounting methods and tax credits, among others.

**ACCT 435. Intermediate Accounting II. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: ACCT 325. This is the second part of the two intermediate level financial accounting courses designed to review the basic financial required statements and provide accounting students with in-depth study of accounting principles advanced by responsible professional organizations. Topics covered include the classification, presentation and disclosure of assets, liabilities and stockholders' equity for external users of financial information.

**ACCT 490. Independent Study in Acct. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ACCT 325 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**ECON 201. Economics. 3 credits, 3 contact hours (3;0;0).**
The nature of a market economy. Microeconomics, demand theory, production possibilities, cost and price, equilibrium analysis, and applications to decision making in the firm. Macroeconomics, national income accounts, consumption, investment, government monetary and fiscal policy, and problems of employment and price levels. Economic analysis leading to an understanding of current developments in the United States economy and international trade and currency problems. Students who have received credit for ECON 265 or ECON 266 may not subsequently receive credit for ECON 201.

**ECON 265. Microeconomics. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 135 or MATH 138 or MATH 111. The theory of price determination and resource allocation under various market structures. The theory of demand, production, costs, factor and product pricing, income distribution, market failure, implications of government intervention in the market, and comparison of the free enterprise and alternative systems. Students who have received credit for SS 201 may not subsequently receive credit for ECON 265.

**ECON 266. Macroeconomics. 3 credits, 3 contact hours (3;0;0).**
The theory of national income determination. The determinants of aggregate production, employment and prices, as well as money and banking, business cycles and monetary and fiscal policy. Students who have received credit for ECON 201 may not subsequently receive credit for ECON 266.

**ECON 485. Special Topics in Economics. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**ENTR 410. New Venture Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Junior standing. Provides an understanding of the process of start up and early stage management of new, technology based, small firms. Emphasis is on recognizing, evaluating and deciding on a new business idea, as well as preparation for and management of the start up process. Preparation and execution of a new business plan.

**ENTR 420. Financing New Venture. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: FIN 315 and ENTR 410 The course is organized around three fundamental issues that entrepreneurs need to understand: 1) how innovations evolve over time, 2) how and whys some innovations are successful and some are not and 3) how one manages a new venture that was formed to develop new technologies. It is intended to help students understand the issues associated with a new venture and to develop a business plan to launch a technology based firm.

**ENTR 430. Entrepreneurial Strategy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: HRM 301, MRKT 330, MIS 345, FIN 315, ACCT 317, OM 375, MGMT 491. Integrates knowledge of the different aspects of business learned in previous course work. In addition, provides an understanding of the decisions that guide the overall operations of a business organization and how the organization interacts with its markets, competitors, and suppliers. For the student who is considering starting or managing a small business. Combines classroom instruction in business strategy along with case analysis of small firms.

**ENTR 440. Lean Startup Accelerator. 3 credits, 3 contact hours (3;0;0).**
This is a hands-on workshop to help students get their new business idea launched. It utilizes the Lean Startup Methodology where students are expected to interview and acquire actual customers during the course.

**ENTR 485. ST:. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of innovation and entrepreneurship and their application not regularly covered in any other business or entrepreneurship course. The precise topics to be covered, along with prerequisites, are announced in the semester prior ro the offering of the course.

**ENTR 490. Independent Study in ENTR. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: ENTR 410 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**FIN 218. Financial Markets and Institutions. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 115 or ACCTt 117, ECON 266 or ECON 201, MATH 105. This course provides an overview of the main features of financial markets and institutions in the United States, including interest rates and rates of return and how they are determined. It also covers securities traded on the U.S. financial markets including bonds, stocks, and derivatives and discusses how financial institutions, especially commercial banks work, along with the role of government in regulating financial markets and institutions.

**FIN 315. Fundamentals of Corporate Finance. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: ACCT 115, or ACCT 117, ECON 265 or ECON 201, MATH 105. This course focuses on how companies invest in real assets and how they raise the money to pay for those investments. Topics covered include the firm and the financial manager, time value of money, bonds, stocks, and net present value. International finance, risk management, capital structure strategy and case studies of technology-based companies will be introduced.

**FIN 401. Securities in Financial Markets. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: FIN 218 and FIN 315. This course offers a quantitative approach to evaluating fixed income securities and to managing bond portfolios. Specific topics include: modern theory of bond pricing, pricing of high risk bonds, derivatives, and risk management.

**FIN 402. Financial Risk Measurement and Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. This course offers an in-depth analysis of the measurement and management of risk in financial markets. Topics include: assessing overall market risk, credit risk, liquidity risk, settlement risk, volatility risk, measuring portfolio risk, and extreme value risk.

**FIN 403. Financial Statement Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. This course offers comprehensive coverage of analysis of financial statements so that students can: a) evaluate the financial position of a firm; b) assess the firm's inherent value and the value of its securities; c) assess the firm's obligations and its ability to meet them; and d) analyze sources and uses of cash.

**FIN 416. Advanced Corporate Finance. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. Advanced corporate finance with an emphasis on the financial management of technology-based organizations. Case studies are used for comparative analysis. Emphasis is on organizational productivity and profitability.

**FIN 417. Adv Portfolio Analysis. 3 credits, 3 contact hours (3;0;0).**

**FIN 422. International Finance. 3 credits, 3 contact hours (3;0;0).**
Prerequisites FIN 218 and FIN 315. Introduction to the international financial management of the firm with an emphasis on technology-based organizations. Topics covered include hedging currency risk, capital budgeting internationally, raising funds internationally. Global competitiveness is addressed with comparative analysis of the financial management practices of American, European and Japanese firms.

**FIN 423. Risk Analysis. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: FIN 315. The management of risk in the business enterprise. Topics include meas-urement of risk and hedging strategies, sources of liability, property and liability insurance, and insurance administration.

**FIN 430. Options and Futures Markets. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: FIN 218, FIN 315, MATH 135 (or MATH 138, MATH 111). This course covers options, forward contracts, futures contracts and swaps, and will give students a working knowledge of how these contracts work, how they are used, and how they are priced. Students will learn how corporations and portfolio managers can hedge different kinds of risks or alter the distribution of returns on their portfolios using various techniques.

**FIN 485. Special Topics in Finance. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**FIN 490. Independent Study in Finance. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: FIN 218, FIN 315 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**MGMT 190. Introduction to Business. 3 credits, 4 contact hours (3;0;1).**
Introduction to the School of Management and the Business major. Foundations of the business enterprise and ecosystem. Organizational structures, governance, financial systems, marketing, and government interactions. Economic, political, psychological, and social influences on business. Incorporates freshman seminar topics related to a successful college life, including time management, study skills, interpersonal relationships, wellness, multicultural issues and career decision making. This course is restricted to freshmen BUSINESS majors only except with permission of SOM's undergraduate program director.

**MGMT 216. Business Statistics. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MATH 105 or MATH 333. Introduction to business data analysis for application in management decision-making processes. Productivity measures, employment trends, national income data, and consumer price changes. Methods for collection of business and economic data, presentation of data and computer applications, index numbers, historical analysis trend projections, survey sampling, and planning for business research.

**MGMT 290. Business Law I. 3 credits, 3 contact hours (3;0;0).**
The basic principles of common and statutory law applicable to business and professional relationships, emphasizing contracts, negotiable instruments, sales of goods, agency and business organizations.

**MGMT 310. Co-op Work Experience I. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: Completion of at least 30 credits at NJIT, approval of the school and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.

**MGMT 316. Business Research Methods. 3 credits, 3 contact hours (2;1;0).**
Prerquisites: MGMT 216, MIS 245. This course covers business research methodologies with an emphasis on data collection/mining and data analysis. It offers the knowledge skills to conduct research in all applicable fields from the traditional areas of business, such as, marketing, finance, human resources, operations and service management, as well as web-based e-commerce related research applications. Upon completion, students will be able to: (1) understand business research methodologies, (2) conduct business research studies, (3) present the results, analyses and recommendations to management.

**MGMT 350. Knowledge Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MIS 245. The purpose of this course is to introduce students to Knowledge Management. This term is used to refer to the ways in which organizations create, gather, manage and use the knowledge. Emphasis is placed on the information systems needed to capture and distribute knowledge and how knowledge can be used to gain competitive advantage.

**MGMT 360. Business Law II. 3 credits, 3 contact hours (3;0;0).**
The course will cover concepts required for the CPA Exam. Current cases will illustrate legal principles and how courts make decisions. Topics include corporate information and termination, agency and employment issues and forms of discrimination, comparisons of U.S. laws with those in other countries, the ethical context for business decisions, insider trading, online securities fraud, and disclosure of financial information on corporate blogs and tweets, including the tax consequences.

**MGMT 390. Principles of Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: junior or senior standing. This course explores strategies that allow companies to grow and compete in today's global marketplace, along with skills you will need to turn ideas into action for success in business. You will get an overview of key business processes, and an understanding of how they work together. Learning will be reinforced by real time case studies. A comprehensive project-based learning exercise will allow you to act as a management consultant and relate what you cover in class to a real company.

**MGMT 410. Co-op Work Experience II. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MGMT 310 or equivalent, approval of the school, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as a co-op/intern. Mandatory participation in seminar and completion of requirements that include a report and/or project.

**MGMT 480. Managing Technology and Innovation. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: Junior standing(57 credits). Introduction to an array of technologies affecting management functions to provide an appreciation and understanding of the importance of new technologies as critical success factors for modern organizations. An integrative approach is taken in analyzing how changes in technology affect individual, group, and organizational effectiveness.

**MGMT 485. Special Topics in Management. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MGMT 490. Independent Study in Managemen. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: HRM 301 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**MGMT 491. International Business. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MGMT 190 or MGMT 390 or HRM 301, FIN 315, ECON 266 or ECON 201. A basic understanding of the activities in international business providing a framework for understanding them from the perspective of a company manager. Covers international trade, multinational enterprises, foreign exchange, foreign direct investment, international financial institutions, barriers to international trade, accounting of taxation, industrial relations, multinational enterprise, and world order.

**MGMT 492. Business Policy. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: senior standing. A capstone course in the area of business administration focusing on the integration of concepts taught in various functional courses such as marketing, finance, operations management, accounting, organizational behavior. Issues related to corporate responsibilities and ethical behavior are also incorporated in this course. Emphasis on application of concepts to real life situation is achieved through case discussion and projects. All SOM students need to earn a C or better in MGMT 492 in order to graduate.

**MGMT 499. Senior Seminar: Career Planning and MFT. 1 credit, 1 contact hour (1;0;0).**
A one credit, satisfactory/unsatisfactory course that will allow students to get the career training they need prior to entering work force, as well as review for the Major Fields Test and to actually take the Major Field Test in the course. Corequisite: MGMT 492. This course runs for the first 10 weeks of the semester.

**MIS 245. Introduction to Management Information Systems. 3 credits, 3 contact hours (3;0;0).**
Concepts of information systems, business process, hardware, software, systems analysis, e-commerce, enterprise systems and computer applications in organizations, techniques of systems analysis, systems designs, implementations, and information management (both technical and behavioral)are studied in the organizational context of management information needs.

**MIS 363. Project Management for Managers. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: Junior standing (57 credits). This course covers theories, tools, and techniques to manage projects in organizations. Students will learn how to put together a project charter, define project goals, and develop project teams, schedules, and budgets. The course will illustrate the key aspects of project lifecycles (initiation, planning, execution, monitor and control, and closing). It will also emphasize aspects of team, performance, risk, and quality management.

**MIS 445. Decision Support Systems and OLAP. 4 credits, 6 contact hours (2;4;0).**
Prerequisites: MIS 345 and OM 375.Introduces students to the use of decision support systems (DSS) to support management decisions. Topics include: DSS software tools, model management, and DSS design and use.

**MIS 485. Special Topics in Management Information Systems. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MIS 490. Independent Study in MIS. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MIS 245 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

**MRKT 330. Principles of Marketing. 3 credits, 3 contact hours (3;0;0).**
Provides an understanding of how environmental factors (political, legal, economy, competition, socio-cultural, and technology) influence the design of product, pricing, promotion and distribution strategies. Topics discussed include strategies to satisfy target markets, market segmentation, buyer behavior, marketing ethics, and an introduction to global marketing issues. Fundamentals of marketing are integrated using cases, videos, and class projects.

**MRKT 331. Consumer and Buyer Behavior. 3 credits, 3 contact hours (3;0;0).**
Prerequisites: MATH 105 and MRKT 330. Psychological, social, and economic influences on consumer behavior. The application of consumer behavioral innovation to marketing decisions: research and measurement techniques, individual influences, environmental influences, and consumer information processing and decision making. A field research project will be undertaken.

**MRKT 332. Advertis Theory & Techn. 3 credits, 3 contact hours (3;0;0).**

**MRKT 338. Product Development and Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. The process of product development is studied in detail with specific emphasis on technology-driven innovation. Techniques for getting closer to customers including TQM principles are also covered.

**MRKT 339. Professional Selling. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. Provides an understanding of multifaceted roles salespeople play and prepares students for sales careers in business-to-business firms. Discusses the personal selling process that include prospecting and qualifying, sales call planning, approaching prospects, giving sales demonstrations and presentations, negotiating sales resistance, confirming and closing "win-win" agreements. Places emphasis on building customer relationships and partnerships by providing customer service and to ensure satisfaction and build customer loyalty. Concepts are discussed and integrated using role-playing, experiential exercies, videos, cases and class projects.

**MRKT 360. Internet Marketing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. Provides an overview of fundamental principles of Internet marketing for the contemporary business environment. Topics include Internet marketing strategies, Internet marketing plan, and development of Internet-based marketing programs.

**MRKT 420. Product & Brand Management. 3 credits, 3 contact hours (3;0;0).**
Pre-requisite: MRKT 330. The aim of the course is to equip students with theoretical and practical knowledge necessary for the successful and efficient management of products and brands. It provides the framework for the analysis of the main factors determining success of a brand in the market and introduces techniques and tools necessary for management of products and brands. This course will provide a fundamental understanding of how to build, measure, and manage a brand. The course will also provide an understanding of the role of product management/manager.

**MRKT 430. Marketing Research. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. The process of marketing research is studied in detail from study design through report preparation. A hands-on, experiential approach is taken with an emphasis on secondary research and multivariate statistical methods. Data analysis is conducted using SAS and/or SPSS.

**MRKT 432. Sales Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 339 This course helps the student to understand the various sales management activities that sales managers are responsible for in their important role as revenue generation managers. Key topics that are discussed within the realm of organizing, managing and controlling the sales force include sales forcasting, budgeting, sales force organization, time and territory management, recruitment, selection and training the salespeople, leadership, motivation, compensation, and sales force performance evaluation. Sales ethics and customer relationship management issues are also addressed.

**MRKT 433. Marketing Channel Management. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330 This course develops a managerial framework to the field of marketing. Theory, research and practice are integrated to disucss distribution channel decision making implications. Students will understand the role played by the distribution system or network of alliances among agents, wholesalers, distributors and retailers to attain a firm's distribution of objectives. The course discusses the flow of goods through a distribution channel from the producer to the final consumer. Key topics include marketing channel strategy, channel design, channel management as a well as selecting, motivating, and evaluating the performance of marketing intermediaries. It also discusses the importance of electronic channels that have become prominent in the distribution process.

**MRKT 434. Business to Business Marketing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. Techniques for marketing industrial products to organizations in the manufacturing, service, government, and non-profit sectors are covered within the context of a global marketplace. Emphasis is on the marketing of high technology products using a customer-driven approach.

**MRKT 435. International Marketing. 3 credits, 3 contact hours (3;0;0).**
Prerequisite: MRKT 330. This course will help students understand how the product, pricing, promotion and distribution elements of the marketing mix are influenced by international forces (cultural, political-legal, economic, competitive, and technological environment). Topics discussed include global market segmentation, marketing ethics, standardization or adaptation of the marketing mix as well as global information systems and market research, segmentation, targeting, and foreign market entry strategies (importing, exporting, licensing, and strategic alliances). Course concepts are integrated using cases, videos, and class projects.

**MRKT 485. Special Topics in Marketing. 3 credits, 3 contact hours (3;0;0).**
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course.

**MRKT 490. Independent Study in Marketing. 3 credits, 3 contact hours (0;0;3).**
Prerequisites: MRKT 330 and approval of proposal by the SOM faculty member or lecturer who will supervise the study. Self-paced study on some aspect of managing organizations. Cannot substitute for any required course nor duplicate the coverage of any regularly offered course. Accepted proposals and project results are kept in a file available to all SOM faculty and instructional staff and to students contemplating starting an independent study project.

# B.S. in Business

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| CS 103 | Computer Science with Business Problems | 3 |
| HUM 101 | English Composition: Writing, Speaking, Thinking I | 3 |
| MATH 135 | Calculus for Business | 3 |
| MGMT 190 | Introduction to Business | 3 |
| FRSH SEM | Freshman Seminar | 0 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| ACCT 215 | Managerial Accounting I | 3 |
| MIS 245 | Introduction to Management Information Systems | 3 |
| ECON 266 | Macroeconomics | 3 |
| HUM 102 | English Composition: Writing, Speaking, Thinking II | 3 |
| Physical Education GUR | | 1 |
| MGMT 290 | Business Law I | 3 |
| | **Term Credits** | **16** |
| **Second Year** | | |
| **1st Semester** | | |
| MATH 105 | Elementary Probability and Statistics | 3 |

| | | |
|---|---|---|
| ECON 265 | Microeconomics | 3 |
| Natural Sciences GUR Elective | | 3 |
| Select one of the following: | | 3 |
| HUM 211 | The Pre-Modern World | |
| HUM 212 | The Modern World | |
| HIST 213 | The Twentieth-Century World | |
| Physical Education GUR | | 1 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| **2nd Semester** | | |
| FIN 218 | Financial Markets and Institutions | 3 |
| Select one of the following: | | 3 |
| HUM 251 | Ethical Issues in Business | |
| 300-level Philosophy course | | |
| MGMT 216 | Business Statistics | 3 |
| Select one of the following: | | 3 |
| ENG 200 | Communicating in Organizations | |
| 300-level or above ENG Elective | | |
| Natural Science Lab Elective | | 4 |
| | **Term Credits** | **16** |
| **Third Year** | | |
| **1st Semester** | | |
| FIN 315 | Fundamentals of Corporate Finance | 3 |
| HRM 301 | Organizational Behavior | 3 |
| MGMT 316 | Business Research Methods | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| Business Concentration Elective Course [1] | | 3 |
| | **Term Credits** | **15** |
| **2nd Semester** | | |
| MIS 363 | Project Management for Managers | 3 |
| OM 375 | Management Science | 3 |
| Business Concentration Elective Course [1] | | 3 |
| 300-level Humanities and Social Sciences (upper-level) GUR Elective | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |
| **Fourth Year** | | |
| **1st Semester** | | |
| MGMT 491 | International Business | 3 |
| Select one of the following: | | 3 |
| 300-level HUM course | | |
| 300-level SS course | | |
| 300-level ENG course | | |
| 300-level THTR course | | |
| 300-level LIT course | | |
| 300-level HIST course | | |
| 300-level PHIL course | | |
| 300-level ECON course | | |
| 300-level Political Science (R790) course | | |
| Business Concentration Elective Course [1] | | 3 |
| Business Concentration Elective Course [1] | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **15** |

| | | |
|---|---|---|
| **2nd Semester** | | |
| MGMT 492 | Business Policy | 3 |
| MGMT 480 | Managing Technology and Innovation | 3 |
| MGMT 499 | Senior Seminar: Career Planning and MFT | 1 |
| Humanities and Social Sciences (upper-level) Capstone Seminar:GUR Elective | | 3 |
| Business Concentration Elective Course [1] | | 3 |
| Free Elective | | 3 |
| | **Term Credits** | **16** |
| | **Total Credits** | **124** |

[1] Study abroad courses can apply.

## Business Concentration Courses

Choose 5 courses in your concentration.


- Accounting Concentration (p. 573)
- Finance Concentration (p. 573)
- Innovation and Entrepreneurship Concentration (p. 574)
- International Business Concentration (p. 574)
- Management Information Systems Concentration (p. 574)
- Marketing Concentration (p. 574)


Students must receive written approval from a faculty advisor, prior to registration, for all option electives.

# Accounting Concentration

## Accounting Concentration

| | | |
|---|---|---|
| Select five of the following: [1] | | 15 |
| ACCT 325 | Intermediate Accounting I | |
| ACCT 425 | Tax Accounting I | |
| ACCT 415 | Auditing | |
| ACCT 335 | Managerial Accounting II | |
| ACCT 435 | Intermediate Accounting II | |
| FIN 403 | Financial Statement Analysis | |
| MGMT 310 | Co-op Work Experience I | |
| **Total Credits** | | **15** |

[1] Accounting majors seeking to sit for the certified public accountant exam should take all concentration courses.

# Finance Concentration

## Finance Concentration

| | | |
|---|---|---|
| Select five of the following: | | 15 |
| FIN 401 | Securities in Financial Markets | |
| FIN 402 | Financial Risk Measurement and Management | |
| FIN 403 | Financial Statement Analysis | |
| FIN 416 | Advanced Corporate Finance | |
| FIN 417 | Adv Portfolio Analysis | |
| FIN 422 | International Finance | |
| FIN 430 | Options and Futures Markets | |
| ENTR 420 | Financing New Venture | |
| MGMT 310 | Co-op Work Experience I | |
| **Total Credits** | | **15** |

# Innovation and Entrepreneurship Concentration

## Innovation and Entrepreneurship Concentration

| | | |
|---|---|---|
| ENTR 410 | New Venture Management | 3 |
| MRKT 338 | Product Development and Management | 3 |
| ENTR 420 | Financing New Venture | 3 |
| ENTR 430 | Entrepreneurial Strategy | 3 |
| HRM 310 | Managing Diversity in Organizations | 3 |
| or HRM 415 | Organizational Design and Development | |
| FIN 403 | Financial Statement Analysis | 3 |
| or FIN 416 | Advanced Corporate Finance | |
| **Total Credits** | | **18** |

# International Business Concentration

## International Business Concentration

| | | |
|---|---|---|
| Select five of the following: | | 15 |
| FIN 422 | International Finance | |
| HRM 310 | Managing Diversity in Organizations | |
| MGMT 310 | Co-op Work Experience I | |
| MGMT 485 | Special Topics in Management | |
| MRKT 435 | International Marketing | |
| **Total Credits** | | **15** |

# Management Information Systems Concentration

## Management Information Systems Specialization

| | | |
|---|---|---|
| Select five of the following: | | 15 |
| CS 114 | Introduction to Computer Science II | |
| CS 332 | Principles of Operating Systems | |
| MRKT 360 | Internet Marketing | |
| IS 390 | Requirements Analysis and Systems Design | |
| MGMT 350 | Knowledge Management | |
| IS 455 | IS Mgmt & Business Processes | |
| MGMT 310 | Co-op Work Experience I | 3 |
| **Total Credits** | | **18** |

# Marketing Concentration

## Marketing Concentration

| | | |
|---|---|---|
| Select five of the following: | | 15 |
| ENTR 410 | New Venture Management | |
| MRKT 331 | Consumer and Buyer Behavior | |
| MRKT 332 | Advertis Theory & Techn | |
| MRKT 338 | Product Development and Management | |
| MRKT 339 | Professional Selling | |
| MRKT 360 | Internet Marketing | |
| MRKT 430 | Marketing Research | |
| MRKT 432 | Sales Management | |
| MRKT 434 | Business to Business Marketing | |
| MRKT 435 | International Marketing | |

| | | |
|---|---|---|
| MGMT 310 | Co-op Work Experience I | |
| **Total Credits** | | **15** |

# Business Minor

(15 - 18 credits)

| | | |
|---|---|---|
| ACCT 117 | Survey of Accounting | 3 |
| FIN 218 | Financial Markets and Institutions [1] | 3 |
| or MGMT 390 | Principles of Management | |
| FIN 315 | Fundamentals of Corporate Finance [1] | 3 |
| or OM 375 | Management Science | |
| MIS 245 | Introduction to Management Information Systems [2] | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| MGMT 3XX or MGMT 4XX | Management Elective | 3 |
| **Total Credits** | | **18** |

[1] At least one course must be in Finance

[2] CCS students should complete MIS 363 Project Management for Managers or an alternate course.

Students should consult with their major advisor to find out if minor courses can fulfill requirements within their primary curriculum.

More information on this minor can be found on the School of Management's website (http://management.njit.edu/academics/undergraduate/minorbusiness.php).

# Economics Minor

(15 credits)

Five intermediate /advanced economics courses (ECON 201 Economics, ECON 265 Microeconomics and ECON 266 Macroeconomics do not qualify) approved by the minor coordinator.

# Innovation and Entrepreneurship Minor

| | | |
|---|---|---|
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| or ACCT 117 | Survey of Accounting | |
| ECON 201 | Economics | 3 |
| MRKT 330 | Principles of Marketing | 3 |
| or MRKT 338 | Product Development and Management | |
| MGMT 390 | Principles of Management | 3 |
| ENTR 410 | New Venture Management | 3 |
| ENTR 420 | Financing New Venture | 3 |
| **Total Credits** | | **18** |

# Innovation and Entrepreneurship Minor (for IDS students)

| | | |
|---|---|---|
| ACCT 115 | Fundamentals of Financial Accounting | 3 |
| or ACCT 117 | Survey of Accounting | |
| STS 258 | Technology, Society and Culture: A Global View | 3 |
| or ECON 201 | Economics | |
| MGMT 390 | Principles of Management | 3 |
| ENTR 420 | Financing New Venture | 3 |
| ENTR 440 | Lean Startup Accelerator | 3 |
| Independent Study/Research [1] | | 3 |
| **Total Credits** | | **18** |

[1] Suggested option is Senior Capstone Design Course in student's major.

Students must register for honors-designated course sections.

**Note: A student who leaves the IDS Program before completing these minor requirements may follow the minor requirements for non-IDS students.**

# Graduate Catalog

Graduate programs are available to full-time students, or working professionals who are interested in part-time study. Some programs are offered online.

More than 3,000 students from across the country and around the world are engaged in graduate study each year at NJIT. NJIT currently offers about 50 master's degrees, 20 doctoral degrees, as well as graduate certificate programs in a wide range of technological specialties through the following colleges and schools:

- Newark College of Engineering (http://nce.njit.edu)
- College of Architecture and Design (http://architecture.njit.edu)
- College of Science and Liberal Arts (http://csla.njit.edu)
- Martin Tuchman School of Management (http://som.njit.edu)
- Ying Wu College of Computing (http://ccs.njit.edu)

NJIT also offers the following **program options**:

- BS-MS & BS-PhD program options (http://www5.njit.edu/graduatestudies/program-options/bs-ms)
- MS-MS & MS-MBA program options (http://www5.njit.edu/graduatestudies/program-options/ms-ms)
- Collaborative doctorate program (http://www.njit.edu/admissions/graduate/howtoapply/criteria/collaborative_programs.php)
- Graduate Certificates (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates)

# Academic Policies and Procedures

The academic calendar lists the dates classes begin and end, dates on which the university is closed for holidays, deadline dates for registration and withdrawal and other dates of interest to the academic community. It may also be accessed at http://www.njit.edu/Calendar/Academic.html.

## Registration for Courses at NJIT

Registration is required each semester. The Registrar's office is located in the Student Mall, on the ground floor of the parking deck. The office is open when classes are in session, Monday, Tuesday, Thursday, Friday from 8:30 a.m. to 4:30 p.m., and Wednesday 8:30 a.m. to 6:00 p.m. Registration procedures for each category of student are listed below.

NJIT has an advance self-registration system that obligates all students currently enrolled in graduate degree programs to register in advance for their courses. An approved registration guarantees class seats until the first class meeting. Students who do not attend the first class meeting may lose their place in class.

All admitted students register online via the Registrar's website at www.njit.edu/Registrar (http://www.njit.edu/old/Registrar).

### Currently Enrolled Students

Currently enrolled students are informed of registration procedures for the fall and spring semesters by the Office of the Registrar during April and October, respectively, and must then register during the advance registration period. Students who fail to comply with these instructions are charged a late fee. Instructions for the summer session are provided separately and mailed to students. Currently enrolled distance-learning students are informed of registration procedures for fall, spring and summer semesters by the Office of Graduate Studies.

### New and Readmitted Students

The Office of University Admissions informs prospective and readmitted students of registration procedures.

### International Students

New international students are only permitted to register after attending the required international student orientation program and must register in person. International students who register appropriately for full-time study will be reported in the Student and Exchange Visitor Information System (SEVIS) administered by the U.S. Immigration and Customs Enforcement Agency.

### Non-Matriculated Students

Non-matriculated students should contact the Office of University Admissions for details of admission and registration procedures at least one month before the date of intended enrollment. Online students should contact the Office of Graduate Studies.

### Approval of Initial Registration

NJIT degree programs are purposely flexible to meet a variety of career and personal objectives within minimum requirements. Students are required to arrange a conference with their graduate advisor as soon as possible after notification of admission to formulate a course of study that meets the requirements of the particular degree program, and reflects the interests and aspirations of the individual student. New students are required to obtain advisor approval for initial course registration. advisors are available for international students during the international student orientation program.

## Auditing a Course

Students who wish to audit a course must state their intention to do so at the time of registration. Change in auditing status is not permitted once a semester has begun. Students who audit are required to pay full tuition and fees for the course. Financial awards are not applicable to audited courses. Audited courses are not counted in determining full-time status. Students on probation are not permitted to audit. Students who wish to attend a course must have an authorized reason for attendance and a registration in that course (regular or audit) and cannot merely "sit in" at their own discretion.

## Undergraduate Registration in Graduate Courses

Undergraduate students who wish to take 500 or 600-level courses must obtain the written approval of the graduate advisor for the program that offers the course and, their undergraduate advisor, and submit an **Approval for Undergraduates Taking Graduate Courses** form. Undergraduates are not permitted to take 700-level courses.

Undergraduate students who enroll in graduate courses for undergraduate credit pay tuition at the undergraduate rate. Grades will follow the graduate grading system.

The undergraduate and graduate advisors will review the student's academic record prior to approval. Approval can be granted only to students who have completed the appropriate prerequisites for the course and are in satisfactory academic standing. The approval will be noted on the **Approval for Undergraduates Taking Graduate Courses** form that requires appropriate signatures and reports the student's cumulative undergraduate GPA. Students shall have a cumulative undergraduate GPA of 2.5 to be approved for registration in 500-level courses (500G for Architecture) and 2.8 for registration in 600-level courses.

Students whose undergraduate GPA is below the 2.5 or 2.8 minimum, are considering courses outside of their current major, are lacking appropriate prerequisites, have completed any prior graduate courses with a grade below a B, or have already completed nine or more credits at the 500 level and above (15 credits for those in the B.S./M.S. program), or have an excessive number of credits for the undergraduate degree will require approval by the Associate Provost for Graduate Studies who will consult with the program advisors.

Undergraduate students should be aware that need-based financial aid may not be sustainable for registration in graduate courses.

## Graduate Registration in Undergraduate Courses

Graduate students may be asked to register in undergraduate courses as conditions of admission, as bridge courses or by direction of the graduate advisor for their current program. Enrollment in other undergraduate courses requires the approval of the graduate advisor, and the undergraduate department offering the course. Tuition for these courses is assessed at the graduate rate. Grades will follow the undergraduate grading system.

## Multiple Program Registrations

A student cannot be matriculated in more than one graduate degree program at a time without explicit pre-approval from the Associate Provost for Graduate Studies. This also applies to programs run cooperatively with Rutgers-Newark. Currently enrolled graduate students who wish to enroll in a subsequent graduate degree program should NOT file an application for admission to the new program until they are in the final semester of their initial program. In addition, students may not be enrolled simultaneously in both a degree and a non-degree graduate program, or as an undergraduate and graduate student.

## Graduate Program Change

Graduate students are admitted to one degree program and not to the university as a whole. **Master’s students** who wish to change major must file the **Graduate Change of Program Form** (http://www.njit.edu/registrar/forms/GraduateChange_of_Program_Form_012414.docx) as early as possible after enrolling in their current program. There is no guarantee or requirement that the new application will be successful. Those on financial support are liable to loss of support from the original department and cancellation of a current award. Program changes require approval of two academic advisors (current and future programs), the Graduate Studies Office and the Registrar. Also, international students need approval of the International Students Office. This form cannot be used by Ph.D. students to apply for program change since it is not generally allowed. Exceptions may be made by the Associate Provost of Graduate Studies after consultation with the graduate and research advisors,

Students who add a course to their program will be charged the full tuition and fee for the course added; however, the flat rate (12-19 credits) may still apply.

All schedule changes are completed via Highlander Pipeline and a schedule change fee will be assessed during late registration as determined by the registrar.

Students cannot receive credit for courses if they are not registered. Attendance in a class without proper registration for that class is not permitted.

## Withdrawal from Courses

Students who wish to withdraw from one or more courses should first determine if the withdrawal would have an impact on full-time status, financial support, or academic standing and progress. They should consult with their advisor or the Office of Graduate Studies in advance. Sometimes their advisor may need to contact the Office of Graduate Studies to appeal on their behalf (e.g., late withdrawal). International students must consult with the Global Initiatives Office because of the possible impact on federal status reporting in SEVIS. Withdrawals are completed through Highlander Pipeline. Failure to withdraw by the deadline will result in a final grade other than W.

Discontinued attendance or verbal approval alone to withdraw will not result in a W and most likely will instead result in an undesirable final grade, generally an F or U.

## Project, Thesis and Dissertation

Students may not register for project, thesis or dissertation credits until they arrange for a department or program-approved faculty advisor to supervise the work. Continued registration for additional thesis or dissertation credits within the overall time limits for completion may be allowed with approval of the academic and research advisors. A master's project registration is only for one semester and the incomplete (I) grade cannot be assigned. Credits for which a U (unsatisfactory) grade is given are not counted as degree credits toward completion of the thesis, project or dissertation.

Master's project and master's thesis registration must be at least 3 credits during a semester. Summer session registration, if needed to allow completion for the August 31st degree date, must be at least 3 credits of project or thesis. Ph.D. students who were already enrolled in the program by August 2015 must register for at least three credits of doctoral dissertation each semester until the accumulation of 24 pre-doctoral and doctoral dissertation research credits (20 credits for CCS students). The student may then register for one dissertation credit each semester until graduation.

All students must have the program advisor's approval and appropriate section identification each time they register for project, thesis, dissertation, pre-doctoral research, co-op, or independent study. Students must register within the deadlines established by the Registrar.

Maximum credit registration each semester is 12 credits for the doctoral dissertation, six credits for the master's thesis and three credits for the master's project. Additional credit registrations, beyond 12 for doctoral dissertations of Ph.D. students already enrolled in the program by August 2015, will require approval of the Associate Provost for Graduate Studies. It is highly recommended that the Master's thesis registration be only three credits in a semester unless a single semester completion is anticipated.

Once a student has begun master's thesis or doctoral dissertation, the student must register for the respective courses each semester until the thesis or dissertation is completed. Unapproved interruptions in thesis or dissertation registrations may be subject to billing for omitted credits.

Students must be registered in project, thesis or dissertation in any semester or summer session in which completion is expected. The advisor for thesis or dissertation assigns the final grade of P when the Office of Graduate Studies confirms it has received all documents in final and approved form and all related bills have been paid.

Approval by the graduate program advisor and the Office of Graduate Studies must be obtained if, for extenuating circumstances, the student wishes to interrupt the thesis, project or dissertation for a semester or more. Students may neither maintain registration, nor fail to register without notifying and getting approval from the graduate program advisor and the Office of Graduate Studies. If a master's project is not completed after two semesters registration (with prior approval of the Graduate Studies Office to repeat the course), a final grade of F is given. Failure to complete a master's project by students who received financial support to do the project may result in dismissal. The university complies with all state and federal laws related to military service.

Although up to two semesters of master’s thesis registration is allowed, additional registration requires an appeal of the academic and research advisors to the Associate Provost for Graduate Studies. However, no more than four semesters and two summers of registration for a master's thesis are permitted. Failure to complete a master's thesis within this period will result in a final grade of U and may result in dismissal.

No more than six years of registration for pre-doctoral and doctoral dissertation research is permitted. Failure to complete a doctoral dissertation in this period will result in a final grade of U and dismissal from the program.

## Continuous Registration Requirement, Programs

Once admitted to a degree program, students must be continuously registered for credit each semester until they complete all degree requirements, unless they have been approved for a leave of absence by the Office of Graduate Studies.

## Continuous Registration Requirement, Thesis/Dissertation

Once a thesis or dissertation has begun, students must register in these each semester until completion. Maintaining registration (MR) is not permitted in place of a credit registration for thesis or dissertation. The grade of I is not permitted for thesis or dissertation.

Students who complete work for theses or dissertations over several semesters receive a grade in the semester in which the work is completed and the final document is approved and received in proper format by the Graduate Studies Office.

## Discontinuance

Domestic students enrolled in graduate programs who find it necessary to temporarily discontinue their studies may either maintain registration, request a leave of absence, or voluntarily discontinue. A discontinuance form must be filed with the Office of Graduate Studies. International students may not discontinue studies without approval from the Office of Global Initatives, but should seek approval for a leave of absence at which time maintaining registration may be authorized. PhD students may maintain registration only by permission of the Office of Graduate Studies. Students who have discontinued must follow procedures defined by the offices of University Admissions and Graduate Studies to resume their studies.

## Leave of Absence

Students who anticipate a protracted absence from the university may request a leave of absence from the Office of Graduate Studies. Students requesting a leave of absence for medical reasons will be required to consult with the Dean of Students office first. Leaves are granted for up to one year and may be extended for a second year. Leaves of absence are not counted toward the time limit in which the degree must be completed, but rules regarding expiration of credit do apply for course work, projects, thesis and dissertation research. Students returning on-time from an approved leave of absence are generally not required to apply for readmission, but are required to inform the Office of Graduate Studies and the Office of University Admissions on their return. International students may be required to apply for readmission and file new financial documents. They also are required to consult with their graduate advisor. The university complies with all state and federal laws related to military service.

## To All Students, Advisors and Faculty

The university continues to make every effort to protect student's academic and personal information. Moreover, maintaining the confidentiality of student's medical information is a legal and ethical duty, as defined by federal and state laws and regulations, and by the courts. Whenever students have a situation that affects their academic standing, it should be brought to the Dean of Students. This includes medical or psychological documentation to support a student's claim. Students should not bring such information to their instructors, nor should it be requested by a faculty member. The Dean of Students has a physician and staff psychologists to evaluate such information to verify its legitimacy. The Dean of Students will then notify the faculty member(s) if a student has a legitimate absence and will ask that the student receive consideration in making up any missed course work or exam. This process ensures confidentiality of students information and, just as important, consistency in dealing with such matters.

## Readmission After Voluntary Discontinuance

Students who have voluntarily discontinued their studies without receiving a leave of absence, and who have not been dismissed from the NJIT graduate program, must apply for readmission to the Office of University Admissions by the application deadline. A non-refundable application fee must accompany applications. Applicants are subject to all probationary and unmet conditions in force at the time they discontinued their studies. Program requirements at the time of readmission will apply in addition to satisfaction of any prior unmet conditions.

## Maintenance of Registration

Students enrolled in a degree program who find it necessary to temporarily discontinue their studies are permitted to maintain registration with approvals as noted above, for a fee of $50 for each semester they do not register and for a maximum of two consecutive semesters. Students working on project, thesis or dissertation are generally not permitted to register for maintaining registration. International students on F-1 and J-1 visa status may not maintain registration unless they have obtained prior written permission from the Office of International Students.

Students who maintain registration are mailed registration notices for the following semester and are not required to reapply for admission. To maintain registration, students must register for "Maintaining Registration" on the registration website.

Each semester in which registration is maintained is counted in the total time period allotted to complete degree requirements except for students with an approved leave of absence. The Graduate Studies Office and the academic department will generally place registration holds on students who maintain registration for two semesters or more.

## Responsibility for Registration

NJIT emails notices in advance, but cannot guarantee delivery. Regardless, students are expected to obtain all necessary information and comply with all registration procedures on time. Students who receive financial support must be in attendance at NJIT and will not be permitted to have other persons register for them.

## Scheduling of Classes

Graduate courses at NJIT and at extension sites are, in general, scheduled for late afternoon and evening hours and Saturdays for the convenience of those employed full-time. Evening courses normally begin at 6 p.m. and end at 9 p.m. Some laboratory sessions begin at 6 p.m. and end at 9:50 p.m.

Courses in heavy demand may be scheduled for additional sections if adequate enrollment can be assured. Day and evening classes during the summer months are possible under the same conditions. Special programs such as the Executive Management program and those offered by Distance Learning have their own schedules.

## Course Cancellations

The university does not guarantee offering all or any of the courses listed in this catalog. When there is inadequate registration, a course may be canceled without notice. The Registrar will attempt to notify all students of course cancellations before the first meeting of the semester.

## Room Changes

Room and laboratory changes are in the online schedule maintained by the Registrar via ***Highlander Pipeline***.

# Courses Taken at Other Colleges

## Cross-Registration Procedures

Students may take courses at Rutgers-Newark provided that the:

- Course is used toward a degree.
- Course is not offered at NJIT, or, because of a conflict in schedule, cannot be taken at NJIT.
- Approval is obtained, in advance, from the student's advisor.
- Approved cross-registration form is submitted by the student to the host school. The course must also be included on the NJIT registration form.

Students in joint programs should register at the school that admitted them to their current degree program. Students from Rutgers-Newark must be matriculated in graduate programs at their home institution to cross-register for NJIT courses. Students from Rutgers-Newark who cross-register into NJIT are considered NJIT non-matriculated students and are therefore limited to 9 credits maximum. In order to take more than 9 credits, these students would have to apply and be admitted as matriculated students for an NJIT graduate degree program.

Summer course registration procedures, and inclusion of courses on NJIT transcripts for students wishing to take courses at Rutgers-Newark, are determined by the Transfer of Credits policy outlined below. In general, cross-registration cannot occur for summer sessions.

## Registration at Another College

To take graduate courses at colleges other than those in the cross-registration program or during the summer sessions at Rutgers-Newark, students must obtain prior approval from their advisor and the Office of Graduate Studies. Students should review the section on **"Transfer of Credits"** if they wish to transfer these courses to an NJIT program. Tuition remission from NJIT is not available for courses taken at educational institutions not participating in NJIT's cross-registration program.

## Transfer of Credits

Transfer credits are calculated by NJIT according to the total number of instructional minutes earned at the other institution. The equivalent instructional minutes of a maximum of 9 credits of graduate work, taken within seven years, from accredited US educational institutions may be transferred and applied to degree requirements at NJIT. Credits from educational institutions outside the United States (except Canada) cannot be transferred as individual courses. On a case by case basis, up to 9 transfer credits may be considered for non-collegiate-based instruction after evaluation by the Associate Provost for Graduate Studies. The university does not grant transfer credit for work experience or other non-instructional activities.

Groups of courses may sometimes be accepted as a block of credits toward some types of programs. Subject to specific MBA program conditions, an equivalent block of 12 credits can be accepted from a graduate degree previously awarded by a US AACSB accredited management program or internationally from a program accredited by AACSB or an AACSB-affiliated accrediting agency. For the MBA program, the proposed block must be based on courses with grades of B or better and on courses with equivalent credit values of 3 or more credits

Credits are transferred only if the courses were taken for full academic credit, were never applied to any other degree, and a final grade of at least B (3.0 GPA equivalent) was attained. In addition, the student's graduate advisor and the Office of Graduate Studies must agree that such courses directly relate to the student's program of study before they can be transferred.

Requests for transfer credit must be submitted on a form available from the Office of Graduate Studies, accompanied by course descriptions from the other educational institution. Students must also arrange for the other institution to send an official transcript to the Office of Graduate Studies at NJIT. Requests may be submitted and approved at any time but are not added to a student's record until matriculation is granted and one semester completed. Grades that are transferred will not be calculated in cumulative GPAs.

## Transfer of Credits Within NJIT

A student may transfer credits from one program to another program within NJIT under certain circumstances. This type of transfer requires consultation of the advisor with the Office of Graduate Studies but does not require completion of a transfer credit form or submittal of NJIT transcripts. All graduate credits taken at NJIT, regardless of the major, appear on a general transcript.

# Academic Standing

## Enrollment Status

Students registered for 9 credits or more throughout an entire semester are considered full-time. International students must be in full-time status every semester. The Office of Global Initiatives will report, in SEVIS, international students who meet the full-time definition under F-1 regulation 8CFR 214(f)(6). Any international students unsure of their status should contact the office at 973-596-2451 or e-mail to global@njit.edu. Students who are not registered for 9 credits and do not meet the conditions for full-time certification are considered part-time.

## Full-time Certification

The Office of Graduate Studies may certify students as full-time even if they are not registered for 9 credits, under any of the following circumstances:

- If a master's thesis registration is included in a prior semester, an additional semester for a maximum of two with only a master's thesis registration is acceptable
- Students have fewer than 9 credits remaining for completion of all degree requirements and are registered for all credits needed to complete the degree. This certification can only be given for one semester.
- Doctoral candidates who completed all required course work and meet the minimum dissertation registration requirements as per NJIT's outlined policy (see below).
- Students originally registered for 9 credits but have substantial extenuating circumstances that require a reduction in course load. Normally this certification applies only in cases of medical or similar emergencies that incapacitate a student for a significant part of a semester. Improper course registration, failure to seek proper advisement, inadequate academic progress, or risk of earning a weak or failing grade are not extenuating circumstances. Inability of an international student who had earlier filed a financial attestation to pay tuition and fees, is also not an extenuating circumstance.
- Students on a full-time cooperative education assignment are registered in a graduate co-op work experience or equivalent course. The Office of Graduate Studies should be consulted for limits on cooperative education because cooperative education has an influence on full-time certification and allowable time to complete the degree.
- Audited courses and withdrawn courses do not count toward full-time status; ESL (English as a Second Language) courses do count as one course each.

## Half-time Students

For federal, financial aid, and other reporting purposes, half-time graduate student status may be defined for students registered for 6 credits or fewer during a semester. Contact the Office of Graduate Studies for more information.

## Grades

The following grades are used for graduate courses:

| Grade | GPA | Significance |
|---|---|---|
| A | 4.0 | Excellent |
| B+ | 3.5 | Good |
| B | 3.0 | Acceptable |
| C+ | 2.5 | Marginal Performance |
| C | 2.0 | Minimum Performance |
| F | 0.0 | Failure |
| I | | Incomplete |
| W | | Approved Withdrawal |
| AU | | Audited (no academic credit) |
| S or U | | Satisfactory or Unsatisfactory |
| P | | Passing for Master's Thesis or Doctoral Dissertation |

(Unlike undergraduate courses, there is no D grade for graduate courses. Assigned grades must be consistent with the level of the course and not the matriculation level of the student in the course. Grades used in GPA calculations (A, B+, B, C+, C, and F) are not to be used as grades for dissertation research (790), pre-doctoral research (792), master's thesis, 0, 1/2, and 1 credit seminars, co-op, teaching methods, and ESL courses. Incompletes are not assignable for these courses with the exception of co-op as described later.)

## Project, Thesis and Dissertation Grades

Grades for these courses are S or U until completion. Students who do not complete a thesis or dissertation in a semester, regardless of accumulated credits, must register again for 3 credits of thesis, or at least 1 credit of dissertation (per program requirements) in the following semester.

## Final Grades in Project, Thesis and Dissertation

Letter grades bearing on the GPA are given for satisfactory completion of a project. The final grade for a completed and approved thesis or dissertation is P. Theses and dissertations require a successful defense before a thesis or dissertation committee as well as submission of the final thesis or dissertation documents to the Office of Graduate Studies, after which the P is assigned by the research advisor.

Semester and cumulative GPA calculations by the Registrar only include courses for which a letter grade is given. For the purpose of GPA calculation, the Registrar only calculates the grades for credits earned in the semester in which the project, thesis or dissertation is completed. Letter grades cannot be given for work not submitted. Receipt of two U grades for project, thesis, dissertation, or pre-doctoral research can result in dismissal from the program.

## Special Topics

Regular letter grades are assigned for special topics courses.

## Independent Study

Regular letter grades are assigned for independent study courses.

## Incomplete

A grade of I (Incomplete) is given when courses cannot be completed because of special circumstances. Students on academic probation are not permitted a grade of Incomplete without permission from the Office of Graduate Studies. Required course work may be finished at the discretion of the instructor, no later than the end of the subsequent semester. Receipt of an I does not require or suggest attendance in the course in the following semester. A letter grade must be assigned by then or a grade of F will be automatically assigned. Students nominated for financial awards must have I grades resolved by the fourth week of the subsequent semester to allow a determination of their eligibility for the award. The new grade cannot be changed.

A grade of I cannot be given for thesis, project, dissertation, seminar, pre-doctoral research, or English as a Second Language (ESL) courses. Students in joint programs or cross-registered from Rutgers-Newark should note that NJIT has a different and much earlier deadline for resolution of I's before they automatically become F's. Some departments may assign an initial I for co-op courses, which may be changed to an S or U based on submittal of a report by the student to the co-op advisor. Students continuing for a second consecutive registration period in co-op with the same employer will have an I assigned as a grade for the first registration. This will be changed to S or U, based on co-op performance and evaluation by the co-advisor at the end of the second registration period.

## Satisfactory and Unsatisfactory

The grades S or U report progress in project, thesis, dissertation, and pre-doctoral research courses. These also can be final grades in seminar, co-op, teaching methods and ESL courses. The grade of S is given for satisfactory progress and U is given for unsatisfactory progress. Students who fail to meet with their advisors or do not satisfy relevant attendance requirements will receive a U grade. Credits for courses in which U is received cannot count toward a degree.

## Grade Reports

The registrar no longer issues grade reports. Grades may be viewed using a confidential password and identification number at http://www.njit.edu/Registrar, the registrar's home page.

## Grade Changes

Grade change requests will not be accepted after the end of the subsequent semester. Students should carefully monitor their records and contact the Registrar or the Office of Graduate Studies about any missing or incorrect grades no later than the end of the following semester.

## Grade Disputes

Students are expected to resolve disputes about grades with their instructors. If they cannot reach a satisfactory settlement with their instructor, students are permitted to request the intervention of the chairperson of the department and the dean of the school or college. The Associate Provost for Graduate Studies may be consulted.The grade appeal policy is available on the Office of the Provost's web site.

## Special Circumstances

Students should bring to the attention of the Associate Provost for Graduate Studies any special circumstances that may adversely affect academic standing. This action must be taken as soon as such circumstances develop.

## Course Repetition

Graduate students may request approval to repeat a course using a form available from the Office of Graduate Studies. The grade received in a repeated course is calculated in the cumulative GPA, but the first grade still appears on the transcript. A maximum of two courses may be repeated in matriculated graduate study. Students may not repeat a course without prior approval from the department and the Office of Graduate Studies. Non-matriculated students, including certificate students, may repeat a maximum of one course. Students who receive an F in a course will be required to repeat that course.

The academic advisor may contact the Associate Provost for Graduate Studies if the course is no longer offered or not applicable to the student's current program, or other extenuating circumstances are believed to exist.

# Progress Toward Degree

## Academic Performance and Satisfactory Progress Policy

New Jersey Institute of Technology requires that students maintain satisfactory progress in working toward a degree. Federal and state regulations governing financial aid and awards require that students receiving aid from government agencies must meet academic performance and progress requirements defined by the university and approved by the appropriate government agencies.

The Office of Graduate Studies, along with academic departments, reviews the academic standing of all graduate students at the end of each semester. To have satisfactory academic standing, students must have a cumulative GPA of 3.0 or above, meet all university requirements and be making satisfactory progress toward a degree. Students who do not have satisfactory academic standing are subject to academic warning, academic probation or academic dismissal.

## Academic Warning

Students who have completed at least one full-time semester (or its equivalent of 9 credits) and do not have satisfactory academic standing may be asked to meet with their graduate advisor to review their academic record.

## Academic Probation

Students who have completed more than 9 credits, and do not achieve satisfactory academic standing may be placed on academic probation or be subject to dismissal. Conditions for continuing graduate study at NJIT are sent, in writing, to students on academic probation. The Office of Graduate Studies will work with advisors and students to determine approaches toward successful program completion. Academic probation may be noted on the permanent academic record. Students on probation for two consecutive semesters are subject to dismissal from the graduate program.

## Dismissal

Students may be dismissed from Graduate Studies for cause at any time. Cause shall include, but is not limited to:

- Failing to meet the conditions of admission.
- Failing to maintain a cumulative GPA of at least 3.0 after completing one semester or attempting at least 9 credits.
- Failing to make satisfactory progress toward a degree.
- Failing to meet the requirements for graduation.
- Failing a required or repeated course more than once.
- Failing to satisfy requirements for project, thesis, or dissertation within the required time limits.
- Failing doctoral qualifying and similar examinations required for continuing studies in the program, or failing to take examinations within prescribed time limits.
- Professional conduct offenses as defined in the NJIT Code of Professional Conduct.
- Making a false representation relating to admission, registration, or the awarding of financial support.
- Failure to pay all tuition, fees and other charges within the required time limits.

Dismissal is noted on the permanent academic record.

Decisions relating to a graduate student's academic status are made in accordance with regulations approved by the faculty and its standing committees.

Students who disagree with a decision should attempt to resolve the matter with those immediately responsible. When a matter cannot be resolved at this level, students should appeal to the Chairperson of the department and then to the Dean of the school or college.

## Readmission if Dismissed

Students dismissed from NJIT for academic reasons may apply for readmission to another degree program after at least one calendar year.

Dismissed students who seek readmission should apply to the Office of University Admissions at least two months before the date of intended readmission. These students must complete, in full, the application for admission and provide all requested documentation, regardless of previous applications. Readmission is treated as a new application. Readmits compete against all other applicants for admission that semester. The circumstances and conditions of the dismissal will be considered in the readmission process.

Students dismissed for professional conduct offenses or for making false representation will not be readmitted to NJIT.

Students who reapply should also include supportive material to justify readmission. Such material may include, but not be limited to, scores obtained in the GRE or GMAT, grades obtained in graduate level work at other institutions, letters of recommendation, and a statement by the applicant. A non-refundable fee must accompany applications.

## General Graduate Degree Requirements

Graduate degree candidates must achieve a cumulative GPA of at least 3.0 in all graduate-level courses (500 level and above) and satisfy other academic and non-academic requirements. These include financial obligations to the university. Students whose programs require a thesis or dissertation must complete these within time limits, format, and policy prescribed by the Office of Graduate Studies. Master's theses and doctoral dissertations must be submitted for final approval to the Office of Graduate Studies. Master's projects need to be submitted only to the advisor. At least three program approval signatures are required for master's theses; at least five are required for doctoral dissertations (at least four signatures are required for the Urban Systems program). Fees that must be paid include, but are not limited to, the binding fee, publishing fee, copyright fee.

## Grade Point Average Calculation

GPAs are calculated for each semester and cumulatively for the entire graduate record. In order to obtain a graduate degree, candidates must have a cumulative GPA of at least 3.0 in all graduate-level courses, exclusive of grades in master's thesis or doctoral dissertation. All 500 level (500G for Architecture) or higher graduate courses are included in the cumulative graduate GPA. Only the initial grades for graduate courses that have been repeated (with a maximum of two allowed) are excluded from GPA calculations. Undergraduate credits taken by graduate students are not counted. Some programs also may require a 3.0 GPA in designated core course requirements.

In addition, the cumulative GPA for all courses counted for the degree, exclusive of master's thesis or doctoral dissertation, must be 3.0 or better. Grades for master's project must be a B or better. Successful completion of a master's thesis or doctoral dissertation, along with defense, will be assigned a grade of P for passing. The P grade is for the thesis or dissertation credits taken in the student's final semester.

## Graduation Certification Course Exclusion

The graduate student’s academic advisor may suggest the exclusion of specific courses for the calculation of the student’s GPA. These courses will not count for graduation certification and degree requirements. Prior approval of the Associate Provost for Graduate Studies is needed. The required form may be requested only by the advisor by contacting the Office of Graduate Studies and justifying the request.

For students transferring between graduate programs, the advisor must submit the form within a month after the student enrolls in the new program.

## Theses and Dissertations

Theses and dissertations submitted for graduate degrees must follow a prescribed university format. The approved format is based on the Estrin/Roche manual: Guidelines for Scientific and Professional Theses. The Office of Graduate Studies provides seminars, guidance documents and continuing assistance for students. The office or its web site should be consulted for more information.

Degrees cannot be certified until the Graduate Studies Office receives and approves the final thesis or dissertation documents with all related requirements completed.  The Graduate Studies Office will notify the advisor and the registrar that these documents have been approved before a final grade of P can be assigned.  The NJIT Library posts completed theses and dissertations on the NJIT website and works with the external bindery.  Students are notified by the Library about availability of completed and bound theses and dissertations, typically several months after degree completion.  The Graduate Studies Office can make arrangements, for a specified period, for sequestering a completed thesis or dissertation for proprietary or patent reasons, if requested by the student or the advisor.

## Special Topics

Special Topics courses are occasionally offered by departments to present new areas of high demand where rapid developments in the field have not allowed time for formal approval of such courses. These are announced by the departments in time for registration and are typically well-enrolled. They may be at the master's or doctoral level. There is no university limitation on the number of special topics courses that may be taken.

## Independent Study

Some programs permit up to three independent study courses (a total of 9 credits) to be taken by graduate students. Independent study is for students who want highly specialized study with a specific faculty member in areas in which specifically titled courses are not normally available. Most departments offer independent study at both the master's and doctoral levels. Students should see their advisors regarding independent study options. For students in doctoral programs, a maximum of two independent study courses may be used to partially satisfy the 700-level course requirements. Enrollment in independent study may be as low as one student under a faculty section number.

## Expiration of Credit

For all degrees, credits expire seven years after completion of the semester in which they are earned. Expired courses cannot be used to fulfill degree requirements and must be replaced by current credits.

Degree requirements must be generally completed within seven years of original admission. For Ph.D. students entering the program after August 2015, the limit is six years of attendance. Approved leaves of absence do not count against these limits although the validity of individual courses may still expire during the seven-year period. Requests for waivers of the seven-year limit for extenuating circumstances, other than mere failure to register, are made to the Associate Provost of Graduate Studies by the student's academics advisor. The technical content and remaining currency of courses is considered in evaluating these requests. The majority of courses in rapidly changing fields are not likely to be accepted after seven years.

## Awarding of Degrees

Degrees are awarded three times each academic year: August, January and May. The university conducts its commencement ceremony once per year, normally in May. Candidates for graduation must file an Application for Candidacy with the registrar. The application must be consistent with the student's program of admission and current record. Forms are available at www.njit.edu/registrar (http://www.njit.edu/registrar). Applications received after the specified deadline are accepted for the requested degree date at the discretion of the registrar and are subject to a late fee. Unsuccessful applications will be automatically added to the next commencement list and students will be billed for the appropriate fees. This will be done a maximum of three times.

Students who have not completed all requirements for the degree cannot participate (walk) in the May commencement.

## Deadline Waiver

Advisors of applicants for the August, January or May degree dates whose master's thesis or doctoral dissertation is substantially complete, but who are unable to submit it in final form by the specified date, may request a deadline waiver from the Associate Provost of Graduate Studies before it is due. Students granted a waiver may be permitted until a date specified by the Office of Graduate Studies to submit the final copy of the work to the office. Such students may then apply for the next scheduled graduation without having to pay for additional thesis or doctoral dissertation credits. Advisors should contact the Office of Graduate Studies for further information.

Students who do not meet the deadline waiver will be required to register for master's thesis or doctoral dissertation in the subsequent enrollment period to allow formal completion.

# Master's Degree Requirements

NJIT offers Master's degrees in a variety of disciplines through the five degree granting colleges and schools: Newark College of Engineering, College of Science and Liberal Arts, College of Computing Sciences, School of Management, and College of Architecture and Design. NJIT also offers master's degrees in interdisciplinary areas that may include coursework from a number of colleges or schools. The programs are flexibly arranged to allow new specializations and to allow new programs to be developed in response to changing needs. All current programs are listed in another section of the catalog. Students seeking more than one Master's degree should consult the Office of Admissions and the Office of Graduate Studies. There are options available that can reduce the time and number of credits for completion of the second degree.

Most master's degrees require a minimum of 30 credits to complete. Some master's degree programs, particularly those in professional areas require additional credits beyond 30 credits. Specific program sections of the catalog describe these requirements. In general, courses for master's programs must be numbered at the 600 level or above; some programs will allow up to two courses numbered 500-599. Some programs may also require a master's thesis or a project.

Up to 9 credits from outside NJIT, subject to approval by the advisor and the Graduate Studies Office and based on NJIT transfer credit policies described elsewhere, may be applied to master's degrees. Generally, NJIT does not allow transfer of credits already used as part of the credit requirements for a prior degree outside of NJIT. However, students who have completed a master's degree elsewhere that includes much more than the typical 30 credits for a master's degree and are considering an NJIT master's degree that also includes much more than the typical 30 credits, such as an MBA or an MArch degree, will be considered for a block transfer of up to 12 credits from the prior degree toward the NJIT degree. These types of transfer will require approval of the advisor and the Associate Provost for Graduate Studies.

## Bridge Program

Students who seek a master's degree in an academic discipline different from that of the bachelor's degree may be admitted to a master's degree program but may be required to complete appropriate undergraduate and/or graduate prerequisites in addition to the normal graduate degree requirements of the program. The program of courses will be individually designed in consultation with their graduate advisor. Bridge courses must be completed before 9 credits of graduate degree courses are earned. Bridge courses are not counted as degree credits but do count in graduate GPA calculations if the course is numbered 500 (500G for Architecture) or higher.

## Master's Thesis Advisor, Committee, and Defense

A master's thesis committee should be formed at the start of the second semester of thesis registration (or at the start of the first semester if a single semester completion seems certain). The committee must have at least three members. All members of the committee must hold faculty rank.

The chair of the committee must be a tenured or tenure track faculty member in the department or program offering the degree. At least one other member of the committee must be a tenure or tenure track faculty member or a research professor in the department or program offering the degree. The Guidelines for Graduate Faculty at NJIT must be met (http://www5.njit.edu/provost/grad-study/) when forming a committee. Approval of the committee is made by the program director and reported to the Graduate Studies Office on a standardized thesis committee appointment form.

The thesis must be defended in a publicly announced oral defense. Each program has its own policies on scheduling and submitting thesis drafts to members of the committee. Students are responsible for following their program's policies. Successful defense of the thesis is determined by vote of the thesis committee. The chair of the thesis committee, one other person who is a tenured or tenure-track faculty or a research professor, and a third member of the committee must be present to hear the defense. Every member of the thesis committee must sign and date the approval page of the final thesis document. A report on passage, conditional passage, or failure of the defense is completed by the thesis committee chair, signed by the thesis committee members, and sent to the Graduate Studies Office on a standardized form.

# Ph.D. Degree Requirements

Detailed descriptions of the degree requirements for specific degrees or degree/discipline combinations may be found in the Degree Programs section of this catalog.

## PhD degree requirements for students entering a Ph.D. program after August 2015

1. Ph.D. coursework registration requirements

Ph.D. students with a recognized Master's degree or equivalent are required to take four 700-level 3-credit courses (12 credits). Ph.D. students with a recognized Baccalaureate degree are required to take eight 600-level or 700-level 3-credit courses (24 credits) of coursework beyond the Baccalaureate degree as well as four additional 700-level 3-credit courses (12 credits), for a total of twelve 3-credit courses (36 credits). Master's project (course 700), Master's thesis (course 701), or more than two independent study courses (courses 725 and 726) cannot be used to satisfy these coursework requirements. A Ph.D. student may substitute a 600-level course for a 700-level course only after the academic advisor appeals on behalf of the student to the Office of Graduate Studies and receives approval. A Ph.D. program may define an additional set of required courses that must be pre-approved by the academic college (multiple colleges may be involved for interdisciplinary programs). Whether or not a program requires additional courses above the aforementioned minimum requirements, a Ph.D. student's dissertation committee may ask the student to take additional courses.

2. Ph.D. dissertation registration requirements

- Ph.D. students who pass the Qualifying Examination (QE) must then register for 3 credits of pre-doctoral research (792B) per semester until they defend successfully the dissertation proposal.
- Ph.D. students who defend the dissertation proposal successfully must then register for the 1-credit dissertation course (790A) each semester until they complete all degree requirements.
- Students may take courses simultaneously with the 790 or 792 course as per Ph.D. program guidelines or dissertation committee recommendation.
- Students who do not meet the following deadlines will be dismissed from the Ph.D. program.
    - The required coursework for the Ph.D. program and the (major part of the) QE must be completed successfully by the end of the second year in the program.
    - The dissertation proposal must be defended successfully either by the end of the third year in the Ph.D. program or four semesters after registering for the first time in the 792 pre-doctoral research course, whichever occurs earlier.
    - The dissertation must be defended successfully by the end of the sixth year in the Ph.D. program.

*(Note: The credit requirements for any joint Ph.D. program, for which the names of multiple universities appear on the diploma, follow the explicit requirements of the joint program.)*

## PhD degree requirements for students entering a Ph.D. program before August 2015

The number of credits required for completion of doctor of philosophy degrees varies with the program and the level of entry into the program. Students holding a prior master's degree generally require a minimum of 60 graduate credits beyond the master's degree (which is assumed to have included at least 30 graduate credits beyond the bachelor's degree). Students entering the doctoral program with a bachelor's degree and who do not wish to complete a master's degree while pursuing the doctoral degree will be required to complete a minimum of 84 graduate credits beyond the bachelor's degree for programs offered by the Newark College of Engineering and 78 graduate credits beyond the bachelor's degree for programs offered by the College of Science and Liberal Arts.

Students who enter an NJIT doctoral program with two or more master's degrees already completed or a large number of appropriate prior graduate credits may be considered for a reduction in the credits required at NJIT. The evaluation of the requirements will be made by the program advisor in consultation with the Associate Provost for Graduate Studies. The minimum credit requirement for the doctoral degree at NJIT is 36 dissertation research credits, regardless of any other requirement waiver.

Doctoral program credit requirements for joint programs for which the names of multiple universities appear on the diploma, are to follow the requirements of the program as approved by the universities, generally a minimum of 72 credits beyond the bachelor's degree.

In addition to overall credit requirements, each program includes the following minimal requirements:

- For those entering the program with master's degrees, 24 credits of course work beyond the master's degree of which at least 12 credits must be at the 700 level and none at the 500 level or lower.
- For both entry levels; baccalaureate or master's start-point, at least 12 credits of course work at the 700 level; no more than two independent study courses may be used to satisfy this requirement. master's project or thesis cannot be used to satisfy this requirement.
- 36 credits minimum of doctoral dissertation research for programs offered jointly with other universities.
- 30 credits minimum of doctoral dissertation research for the programs offered by the College of Computing Sciences.
- Dissertation research credits in accordance with the program approval documents for programs offered jointly with other universities.
- Seminar attendance each semester or as required by the program. Nominal credit values, if any, for registration in seminar do not count toward fulfillment of overall credit requirements.

Students who wish to complete a master's degree while pursuing a doctorate in the same field must be approved for this by the doctoral department, the Associate Provost for Graduate Studies, and the director of graduate admissions, and satisfy all requirements for the master's degree, including any thesis or project requirement. In general, such permission is given only after passage of the research proposal exam or if the student is near completion of the doctorate. Students in doctoral programs initially, who terminate their studies at the master's level, will lose further eligibility for support.

## Qualifying Examination

Students must pass a qualifying examination within two years of being admitted into doctoral programs. Students are only permitted to take the examination twice. The passage of qualifying examinations is reported to the Office of Graduate Studies on the Qualifying Examination form. Each department determines its own policies with regard to format, confidentiality, grading, and review of examinations by faculty and students. Students are, at their request, permitted to view their examination papers in the presence of a designated faculty member and to see correct examination answers.

## Dissertation and Pre-Doctoral Research Credits for Students Already Enrolled in the Ph.D. Program Before August 2015

Students who entered the Ph.D. program before August 2015 may register for doctoral dissertation credits (course number 790) only after passage of the qualifying examination. They may register for a maximum of 6 credits of pre-doctoral research (course number 792) prior to passage of the qualifying exam. These credits may count toward the required number of dissertation credits for the degree. Dissertation and pre-doctoral dissertation credits are graded as S or U except that P is assigned to the last registration for doctoral dissertation upon completion of the degree.

## Dissertation Advisor, Dissertation Committee and Research Proposal

Doctoral students are required to have a dissertation advisor selected, a dissertation committee formed, and research proposal approved within one year of passage of the qualifying examination.

The department chairperson or doctoral program director is responsible in the student's department/program for approving originally the formation of dissertation committees. The committee must be finally approved by the Associate Provost for Graduate Studies. The Guidelines for Graduate Faculty at NJIT must be met when forming a committee (http://www5.njit.edu/provost/grad-study/). The committee consists of a minimum of five members (four for the Urban Systems program), one of whom is external to the program or to NJIT. The majority of the committee members are tenured or tenure-track faculty from the student's program or department having research experience or developing research interests related to the dissertation research. The dissertation committee chairperson typically is the doctoral candidate's dissertation advisor, but other faculty may be selected, provided they are from the student's program or department. The dissertation committee chair must be a tenured or tenure-track faculty member in the program. Two committee members, including an external member, may serve as co-advisors. The advisor or at least one of the co-advisors must be a tenured or tenure-track faculty member from the program.

The other members of the dissertation committee, except for an external member from outside the university, must have faculty rank at the level of Assistant Professor, Associate Professor, Professor, Distinguished Professor, or Research Professor. Former students of any committee member, who are less than four years beyond doctoral completion, are specifically excluded from membership. Post-doctoral Associates, Instructors, Special Lecturers, Research and Teaching Assistants, or any other student category, are specifically excluded from membership. The external members should either have appropriate faculty rank elsewhere or have sufficient research expertise to warrant inclusion on the dissertation committee.

Part-time doctoral students pursuing the doctorate with industry collaboration (i.e., collaborative Ph.D.) may have at least one dissertation committee member from the participating industrial partner whose research credentials would otherwise be appropriate for a member of the university faculty. Committees for joint doctoral programs with other universities shall either follow these policies or the specific policies for the joint program consistent with the program approval and related documents.

Each doctoral program has specific requirements for preparing, presenting and accepting proposals. Research is expected to investigate or develop a unique contribution to science and technology. Research may be experimental, analytical, applied, or theoretical, provided it satisfies this criteriion and is approved by the dissertation committee. It should be of a quality to warrant scholarly presentation or paper submission to reputable journals in accordance with program practice.

## Residency

Doctoral candidates must spend at least one academic year in full-time residence. This requirement is sometimes waived with the approval of the dissertation committee and the Associate Provost for Graduate Studies. Such waivers are granted when a candidate's dissertation research requires use of research facilities at an approved off-campus site. A typical example for residency requirement waiver would apply in the case of students in the collaborative doctorate option.

## Doctoral Candidacy

Doctoral candidates are doctoral students who have completed all other requirements for the degree except for completion of the dissertation and the defense. This includes, as a minimum, passage of the doctoral qualifying examination, approval of the research proposal and completion of all course work. Status as a doctoral candidate does not imply candidacy for the degree. A degree candidate will be both near degree completion and have made a formal degree application for a particular graduation date.

## Dissertation and Defense

The dissertation should be a scholarly publication of the quality to warrant conference presentation or paper submission to reputable journals. The dissertation must be defended in a publicly announced oral defense. Successful defense of the dissertation is determined by vote of the dissertation committee. All members of the committee must be present to hear the defense.

Each program has its own policies on scheduling and submitting dissertation drafts to members of the dissertation committee. Students are responsible for following their program's dissertation policies. In regard to format, the standard reference is the latest edition of the *Estrin/Roche Manual: Guidelines for Scientific and Professional Theses*. Office of Graduate Studies policies on number of copies, deadlines, fee payments, information documents, and grade submission for acceptance of the final dissertation and for doctoral degree certification are to be followed. The Office of Graduate Studies provides guidance and assistance to students working on the final details of the dissertation. Students should contact the office for appointments early in the final semester. The review of format should proceed well in advance of final document approval and dissertation defense.

Every member of the dissertation committee must sign and date the approval page of the final dissertation document.

## Graduate Certificate Requirements

Certificates require completion of 12 specified credits with a GPA of 3.0 or better. Only one course repetition is permitted for certificate students to improve the GPA. The cumulative GPA of the entire graduate record at NJIT also must be 3.0. Graduate certificate credits may be applied to a following master's degree. Dual use of credits from a completed first master's degree to a second and following certificate is not permitted.

Students in certificate programs are usually considered to be non-matriculated students for the duration of the certificate program. Graduate certificate programs are generally completed before students are admitted to a following matriculated master's program. Students who did not apply for admission to a certificate program initially and instead complete the certificate requirements as part of a completed graduate degree program may be permitted to receive a certificate also with approval of the graduate program director.

# Special Program Options

## BS/MS and Dual Degree Programs

These accelerated dual degree programs permit undergraduates to earn credits toward a master's degree or a doctoral degree. Students in BS/MS normally take 6 credits of graduate course work in their senior year. Exceptional students with a cumulative GPA higher than 3.5 may take 9 credits of graduate course work in their senior year. These credits may be counted toward both a bachelor's degree and a following master's degree if enrollment as a graduate student in the master's degree program occurs within two years of completion of the bachelor's degree. After enrollment as a graduate student, those who wish to apply the 6 or 9 credits to the graduate degree program should contact the Office of Graduate Studies. Graduate study may be completed full or part-time.

Full-time undergraduate students become eligible to apply for the BS/MS program after they complete at least five courses in their major and have maintained a GPA of 3.0 or better. Students in the Albert Dorman Honors College are pre-approved for the BS/MS program at the time of admission to NJIT but will receive letters about activating their status in BS/MS if their GPA is still above 3.0 and have earned between 57 and 110 undergraduate credits. The activation letter will instruct Honors College students about contacting the academic department undergraduate advisor. All other students with a 3.0 or better GPA will have to submit an application to the Office of Graduate Studies no later than one year prior to graduation. The application will list the graduate courses to be taken in the senior year and requires the signatures of the undergraduate and graduate advisors. Applicants must satisfy all university requirements for admission to graduate programs (they must eventually submit an application to Admissions).

Exceptional students may seek to go into an NJIT doctoral program directly through the BS/PhD program and must have a record consistent with university criteria for doctoral study (3.5 GPA or better). GRE scores are required for doctoral admission.

Several other combinations of Bachelor’s and Master’s degrees exist or are under development. The number of dual-use credits for these combinations may exceed 6 credits in accordance with specific program requirements. Two examples are the B. Arch/MS and the BS/MBA programs which allow

12 dual-use credits. Information and applications for BS/MS, BS/PhD, and other accelerated dual degree programs can be obtained from the Office of Graduate Studies website under forms and printed materials.

## MS/MS and Dual Master's Programs

The MS/MS program allows students to pursue a second NJIT Master of Science degree on completion of the first and to count two courses (6 credits) from the first degree toward the second. The option must be exercised within two years of completion of the first degree. The approval of the advisors of the two programs is required. Upon receiving the signed approval form, the Office of Graduate Studies will direct the Registrar on transfer of the two dual-use courses to the second program. The MS/MS program option is not intended for students who have left the doctoral program without completion of the degree. Up to 6 credits may be transferred to the second Master's degree from outside NJIT. Thesis, project, pre-doctoral research, independent research and similar courses may not be used.

Several other Master’s degree combinations can allow more than 6 credits to count toward both degrees. In general, these apply to situations in which the first or the second degree programs requires considerably more than 30 credits. Examples are the Master of Architecture and the Master of Business Administration programs. The allowable dual counting of credits for the Master of Architecture in combination with other programs is described in the catalog sections on Architecture and Infrastructure Planning. Subject to specific course approval and the two year time limit for MS/MS as described above, up to 12 credits from a previously completed NJIT MS program in Computer Science, Information Systems, or Engineering Management may be applied toward completion of the 48 credit Master of Business Administration degree program. Subject to course approval, up to 18 credits may be used from a previously completed NJIT MS program in Management toward the completion of the 48 credit Master of Business Administration degree program.

## The Collaborative Doctorate

The Collaborative Doctorate is designed for engineers, executives, scientists, military personnel, state and federal government employees, and educators who want to pursue a Ph.D. degree while continuing full-time employment. The academic requirements are the same as for regular NJIT doctoral programs but the collaborative nature of the program also allows participants to draw on the combined expertise and resources of the university and their employer. Dissertation research is expected to investigate or develop an original contribution to science, technology or management. Research may be experimental, analytical, applied or theoretical provided that it satisfies all criteria set by the dissertation committee.

More information about the program is available at http://catalog.njit.edu/graduate/academic-policies-procedures/collaborative-doctorate/index.html.

# Graduate Certificates

NJIT's graduate certificates give students the opportunity to:

(a) improve their skills in their current occupation by developing expertise in advanced topics,
(b) acquire knowledge to pursue new careers, or
(c) explore emerging fields before committing to relevant master’s degree programs that require more courses.

Many students pursue a graduate certificate for personal growth or part-time.

Each certificate program contains 4 graduate courses (equivalent to a total of 12 graduate credits) that are normally part of the curriculum for a 30-credit Master's degree program. After successful completion of a graduate certificate, a student may decide to continue studying at NJIT towards the corresponding Master's degree by taking advantage of rapid matriculated acceptance and eventual acquisition of two credentials (essentially for the price of the Master’s degree).

Graduate Certificates are available in:

***Full List of Graduate Certificates***

| Certificate Name | Industry | College | Dept | Advisor | Related MS |
|---|---|---|---|---|---|
| **Applied Statistics Methods** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/applied-statistical-methods-cert) | Applied Mathematics, Biostatistics | CSLA (http://csla.njit.edu) | MATH (http://math.njit.edu) | Ji Meng Loh (http://directory.njit.edu/PersDetails.aspx?persid=loh) | APST (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/applied-statistics-ms) |

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|---|---|---|---|---|---|
| **Big Data Essentials** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/big-data-essentials-cert) | Computing, Analytics | CCS (http://ccs.njit.edu) | CS (http://cs.njit.edu) | Chase Wu (http://directory.njit.edu/PersDetails.aspx?persid=chasewu) | CS (http://catalog.njit.edu/graduate/computing-sciences/computer-science/ms) |
| **Biomedical Device Development** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/biomedical-device-development-cert) | Biomedical | NCE (http://engineering.njit.edu) | BMED (http://biomedical.njit.edu) | Max Roman (http://directory.njit.edu/PersDetails.aspx?persid=mxr6074) | BMED (http://catalog.njit.edu/graduate/newark-college-engineering/biomedical/ms) |
| **Biostatistics Essentials** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/biostatistics-cert) | Biostatistics | CSLA (http://csla.njit.edu) | MATH (http://math.njit.edu) | S. Subramanian (http://directory.njit.edu/PersDetails.aspx?persid=sundars) | BSTA (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/biostatistics-ms) |
| **Business and Information Systems** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/business-information-systems-cert) | Management, Information Systems | CCS (http://ccs.njit.edu) | IS (http://is.njit.edu) | George Olsen (http://directory.njit.edu/PersDetails.aspx?persid=golsen) | BIS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/business-information-systems-ms)/CBUS (http://catalog.njit.edu/graduate/computing-sciences/computer-science/computing-business-ms)/IS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/ms) |
| **Construction Management** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/construction-management-cert) | Civil Engineering | NCE (http://engineering.njit.edu) | CEE (http://civil.njit.edu) | Heidi Young (http://directory.njit.edu/PersDetails.aspx?persid=hyoung) | CE (http://catalog.njit.edu/graduate/newark-college-engineering/civil-environmental/civil-ms)/EM (http://catalog.njit.edu/graduate/newark-college-engineering/mechanical-industrial/engineering-management-ms) |

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| **Data Mining** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/data-mining-cert) | Computing, Databases | CCS (http://ccs.njit.edu) | IS (http://is.njit.edu) | George Olsen (http://directory.njit.edu/PersDetails.aspx?persid=golsen) | CS (http://catalog.njit.edu/graduate/computing-sciences/computer-science/ms)/IS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/ms)/BIS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/business-information-systems-ms) |
| **Digital Marketing Design Essentials** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/digital-marketing-design-cert) | Digital Media, Social Media | CSLA (http://csla.njit.edu) | HUM (http://humanities.njit.edu) | Andrew Klobucar (http://directory.njit.edu/PersDetails.aspx?persid=klobucar) | PTC (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/professional-technical-communication-ms) |
| **Finance for Managers** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/finance-managers-cert) | Management, Finance | SOM (http://management.njit.edu) | MGMT (https://management.njit.edu) | Shanthi Gopalakrishnan (http://directory.njit.edu/PersDetails.aspx?persid=sgopalak) | MGMT (http://catalog.njit.edu/graduate/management/management/ms)/MBA (http://catalog.njit.edu/graduate/management/management/technology-mba) |
| **Financial Mathematics** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/financial-mathematics) | Applied Mathematics, Finance | CSLA (http://csla.njit.edu) | MATH (http://math.njit.edu) | Andrew Pole (http://directory.njit.edu/PersDetails.aspx?persid=pole) | MTCF (http://math.njit.edu/academics/graduate/ms-computationalfinance) |
| **Information Security** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/information-security-cert) | Computing, Network Security | CCS (http://ccs.njit.edu) | IS (http://is.njit.edu) | George Olsen (http://directory.njit.edu/PersDetails.aspx?persid=golsen) | CSP (http://catalog.njit.edu/graduate/computing-sciences/computer-science/cyber-security-privacy-ms)/IS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/ms)/ITAS (http://catalog.njit.edu/graduate/computing-sciences/information-technology/administration-security-ms) |

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| **Instructional Design, Evaluation** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/instructional-design-evaluation-assessment-cert) **and Assessment** | Education, Digital Trainers | CSLA (http://csla.njit.edu) | HUM (http://humanities.njit.edu) | Andrew Klobucar (http://directory.njit.edu/PersDetails.aspx?persid=klobucar) | PTC (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/professional-technical-communication-ms) |
| **Intelligent Transportation Systems** (http://www5.njit.edu/graduatestudies/degree-progams/graduatecertificates/intelligent-transportation-systems) | Transportation, Civil Engineer | NCE (http://engineering.njit.edu) | CEE (http://civil.njit.edu) | Joyoung Lee (http://civil.njit.edu/people/Lee.php) | TRAN (http://catalog.njit.edu/graduate/newark-college-engineering/civil-environmental/transportation-ms) |
| **International Commerce** | International Business | SOM (http://management.njit.edu) | MGMT (https://management.njit.edu) | Cheickna Sylla (http://directory.njit.edu/PersDetails.aspx?persid=sylla) | MGMT (http://catalog.njit.edu/graduate/management/management/ms)/MBA (http://catalog.njit.edu/graduate/management/management/technology-mba) |
| **IT Administration** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/it-administration-cert) | Computing, Network Security | CCS (https://ccs.njit.edu) | IT (http://it.njit.edu) | Michael Halper (http://directory.njit.edu/PersDetails.aspx?persid=halper) | ITAS (http://catalog.njit.edu/graduate/computing-sciences/information-technology/administration-security-ms) |
| **Management Essentials** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/management-essentials-cert) | Management, Business | SOM (http://management.njit.edu) | MGMT (https://management.njit.edu) | Cheickna Sylla (http://directory.njit.edu/PersDetails.aspx?persid=sylla) | MGMT (http://catalog.njit.edu/graduate/management/management/ms)/MBA (http://catalog.njit.edu/graduate/management/management/technology-mba)/BIS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/business-information-systems-ms) |
| **Management of Technology** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/management-technology-cert) | Management, Business | SOM (http://management.njit.edu) | MGMT (https://management.njit.edu) | Cheickna Sylla (http://directory.njit.edu/PersDetails.aspx?persid=sylla) | MGMT (http://catalog.njit.edu/graduate/management/management/ms)/MBA (http://catalog.njit.edu/graduate/management/management/technology-mba)/BIS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/business-information-systems-ms) |

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| **Network Security and Information** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/network-security-information-assurance-cert) **Assurance** | Computing, Network Security | CCS (http://ccs.njit.edu) | IS (http://is.njit.edu) | George Olsen (http://directory.njit.edu/PersDetails.aspx?persid=golsen) | IS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/ms)/CSP (http://catalog.njit.edu/graduate/computing-sciences/computer-science/cyber-security-privacy-ms)/ITAS (http://catalog.njit.edu/graduate/computing-sciences/information-technology/administration-security-ms) |
| **Pharmaceutical Management** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/pharmaceutical-management-cert) | Management, Pharma, FDA | NCE (http://engineering.njit.edu) | CPBE (http://chemicaleng.njit.edu) | Piero Armenante (http://directory.njit.edu/PersDetails.aspx?persid=armenant) | PSM (http://catalog.njit.edu/graduate/newark-college-engineering/mechanical-industrial/pharmaceutical-systems-management-ms)/PHEN (http://catalog.njit.edu/graduate/newark-college-engineering/chemical-biological-pharmaceutical/pharmaceutical-ms) |
| **Pharmaceutical Manufacturing** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/pharmaceutical-manufacturing-cert) | Drug Manufacturing, FDA | NCE (http://engineering.njit.edu) | CPBE (http://chemicaleng.njit.edu) | Piero Armenante (http://directory.njit.edu/PersDetails.aspx?persid=armenant) | PHEN (http://catalog.njit.edu/graduate/newark-college-engineering/chemical-biological-pharmaceutical/pharmaceutical-ms) |
| **Pharmaceutical Technology** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/pharmaceutical-technology-cert) | Drug Development, FDA | NCE (http://engineering.njit.edu) | CPBE (http://chemicaleng.njit.edu) | Piero Armenante (http://directory.njit.edu/PersDetails.aspx?persid=armenant) | PHEN (http://catalog.njit.edu/graduate/newark-college-engineering/chemical-biological-pharmaceutical/pharmaceutical-ms) |
| **Power Systems Engineering** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/power-systems-engineering-cert) | Power and Energy | NCE (http://engineering.njit.edu) | ECE (http://ece.njit.edu) | Mengchou Zhou (http://ece.njit.edu/people/zhou.php) | EE (http://catalog.njit.edu/graduate/newark-college-engineering/electrical-computer/electrical-ms)/PES (http://catalog.njit.edu/graduate/newark-college-engineering/electrical-computer/power-energy-systems-ms) |

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| **Project Management** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/project-management-cert) | Management, Engineering | NCE (http://engineering.njit.edu) | MIE (http://mie.njit.edu) | A. Bladikas (http://directory.njit.edu/PersDetails.aspx?persid=bladikas) | EM (http://catalog.njit.edu/graduate/newark-college-engineering/mechanical-industrial/engineering-management-ms) |
| **Quantitative Tools in Finance** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/quantitative-tools-finance) | Applied Mathematics, Finance | CSLA (http://csla.njit.edu) | MATH (http://math.njit.edu) | Andrew Pole (http://directory.njit.edu/PersDetails.aspx?persid=pole) | MTCF (http://math.njit.edu/academics/graduate/ms-computationalfinance) |
| **Social Media Essentials** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/social-media-essentials-cert) | Digital Media, Social Media | CSLA (https://csla.njit.edu) | HUM (http://humanities.njit.edu) | Andrew Klobucar (http://directory.njit.edu/PersDetails.aspx?persid=klobucar) | PTC (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/professional-technical-communication-ms) |
| **Software Engineering, Analysis,** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/software-engineering-analysis-design-cert) **and Design** | Software Development | CCS (http://ccs.njit.edu) | IS (http://is.njit.edu) | George Olsen (http://directory.njit.edu/PersDetails.aspx?persid=golsen) | SE (http://catalog.njit.edu/graduate/computing-sciences/computer-science/software-engineering-ms)/IS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/ms) |
| **Supply Chain Engineering** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/supply-chain-engineering) | Industrial Engineering | NCE (http://engineering.njit.edu) | MIE (http://mie.njit.edu) | Sanchoy Das (http://mie.njit.edu/people/das.php) | IE (http://catalog.njit.edu/graduate/newark-college-engineering/mechanical-industrial/industrial-ms)/EM (http://catalog.njit.edu/graduate/newark-college-engineering/mechanical-industrial/engineering-management-ms)/MNE (http://catalog.njit.edu/graduate/newark-college-engineering/mechanical-industrial/manufacturing-systems-ms) |
| **Technical Communication Essentials** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/technical-communication-cert) | Writers, Editors, Digital Media | CSLA (http://csla.njit.edu) | HUM (http://humanities.njit.edu) | Andrew Klobucar (http://directory.njit.edu/PersDetails.aspx?persid=klobucar) | PTC (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/professional-technical-communication-ms) |

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| **Transportation Studies** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/transportation-studies-cert) | Transportation Engineer | NCE (http://engineering.njit.edu) | CEE (http://civil.njit.edu) | I Jy Steven Chien (http://directory.njit.edu/PersDetails.aspx?persid=chien) | TRAN (http://catalog.njit.edu/graduate/newark-college-engineering/civil-environmental/transportation-ms)/CE (http://catalog.njit.edu/graduate/newark-college-engineering/civil-environmental/civil-ms) |
| **Web Systems Development** (http://www5.njit.edu/graduatestudies/degree-programs/graduatecertificates/web-systems-development-cert) | Web Development | CCS (http://ccs.njit.edu) | IS (http://is.njit.edu) | George Olsen (http://directory.njit.edu/PersDetails.aspx?persid=golsen) | IS (http://catalog.njit.edu/graduate/computing-sciences/information-systems/ms) |

# Collaborative Doctorate

# Collaborative Doctorate

The Collaborative Doctorate is designed for engineers, executives, scientists, military personnel, state and federal government employees, and educators who want to pursue a Ph.D. degree while continuing full-time employment. The academic requirements are the same as for regular NJIT doctoral programs but the collaborative nature of the program also allows participants to draw on the combined expertise and resources of the university and their employer. Dissertation research is expected to investigate or develop an original contribution to science, technology or management. Research may be experimental, analytical, applied or theoretical provided that it satisfies all criteria set by the dissertation committee.

**Requirements**

Students are often recommended by employers who may commit to a proposed area of research in concert with the dissertation committee. The student's employer may suggest a researcher to serve on the student's Ph.D. dissertation committee. This researcher may also become the student's Ph.D. dissertation co-advisor after approval by the department and the Associate Provost for Graduate Studies. Employers who have a proprietary interest in the student's dissertation research, including patent, copyright and technology transfer rights, are expected to execute formal IP (Intellectual Property) agreements with the university  prior to the start of the dissertation research.

**Programs**

The Collaborative Doctorate is available in all academic disciplines that award the Ph.D. degree.

Students must meet university requirements for admission to doctoral programs and their dissertation research must satisfy university policies. They are expected to continue employment until they complete all degree requirements. Annual reviews of progress will be conducted.

The student's dissertation committee and Office of Graduate Studies define residency requirements. It is expected that the employer will permit a concentrated effort on dissertation research. Seminar requirements are also defined by the dissertation committee, and may allow presentations or attendance at professional society meetings in place of on-campus seminars.

For more information about the program or to discuss potential paths that can lead to the degree, contact the Associate Provost for Graduate Studies (ziavras@njit.edu).

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# Executive Program

## Executive Master of Business Administration

Tailored to the demanding schedules of working professionals, the solution focused 18-month, 48-credit program is customized for career advancement without interruption of professional obligations.  Built upon the hallmarks of Innovation, Immersion, and Integration, this practical and results-oriented option emphasizes the application of advanced management strategies to traditional business challenges.  With the added bonus of Saturdays and on-line flexibility, the EMBA offers both breadth and depth of business experience in an accelerated mode of delivery.  Students are assigned independent and group projects emphasizing the employment of innovative management strategies in traditional corporate settings.  Further, the students represent diverse industries and job functions, providing an enriching experience and balanced perspective. The curriculum consists of 4 Thematic Areas: Leadership, Globalization, Creativity and Innovation, and Business and Government Relations.

EMBA candidates have the opportunity to participate in a 7-10 day international study tour. Meeting with business leaders in their work environments, students learn first-hand the opportunities and issues posed by today’s volatile-yet-exciting international business climate. Recent tours have included Brazil, France, The Czech Republic, Russia, Estonia, Chile, Argentina, and China. Students have called the trips “invaluable.” *[I gained] “critical insight….we would never have learned in any classroom or textbook.”*

## Professional Leverage

The program offers the additional benefit of PMP or Risk Management certification training. This new program feature represents an integration of the EMBA with industry recognized professional qualifications.

## Admission Requirements

These criteria are standard admission guidelines; however, each candidate is evaluated based upon his/her individual profile.

Candidates must have an earned bachelor’s degree (4 year US equivalent) and must take the GMAT (minimum score of 500); the GRE (with a comparable score) is also acceptable.

## GMAT Waivers

- Candidates with an earned Master’s or PhD from a US or Canada based “accredited" program
- Candidates with a minimum GPA of 2.8 from a US based research intensive University
- Candidates [without masters degrees], who have “significant” management experience, may appeal to the EMBA admission committee for a GMAT waiver; there is no waiver guarantee.

# Course Codes

## NJIT Courses

The courses listed here have been approved in accordance with the policies of NJIT. Department or university needs may necessitate changes in this list, and courses may be cancelled because of insufficient registration. A list of scheduled courses will be issued by the registrar before each semester begins. Information found in the Degree Programs section of this catalog serves as a guide for program planning in consultation with departmental or program advisors.

## Alphabetical Code

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|---|---|
| ACCT | Accounting |
| ARCH | Architecture |
| BINF | Biomedical Informatics |
| BME | Biomedical Engineering |
| CE | Civil Engineering |
| CHE | Chemical Engineering |
| CHEM | Chemistry |
| CIS | Computer and Information Sciences |
| ECE | Electrical and Computer Engineering (formerly CoE, EE) |
| ECON | Economics |
| EM | Engineering Management |
| ENE | Environmental Engineering |
| EPS | Environmental Policy Studies |
| EVSC | Environmental Science |
| FIN | Financial Management |
| HIST | History |
| HRM | Human Resource Management |
| IE | Industrial Engineering |
| MATH | Mathematics |
| ME | Mechanical Engineering |

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|---|---|
| MECH | Mechanics |
| MGMT | Management |
| MIP | Infrastructure Planning |
| MIS | Management Information Systems (formerly Information Systems Management) |
| MNE | Manufacturing Systems Engineering |
| MPH | Public Health |
| MRKT | Marketing Management |
| MTSE | Materials Science and Engineering |
| OPSE | Optical Science and Engineering |
| OSHE | Occupational Safety and Health Engineering |
| PHEN | Pharmaceutical Engineering |
| PHYS | Physics |
| TRAN | Transportation |

## Numerical Code

Numbers from 500 to 599 (500G to 599G for Architecture) indicate entry-level graduate courses normally offered for students who require additional background for admission to 600- or 700-level courses.

Numbers from 600 to 699 indicate regular-level graduate courses normally associated with master's-level study.

Numbers from 700 to 799 indicate advanced-level graduate courses normally associated with research and/or doctoral-level study.

## Rutgers-Newark Courses

The current Rutgers-Newark Schedule of Classes (https://sis.rutgers.edu/soc) can be viewed for cross-registration along with the **Rutgers catalog** when planning for cross-registration.

# Student Rights and Responsibilities

## Rights and Responsibilities

### Code of Professional Conduct

New Jersey Institute of Technology requires students to conduct themselves with decorum and to adhere to standards of ethical and professional behavior. NJIT has adopted, and requires all students to comply with, a Code of Professional Conduct. The policies and procedures governing this code are contained in a separate publication, the Student Handbook, and are deemed incorporated into this catalog. The student handbook, maintained by the Dean of Students Office, is available online at: www.njit.edu/handbook/ (http://www.njit.edu/handbook)

### Identification Card

All students must carry an NJIT identification card while on campus. An ID card must be presented at the request of a university administrator, faculty member or public safety officer. Facilities, parking, building access, and services of the university require presentation of a valid university ID.

Students should obtain an ID card as soon as possible after registration is completed. Photographs for ID cards are taken throughout the semester in the Department of Public Safety, located in the parking facility. Dates and times to obtain an ID are posted at the Campus Center Information Desk. Proof of registration in the form of a tuition receipt or registrar's receipt is required to obtain an ID card. These receipts also will be accepted as NJIT identification until the ID card is issued. ID validation stickers are issued each semester and are available at the Department of Public Safety or the Campus Center Information Desk.

Lost or stolen IDs should be reported as soon as possible to the Department of Public Safety. A replacement for a lost card is obtained by paying a $25 charge at the Bursar's Office cashier's window in the Student Services Mall and presenting the receipt at the Department of Public Safety where the card will be re-issued.

NJIT cards are not transferable. Cards are not to be loaned to anyone for any reason. ID cards are the property of NJIT and must be returned upon request.

### Family Educational Rights and Privacy Act

*(Effective Fall 2014, this policy supersedes all previous policies)*

The Family Educational Rights and Privacy Act (FERPA) affords eligible students certain rights with respect to their education records. (An “eligible student” under FERPA is a student who is 18 years of age or older or who attends a postsecondary institution.) These rights include:

1. The right to inspect and review the student's education records within 45 days after the day New Jersey Institute of Technology receives a request for access. A student should submit to the registrar a written request that identifies the record(s) the student wishes to inspect. The registrar will make arrangements for access and notify the student of the time and place where the records may be inspected. If the records are not maintained by the registrar, the registrar shall coordinate access to inspect those records.

2. The right to request the amendment of the student’s education records that the student believes is inaccurate, misleading, or otherwise in violation of the student’s privacy rights under FERPA.

A student who wishes to ask New Jersey Institute of Technology to amend a record should write the registrar, clearly identify the part of the record the student wants changed, and specify why it should be changed.

If New Jersey Institute of Technology decides not to amend the record as requested, New Jersey Institute of Technology will notify the student in writing of the decision and the student’s right to a hearing regarding the request for amendment. Additional information regarding the hearing procedures will be provided to the student when notified of the right to a hearing.

3 . The right to provide written consent before New Jersey Institute of Technology discloses personally identifiable information (PII) from the student's education records, except to the extent that FERPA authorizes disclosure without consent. See “Additional Disclosure Information” below.

4. The right to file a complaint with the U.S. Department of Education concerning alleged failures by the New Jersey Institute of Technology to comply with the requirements of FERPA. The name and address of the Office that administers FERPA is:

Family Policy Compliance Office

U.S. Department of Education

400 Maryland Avenue, SW

Washington, DC 20202

**Disclosure of Directory Information**

New Jersey Institute of Technology, at its discretion, may provide directory information, in accordance with the provisions of the law including a student's name, address, telephone listing, date and place of birth, major field of study, participation in officially recognized activities and sports, weight and height of members of athletic teams, dates of attendance, degrees and awards received, and the most recent previous educational agency or institution attended by the student.

Students may request to withhold disclosure of directory information. To ensure that a request is properly processed, it must be submitted on the official ‘Request to Prevent Disclosure of Directory Information Form’, which is available in the Office of the Registrar. Request for non-disclosure will be honored by New Jersey Institute of Technology for one academic year and must be filed again at the beginning of the next academic year. New Jersey Institute of Technology assumes that failure on the part of any student to specifically request on the official form preventing the disclosure of directory information indicates individual approval of disclosure.

**Additional Disclosure Information**

FERPA permits the disclosure of PII from students’ education records, without consent of the student, if the disclosure meets certain conditions found in §99.31 of the FERPA regulations. Except for disclosures to school officials, disclosures related to some judicial orders or lawfully issued subpoenas, disclosures of directory information, and disclosures to the student, §99.32 of FERPA regulations requires the institution to record the disclosure. Eligible students have a right to inspect and review the record of disclosures. A postsecondary institution may disclose PII from the education records without obtaining prior written consent of the student –

• To other school officials within New Jersey Institute of Technology whom New Jersey Institute of Technology has determined to have legitimate educational interests. A school official is a person employed by New Jersey Institute of Technology in an administrative, supervisory, academic, research, or support staff position (including law enforcement unit personnel and health staff); a person serving on the board of trustees; or a student serving on an official committee, such as a disciplinary or grievance committee. A school official has a legitimate educational interest if the official needs to review an education record in order to fulfill his or her professional responsibilities for New Jersey Institute of Technology. This includes contractors, consultants, volunteers, or other parties to whom the school has outsourced institutional services or functions, provided that the conditions listed in §99.31(a)(1)(i)(B)(1) - (a)(1)(i)(B)(2) are met. (§99.31(a)(1))

• To officials of another school where the student seeks or intends to enroll, or where the student is already enrolled if the disclosure is for purposes related to the student’s enrollment or transfer, subject to the requirements of §99.34. (§99.31(a)(2))

• To authorized representatives of the U. S. Comptroller General, the U. S. Attorney General, the U.S. Secretary of Education, or State and local educational authorities, such as a State postsecondary authority that is responsible for supervising New Jersey Institute of Technology State-supported education programs. Disclosures under this provision may be made, subject to the requirements of §99.35, in connection with an audit or evaluation of

Federal- or State-supported education programs, or for the enforcement of or compliance with Federal legal requirements that relate to those programs. These entities may make further disclosures of PII to outside entities that are designated by them as their authorized representatives to conduct any audit, evaluation, or enforcement or compliance activity on their behalf. (§§99.31(a)(3) and 99.35)

• In connection with financial aid for which the student has applied or for which the student has received, if the information is necessary to determine eligibility for the aid, determine the amount of the aid, determine the conditions of the aid, or enforce the terms and conditions of the aid. (§99.31(a)(4))

• To organizations conducting studies for, or on behalf of, the school, in order to: (a) develop, validate, or administer predictive tests; (b) administer student aid programs; or (c) improve instruction. (§99.31(a)(6))

• To accrediting organizations to carry out their accrediting functions. ((§99.31(a)(7))

• To parents of an eligible student if the student is a dependent for IRS tax purposes. (§99.31(a)(8))

• To comply with a judicial order or lawfully issued subpoena. (§99.31(a)(9))

• To appropriate officials in connection with a health or safety emergency, subject to §99.36. (§99.31(a)(10))

• Information the school has designated as “directory information” under §99.37. (§99.31(a)(11))

• To a victim of an alleged perpetrator of a crime of violence or a non-forcible sex offense, subject to the requirements of §99.39. The disclosure may only include the final results of the disciplinary proceeding with respect to that alleged crime or offense, regardless of the finding. (§99.31(a)(13))

• To the general public, the final results of a disciplinary proceeding, subject to the requirements of §99.39, if the school determines the student is an alleged perpetrator of a crime of violence or non-forcible sex offense and the student has committed a violation of the school’s rules or policies with respect to the allegation made against him or her. (§99.31(a)(14))

• To parents of a student regarding the student’s violation of any Federal, State, or local law, or of any rule or policy of the school, governing the use or possession of alcohol or a controlled substance if the school determines the student committed a disciplinary violation and the student is under the age of 21. (§99.31(a)(15))

## Anti-Discrimination Policy

New Jersey Institute of Technology reaffirms its commitment to a policy of non-discrimination on the basis of race, sex, sexual orientation, age, religion, ethnic origin, handicap or veterans' status in its employment policies, educational programs and activities under university control.

Assuring a climate of equal opportunity is the direct responsibility of all levels of management. Administrative and supervisory personnel are required to comply with applicable government regulations and the affirmative action goals of the university. Among these are Executive Orders 11246 and 11375 (Affirmative action); the Civil Rights Act of 1964, as amended; Title IX of the Education Amendments of 1972 (Sex Discrimination); Section 504 of the Rehabilitation Act of 1973; Americans with Disabilities Act (Non-discrimination on the Basis of Handicap); The New Jersey Law Against Discrimination, Title 10, Chapter 5, 10:5-1 to 10:5-28, NJ Revised Statutes, as amended; and the New Jersey Governor's Code of Fair Practices, Executive Order No. 21 (1965), as amended and Executive Order No. 39 (1991), "Prohibition in State Government of Discrimination Based on Sexual Orientation."

Any reported act of discriminatory behavior will be investigated through the Office of the Dean of Student Services, the Office of Compliance and Training, or the Office of General Counsel and Employment Policy Relations.

## Sexual Harassment Policy

It is the continuing objective of the university to offer a work and study environment to its employees and students that rewards career and educational goals based upon relevant factors such as ability and work performance. Sexual harassment of employees and students is unacceptable. It is a barrier to educational and professional development and contrary to law and university policy.

In accordance with the NJIT Sexual Harassment Policy and Procedures, persons found to have violated university policy will face investigation, managerial review and possible disciplinary action up to and including employment termination and or dismissal from the university (for students). For a full copy of the university's policy prohibiting sexual harassment, please contact the Office of General Counsel and/or the Office of Compliance and Training.

## Copyright Ownership

NJIT believes its role as an educational institution is best served by disclosing to the public all academic research, projects, theses and dissertations developed by students during the course of their studies or employment at the university.

Projects, theses and dissertations created by students shall be governed by the following provisions as outlined in NJIT's copyright policy under "Ownership and Disposition of Copyrightable Materials":

**A.** Copyright ownership of projects, theses and dissertations generated by research that is performed in whole or in part by the student with financial support in the form of wages, salaries, stipend, or grant from funds administered by the University shall be determined in accordance with the terms of the support agreement, or in the absence of such terms, shall become the property of the University.

**B.** Copyright ownership of projects, theses and dissertations generated by research performed in whole or in part utilizing equipment or facilities provided to the University under conditions that impose copyright restriction shall be determined in accordance with such restrictions.

**C.** Copyright in projects, theses and dissertations not within the provisions of Categories A and B of this policy shall be the property of the author. However, the student must, as a condition of a degree award, grant royalty-free permission to the University to reproduce and publicly distribute copies of the project, thesis or dissertation.

Requests for permission to publish Category A and B should be addressed to the Office of Intellectual Property.

For further information, call the Office of Intellectual Property, (973) 596-5825.

## Ownership of Intellectual Property

In accordance with university policy, NJIT retains all right, title and interest to any and all intellectual property (i.e., inventions, discoveries, creative works, trade secrets and know-how) developed by NJIT students during the course of their studies or employment at the university or while using university facilities.

To protect against premature disclosure of an invention and/or publication of anything that may be of a proprietary nature, students must immediately report their intent to do so to the **Office of Technology Development**. Students must neither publish nor discuss proprietary information with anyone other than the Office of Technology Development or members of the University's Intellectual Property Committee. When a project, thesis or dissertation covers material that is potentially proprietary, both the student and the advisor must report the existence of such material to the Office of Graduate Studies and the Office of Technology Development; so that the University may expedite its review of such material and determine whether or not it is proprietary and should be protected under the University's guidelines for protecting its Intellectual Property. If necessary, the Office of Graduate Studies and the Office of Technology Development will take steps to sequester patentable material in archival documents such as theses and dissertations. If the University applies for a patent, the student will sign an appropriate assignment agreement. All income derived from such intellectual property will be shared between NJIT and the student in accordance with the University's published policy (see http://www.njit.edu/research/officetech/inventors/inventors.php).

For further information, call the Office of Intellectual Property, (973) 596-5825.

## Property Loss and Damage

NJIT is not responsible for loss of property by fire or theft in its buildings or grounds. NJIT is not responsible for property damaged as the result of vandalism in its buildings or grounds.

## Drug Abuse Prevention Program

New Jersey Institute of Technology prohibits the use of illegal drugs on its premises. University policy concerning possession and consumption of alcoholic beverages on campus subscribes to strict enforcement of the laws of the State of New Jersey, the County of Essex and the City of Newark. In addition, the policy stipulates that any consumption must occur within a responsible social framework wherein beverages are not the focus of the event.

Students with drug and alcohol abuse problems should be aware that they can receive information, counseling and referral assistance from the Office of the Dean of Student Services, the Counseling Center, the Health Services Office, or the Stop-In Center. The professional staff of the Counseling Center can provide substance abuse counseling and assessment in some situations and will refer more serious problems to off-campus facilities and services.

In addition, the university, through the Division of Student Services, offers a series of educational programs focused on the areas of drug and alcohol information and substance abuse prevention.

## Drug-Free Workplace Policy

Student employees are subject to university policies regarding employment. New Jersey Institute of Technology is committed to maintaining a drug-free workplace in compliance with applicable laws. The university is further committed both to rigorous enforcement of applicable laws and policies and to support for those trying to cope with drug-related problems. The unlawful possession, use, distribution, dispensation, sale, or manufacture of controlled substances is prohibited on university premises. Any NJIT employee determined to have violated this policy or engaged in drug-related problems that have an impact upon the workplace may be subject to disciplinary action up to and including termination. At the discretion of the university, any employee convicted of a drug offense involving the workplace shall be subject to employee discipline (up to and including termination) and/or required to satisfactorily complete a drug rehabilitation program as a condition of continued employment.

The illegal use of controlled substances can seriously injure the health of employees, adversely affect the performance of their responsibilities, and endanger the safety and well-being of fellow employees, students, and members of the general public. Therefore, the university urges employees engaged in the illegal use of controlled substances to seek professional advice and treatment. Anyone who is employed at NJIT who has a drug problem is encouraged to contact the Director of the Employee Assistance Program (EAP), who will assist in obtaining available treatment. Employees engaged in contracts with the U.S. Department of Defense are additionally subject to Department of Defense requirements and may be required to submit to tests for the illegal use of controlled substances.

As a condition of employment, an employee of NJIT will notify his/her supervisor if he or she is convicted of a criminal drug offense involving the workplace within five days of the conviction. In the event any such conviction involves an employee working on a federal contract or grant, the university will notify the granting or contracting federal agency within 10 days of receiving notice of a conviction. A copy of this statement shall be given to all employees.

This statement and its requirements are promulgated in accordance with the requirements of the Drug-Free Workplace Act of 1988 enacted by the United States Congress. The university will continue its efforts to maintain a drug-free environment by adhering to the above policy and by providing through the EAP and the offices of Human Resources, and Compliance and Training, ongoing drug awareness programs.

# Admissions and Financial Support

If you're looking for an edge, start by enrolling in one of our undergraduate, graduate or continuing education programs and becoming an active participant in the NJIT experience.

Find out what sets NJIT apart (http://www.njit.edu/admissions/whatssospecial) from other schools and what's new on campus and in the classroom. As a public university, our tuition and fees -- combined with a generous financial assistance (http://www5.njit.edu/financialaid) (undergraduate and graduate) program -- put the edge within your reach.

NJIT awards funding to a select number of qualified full time Ph.D. students in the form of teaching and research assistantships. It also provides fellowships to a limited number of Master's and PhD students. For more information: http://www5.njit.edu/graduatestudies/finaid.php

# Admissions

Every application for admission is processed through the Office of University Admissions and is reviewed by the Graduate Admissions Committee. Candidates are notified of their admission status by mail. Admission decisions cannot be communicated by telephone, e-mail, fax, in-person, or to third parties. For admissions information contact:

- **Office of University Admissions**
- New Jersey Institute of Technology
- University Heights
- Newark, NJ 07102-1982
- (973) 596-3300, fax (973) 596-3461, e-mail: admissions@njit.edu

For an online application for admission go to www.njit.edu/admissions/apply-online.php (http://www.njit.edu/admissions/apply-online.php)

## Test Requirements

### Graduate Record Examinations (GRE)

The GRE (general test) is required of all applicants to doctoral programs, all applicants seeking financial support, and all applicants whose most recent degree was awarded from an institution outside of the United States.

Specific master's programs: applied physics, architecture, biology, infrastructure planning, materials science and full-time applicants to engineering programs require all applicants to submit official GRE scores.

The GRE can be used to fulfill test requirements for the master's programs in information systems and in public health. The GRE is highly recommended for all other programs.

For further information about taking the GRE, contact: Educational Testing Service, P.O. Box 6000, Princeton, NJ, 08541; phone (609) 771-7670, 8 a.m. to 8:45 p.m.; www.gre.org (http://www.gre.org)

### Graduate Management Admission Test (GMAT)

The GMAT is required for all applicants for the MBA in Management of Technology and the MS in Management programs. Students with significant business experience who are seeking admission into the MS in Management program may apply for a GMAT waiver. For additional information, contact the graduate admissions office at (973) 596-6378. The GMAT also can be used to fulfill test requirements for the master's programs in information systems and in public health.

For further information about taking the GMAT, contact: Educational Testing Service, P.O. Box 592, Princeton, NJ, 08541; phone (609) 771-7330, 8 a.m. to 8:45 p.m.; or www.gmat.org (http://www.gmat.org)

## Law School Admission Test (LSAT)

The LSAT can be used to fulfill test requirements for the master's program in public health.

For further information about taking the LSAT, contact: Law School Admission Council, (215) 968-1001 or www.lsac.org (http://www.lsac.org)

## Medical College Admission Test (MCAT)

The MCAT can be used to fulfill test requirements for the master's programs in information systems and in public health.

For further information about taking the MCAT, contact: Association of American Medical Colleges, (202) 828-0600 or https://www.aamc.org/students (https://www.aamc.org/students)/ (https://www.aamc.org/students) For registration materials, contact: MCAT Program Office, P.O. Box 4056, Iowa City, Iowa, 52243; or phone (319) 337-1357.

## Test of English as a Foreign Language (TOEFL)

All international applicants must show a TOEFL score of at least 550 (paper-based); 213 (computer-based); 79 (internet-based).

For further information about taking the TOEFL, contact: TOEFL/TSE Services, P.O. Box 6151, Princeton, NJ 08541; phone (609) 771-7100 Monday--Friday, between 8 a.m. and 9:45 p.m. and Saturday, between 9 a.m. and 4:45 p.m. New York time, for recorded information or personal assistance; or see www.toefl.org (http://www.toefl.org).

## International English Language System (IELTS)

International applicants may submit results from the IELTS exam in lieu of the TOEFL.  The minimum score is 6.5 with no sub-score lower than 6.0.

For further information about taking the IELTS, contact IELTS; www.ielts.org (http://www.ielts.org).

# Master's Degree Programs

Master's degree programs provide advanced education needed by professionals in an era of rapidly expanding technology and normally require more specialization in the academic discipline of the student's bachelor's degree.

Applicants for admission to graduate study must have completed an undergraduate program accredited in the United States or its equivalent and demonstrate superior academic achievement in an appropriate discipline. Students are expected to have placed in the top half of their graduating class and program and to have achieved a cumulative GPA no lower than 2.8 on a 4.0 scale. Individual departments may impose requirements that are more stringent. Applicants with undergraduate degrees in engineering technology must have ranked in the top quarter of their class and have a cumulative GPA of at least 3.0.

All applicants should submit supplementary evidence of their potential for successful graduate work. Letters of recommendation, GRE or GMAT scores, a publications record, prior research experience, a record of exceptional career development, a statement of the applicant's objectives, interests and professional experience are examples of appropriate supplementary evidence.

## Bridge Program

Students who seek a master's degree in an academic discipline different from that of the bachelor's degree may be admitted to a master's degree program but may be required to complete appropriate undergraduate and/or graduate prerequisites in addition to the normal graduate degree requirements of the program. The program of courses will be individually designed in consultation with their graduate advisor. Bridge courses must be completed before 9 credits of graduate degree courses are earned. Bridge courses are not counted as degree credits but do count in graduate GPA calculations if the course is numbered 500 (500G for Architecture) or higher.

## Admissions Procedures for Master's Study

An Application for Admission to Graduate Study form may be obtained from the Office of University Admissions or submitted via online at www.njit.edu/admissions/apply-online.php (http://www.njit.edu/admissions/apply-online.php). A non-refundable application fee of $75 must accompany the application. Applications may be deferred for one semester for a delay in admission without incurring another $75 fee. Official transcripts from all colleges and universities previously attended are required. To be accepted as official, transcripts must be sent directly to the Office of University Admissions by the institutions concerned. Applications for fall (September) admission must be received by June 1; for spring (January) admission by November 1. Applications for financial support for fall (September) must be received by December 15. Applications for financial support for spring (January) must be received by October 15. Supporting documents must also reach the Office of University Admissions by the above dates. Incomplete applications or applications received after these dates will normally be processed for the following semester.

## Program Transfers

Students who wish to transfer from one master's degree program at NJIT to another at NJIT must complete the Change of Program Form and submit to the Office of Graduate Studies. Courses taken in one program are not necessarily transferable to another, nor may credits be applied to more than one degree, except as provided by the M.S./M.S. program. Students admitted to one degree program are normally required to be in the original program for one full year before admission and enrollment in another degree program.

## Joint Master's Degrees with Other Universities

The university cooperates with Rutgers-Newark and with Rutgers Biomedical and Health Sciences in unique offerings of joint master's programs. Specific information about application and admission requirements for each is provided in the degree program descriptions located in the Degree Program section of this catalog. Programs that lead to joint master's degrees are applied physics, biology, computational biology, environmental science, and history with Rutgers-Newark and public health with Rutgers-Newark and RBHS.There is also a dual degree program in which a student may simultaneously earn a masters degree in Infrastructure Planning from NJIT and in City and Regional Planning from Rutgers-New Brunswick.

# Doctoral Programs

New Jersey Institute of Technology offers doctoral programs to fill society's need for creative research scientists and engineers.

## Admissions Requirements for Doctoral Study

Applicants are required to have an appropriate academic background as described by the individual degree programs, which are located in the Degree Programs section of this catalog, and a GPA of at least 3.5 on a 4.0 scale in prior study. GRE scores are required for admission to all doctoral programs. Individual programs may establish additional or more stringent requirements.

An applicant who wishes to pursue a doctoral degree in a field different from that of previous study, and who is otherwise qualified, may establish eligibility by satisfactorily completing a program of study recommended by the department in which they seek admission.

Applicants who wish to complete a master's degree while pursuing a doctorate must apply for admission to the master's program. This requires the approval of the doctoral program and dean of graduate studies, and where permitted, generally occurs only at or near the completion of the doctoral program.

Mid-career scientists and engineers interested in part-time study may wish to consider the collaborative doctorate option described in the Graduate Studies section of this catalog.

## Admissions Procedures for Doctoral Study

Admissions procedures are the same as for a master's degree. In addition, three letters of recommendation are required from individuals who can best judge the applicant's ability to pursue independent research and complete a doctoral program.

## Joint Doctoral Degrees with Other Universities

NJIT cooperates with other universities in Newark in operating and developing doctoral programs of mutual interest.

The university participates in unique offerings of joint doctoral programs with Rutgers-Newark and RBHS. Students may apply and be admitted through either university. Programs that lead to joint degrees are applied physics, biology, environmental science and mathematical sciences with Rutgers-Newark, biomedical engineering with RBHS and urban systems with both Rutgers-Newark and RBHS.

NJIT faculty participate in the doctoral program in management offered by Rutgers-Newark. NJIT faculty supervise Rutgers doctoral students in this program. Admissions to the doctoral program in management is handled by Rutgers-Newark.

# Admission Classifications

## Degree (Matriculated Students)

### Regular Admission

Applicants who meet NJIT standards and have an appropriate undergraduate academic background for the degree program to which they are seeking admission will be offered regular admission as degree-seeking (matriculated) students.

### Conditional Admission

NJIT expects applicants to have a superior academic record, but recognizes that interest, creativity, maturity, and motivation are also important. Conditional admission to the university may be granted to applicants who do not have the appropriate academic background required for a particular degree program, but who have an academic record that meets NJIT's scholastic standards.

Once granted conditional admission, students must complete conditional or bridge courses specified by the university within their first two semesters. Such courses may be at either the undergraduate or graduate level and are NOT counted as degree credits although all courses numbered 500 (500G for Architecture) or higher are calculated in the cumulative GPA. Students must attain grades specified by the university and are not permitted to take more than 9 credits that count as graduate degree credits at NJIT before meeting the terms of conditional admission. Failure to meet these conditions may result in dismissal from the university.

## Contingent Admission

Students who apply for admission to graduate programs before completing their bachelor's degree, and whose records demonstrate superior academic achievement, may be offered admission to NJIT contingent on their showing proof of receiving a bachelor's degree appropriate for the degree program for which they are seeking admission. Such students must show proof of graduation before being permitted to enroll in a graduate program.

## Change of Program

Students are admitted to one graduate degree program and not to the university as a whole. Students who wish to change major on arrival at NJIT must file an application for the new program and must generally remain in the original program for one full year before the application is approved. There is no guarantee or requirement that the new application will be successful. Those on support are liable to loss of support from the original department and cancellation of a current award.

## Change of Level

Students who wish to change current degree level must file an application for admission to the new degree level. There is no requirement or guarantee that the application will be successful. Students who wish to drop down to a master's program from a doctoral program should be aware of the impact of this action on current and future financial support. Students who wish to raise their level from a master's to a doctoral program should be aware of any impact on incomplete master's theses or projects.

# Non-Degree (Non-Matriculated Students)

Students who wish to take graduate courses without seeking a degree (non-matriculated status) should contact the Office of University Admissions for a Non-Degree Application Form.

Non-matriculated students may be permitted to take a maximum of 9 graduate-level credits accumulated over three registration periods, except students seeking a graduate certificate. These students may take a maximum of 12 graduate-level credits accumulated over four registration periods. Students wishing to take credits beyond these limits must apply and be accepted to a degree program as a matriculated student.

Academically qualified students who do not desire to enter degree programs may enroll in certain individual graduate courses. Such students must present transcripts of previous academic work or other appropriate evidence at each registration in order to indicate adequate preparation for the course work involved. If approved by the Office of University Admissions, registration will be permitted if space is available. Permission to enroll as a non-matriculated student does not imply eventual admission to a degree program.

## Graduate Certificate Programs

NJIT offers designated courses in concentrated areas for students wishing to obtain a graduate certificate in specific areas. These require completion of 12 NJIT credits at the graduate level. Students in these programs are generally non-matriculated students for the duration of the certificate program. Graduate certificate programs may also be completed during a matriculated graduate program by making use of degree credits. Students in a matriculated degree program are not permitted to receive a certificate until completion of the degree program. Only one certificate can be earned within the credits applied toward a master's degree.

## Students Matriculated at Other Universities

Graduate degree students at other colleges or universities may take courses for credit at NJIT for transfer back to their home institution. In addition to satisfying the course prerequisites, students must furnish a letter of approval from an appropriate administrative officer of their home institution.

## NJIT Undergraduates

NJIT undergraduates may register for graduate courses, 500- or 600-level, with written approval from both their undergraduate advisor and from the graduate advisor in the department in which the course is taught. NJIT students in the BS/MS program are required to take 6 graduate-level credits while undergraduates to satisfy BS/MS program requirements.

## Rejected Applicants

Students whose application for admission to a degree program is unsuccessful are not permitted to register as non-matriculated students.

## International Students

International students on F-1 and J-1 visas are not permitted to register as non-matriculated students. Students on other visas should consult the Office of University Admissions regarding non-matriculated status.

## Auditors

Students who wish to attend courses for which they are qualified, but who do not wish to be graded in the course, may be permitted to enroll as auditors. Registration will be approved only after a review of credentials by the Office of University Admissions and only if space is available. A notation signifying that the course was audited will be made on the student's record, but no credit will be granted for the course. Students who wish to audit a course must state their intention at the time of registration. A change to, or from, auditor status is not permitted once a semester has begun. Students who audit a course are required to pay full tuition and fees. There is no tuition remission allowable for audited courses. Audited courses cannot be counted in determining full-time status.

## Transfer Students

Students enrolled in graduate programs at other institutions may apply for transfer to NJIT by completing the normal admission procedure. Transfer students may apply for credit for courses taken at other U.S. educational institutions by following procedures outlined in "Transfer of Credits from Outside NJIT" in the Academic Policies and Procedures section of this catalog. In addition, international students wishing to transfer from other educational institutions in the United States must:

- Demonstrate a cumulative GPA of at least 3.0 in graduate courses taken at other U.S. educational institutions;
- Complete the required immigration procedures for transfer; and
- Be eligible for admission to the NJIT program of their choice.

To transfer to NJIT from an other institution in the U.S., international students must already have been placed into SEVIS, The Student and Exchange Visitor Information System. NJIT will ask the "leaving institution" to verify the student's current standing in F-1 or J-1 status under immigration regulations. All financial and academic requirements must be completed before admission will be granted and the I-20 or DS-2019 issued.

## International Students and TOEFL

New Jersey Institute of Technology welcomes applications from international students with records of superior academic achievement. In addition to the procedures stated below, international students are required to provide evidence of English language proficiency by submitting either the Test of English as a Foreign Language (TOEFL) or the International English Language System (IELTS) scores

For further information about taking the TOEFL, contact: TOEFL/TSE Services, P.O. Box 6151, Princeton, NJ 08541; (609) 771-7100 Monday-Friday, between 8 a.m. and 8:00 p.m. New York time, for recorded information or personal assistance; or see www.toefl.org (http://www.toefl.org).

For further information about taking the IELTS, contact IELTS; www.ielts.org (http://www.ielts.org).

Students with TOEFL scores of 550 (Paper-based); 213 (Computer-based); 79 (Internet-based); 6.5 (IELTS) or better are not required to take an ESL course but are encouraged to improve their English-language skills by doing so voluntarily.

All ESL courses are graded on an S/U (Satisfactory/Unsatisfactory) basis. The course credits count towards the 9 credits required for full-time status; however, the credits do not count toward degree credits.

### International Students Who Seek Financial Support

Those seeking financial support from NJIT at the time of admission will be required to achieve a TOEFL score of at least 550 (Paper-based ); 213 (Computer-based); 79 (Internet-based). Students who may be offered Teaching Assistant or similar positions are required to be tested for spoken English proficiency in advance of classroom or laboratory placement. The test is offered at NJIT after admission. New international students offered TA or similar awards must also participate in the teaching assistant training program offered by ESL staff in advance of the first semester (usually in August.)  All new TAs must register for ENG 599 in their first TA assigned semester.

## International Student Financial Statement

In accordance with Department of Homeland Security, Bureau of Citizenship and Immigration Services requirements, international students must also submit to the Office of University Admissions an International Student Financial Statement to demonstrate financial resources sufficient to meet the academic and living costs of their anticipated stay at the university. International students should note that they will be required to pay non-resident tuition rates. Immigration papers (e.g., I-20, DS-2019) will NOT be issued until the International Student Financial Statement is on file with the Office of University Admissions.

### Academic Credential Equivalents for International Students

Undergraduate degrees must be equivalent to the typical four-year program in the United States. NJIT is working with a number of countries and universities to provide a transition from two- and three-year degree programs to baccalaureate and later graduate study. To be eligible for admission to graduate study at NJIT, international students must have the following minimum academic qualifications.

| | |
|---|---|
| Argentina | Licenciatura |
| Bahamas | Honors bachelor's degree |
| Barbados | Honors bachelor's degree |
| Bolivia | Licenciatura |
| Brazil | Bacharel or Licenciado |
| Canada | Honors bachelor's degree or equivalent |
| Chile | Bachillarato, Licenciatura? or Titulo of at least four-year duration |
| People's Republic of China | Bachelor's degree |

| | |
|---|---|
| Colombia | Licenciatura or Titulo |
| Dominican Republic | Licenciatura of at least four-year duration |
| Ecuador | Licenciatura or Titulo |
| Egypt | Bachelor's degree |
| El Salvador | Licenciatura |
| France | Maitrise or equivalent |
| Germany | Ptychion |
| Guatemala | Licenciatura |
| Haiti | Diplome d"EtudesSuperieures or Licence of at least four-year duration |
| Honduras | Licenciatura of at least four-year duration |
| Hong Kong | Honors bachelor's degree |
| India | Bachelor's degree(first class) in Engineering or Architecture, master's degree in other? |
| Indonesia | Sarjana or Insinyur |
| Iraq | Bachelor's degree |
| Israel | Bachelor's degree |
| Italy | Laurea |
| Jamaica | Honors bachelor's degree |
| Japan | Bachelor's degree |
| Jordan | Bachelor's degree |
| Korea | Bachelor's degree (Taehak Taehakkyo) |
| Kuwait | Bachelor's degree |
| Lebanon | Bachelor's degree, Licence of at least four-year duration, or Maitrise |
| Libya | Bachelor's degree |
| Malaysia | Bachelor's degree |
| Mexico | Licenciatura of at least four-year duration |
| Morocco | Licence or Ingenieur d'Etat |
| Netherlands | Doctorandus, Ingenieur or Meester |
| Nicaragua | Licenciatura |
| Nigeria | Honors bachelor's degree |
| Norway | Cand. Mag |
| Pakisthan | Bachelor's degree in engineering or other four-year bachelor's degree or master's degree |
| Panama | Licenciatura |
| Paraguay | Licenciatura? of at least four-year duration |
| Peru | Bachillerato, Licenciatura or Professor from four-year university program |
| Philippines | Bachelor's degree |
| Saudi Arabia | Bachelor's degree |
| Singapore | Honors bachelor's degree |
| Sweden | Filsofie Kandidatexamen or Ekonoexamen |
| Switzerland | Licence or Diplom of at least a four-year duration |
| Syria | Lisentiate or bachelor's degree |
| Rep. of China | Bachelor's degree |
| Thailand | Bachelor's degree |
| Trinidad and Tobago | Honors bachelor's degree |
| Turkey | Lisans or Bachelor's degree |
| United Kingdom | Honors bachelor's degree |
| Uruguay | Licenciatura of at least four-year duration |
| Venezuela | Licenciatura or equivalent |

Students from countries whose universities do not provide transcripts, or who experience exceptional difficulty in obtaining transcripts, should contact the Office of University Admissions for special instructions. Students whose credentials cannot be evaluated by the Graduate Admissions Committee will be required to submit a Credential Evaluation Report from an approved agency. For further information, contact World Education Service, Inc., Old Chelsea Station, P.O. Box 745, New York, NY 10113-0745, (212) 966-6311; e-mail: info@wes.org

# Financial Support

## Financial Support and Graduate Awards

Various financial support and graduate award options are available to NJIT graduate students. Financial support comes from either NJIT internal funds or from external sources. Information on need-based support is detailed on the office of **Financial Aid Services Web site**. Eligibility and selection criteria are summarized in the following table for both need-based and merit-based support. Funds for these are not guaranteed.

| Type of Support | Contact | Who is Eligible |
|---|---|---|
| Federal Loans | Financial Aid 973-596-3479 | US citizens, permanent residents; students enrolled at least half time, based on financial need; must file the Free Application for Federal Student Aid. |
| Private Loans | Financial Aid 973-596-3479 | US citizens, permanent and non-resident students enrolled at 3 credits; need is not a factor and filing a Free Application for Federal Student Aid (FAFSA) is not a requirement. |
| Industry Co-op | Career Development Services 973-596-3100 | Full-time students, based on position availability; master's students; doctoral students only by exception with approval by the associate provost of graduate studies |
| Work-study | Financial Aid 973-596-3479 | US citizens, permanent residents, international students, full-time and part-time students, based on position availability. |
| Scholarships, Fellowships, Grants | Graduate Studies 973-596-3462 | Based on funding source, full-time students, often supporting under-represented groups. |
| Assistantships | Graduate Studies 973-596-3462 | Full-time, based on academic merit or priorities and on funds available. |

## NJIT Awards

Close to 400 teaching, research and graduate assistantships, based on academic merit, are awarded to qualified full-time students.

Prospective students can apply for financial support by using the Application for Admission to Graduate Study. Prospective students seeking financial support are urged to apply no later than December 15th for the fall semester of the following academic year and October 15th for the spring semester of the current academic year.

Prospective students seeking financial support should indicate their interest on the admissions application form. Continuing students seeking need-based support should contact the Office of Financial Aid. Continuing students seeking merit-based financial support should contact the Office of Graduate Studies. GRE or GMAT scores are required of all applicants to doctoral programs, all applicants seeking financial support, and all applicants whose most recent degree was awarded from an institution outside of the United States. Some specific master’s programs require them as well.Check the Admissions web site for updated information.

Competition for financial support is strong and only successful applicants are notified. Teaching, research, and graduate assistantship offers may include full or partial tuition, a stipend or both. Additional funds for the summer may be awarded.

## Assistantships

Each year there are more than 400 teaching and research assistantships in academic and research departments, which are funded internally or externally. Teaching assistants conduct recitation, grading, discussion, laboratory, or provide other type of course support under the supervision of permanent faculty. These duties are considered part-time work equivalent to twenty hours per week. Research assistants conduct research under the supervision of NJIT faculty. Non-academic departments also sometimes employ students as graduate assistants. Duties range from academic support to day-to-day operation of administrative offices.

## Provost Fellows

A limited number of fellowships with very competitive stipends and full tuition and fee support are offered to outstanding doctoral students.

## Grader

A grader is appointed for part-time service and grades course work under the direction and supervision of a faculty member. Graders are normally hired on an hourly basis. Compensation is based on hourly rates established for this position.

## Special Awards

Special awards for service may be established each year. Students should contact the Office of Graduate Studies for further information.

## Non-Service Fellowships or Scholarships

The Office of Graduate Studies may be contacted for the availability of private, state, federal or foundation awards that do not require service to NJIT.

## Unemployed or Displaced Workers

Students receiving tuition support because of an unemployed or displaced worker's program are alerted to potential loss of this form of support because of any salary or stipend that may be received for any form of on-campus or off-campus employment.

## Stipend Support Levels for Teaching Assistants

These awards are available to doctoral students and normally provide full support.

**Teaching Assistant** (not supported by grants):

| | | |
|---|---|---|
| Doctoral students | $ 20,000 | 9 months at $2,222/month |

Stipend support levels are re-evaluated each year and the levels reported above are minimum values for 20 hours per week of service for 9 months over the fall and spring semesters.

**Research Assistants** (on external funds from grants minimum award level)

| | |
|---|---|
| Doctoral Students | $26,000 (12 months) |

Partial awards are possible from grants. Award periods are scheduled for two consecutive 4 and ½ month periods for 9 month awards and any following summer periods

## Maximum Annual Support

While NJIT does allow multiple sources of support for individual students, there is an annual limit established each year for the maximum amount of support that an individual student may receive from all sources. The limit is established at a reasonably high and competitive level in comparison to reported maxima provided by a number of federal support programs. Students who are receiving support from outside NJIT must report this to their graduate program advisor and to the Graduate Studies Office to assure their not exceeding NJIT limits. Total support that would be in excess of the NJIT limit may require an adjustment in the support provided by NJIT sources. Excess support can also negatively impact need-based support arrangements.

## Summer Support

Depending on availability of funds, students may be eligible for stipends and tuition support for June, July and August. NJIT has two summer award periods, the first covering late May and June, the second covering July and most of August. The split of summer award periods is based on the combination of the semester-based academic calendar used at NJIT and the changeover to a new fiscal year on July 1. Interested students should consult their faculty advisors in March or April.

## International Students

Private loans are available through the Office of Financial Aid. These loans require a cosigner who is a U.S. citizen or permanent resident alien.To learn more, go to: http://www5.njit.edu/financialaid/typesofaid/educationloans/privateloans.php.

International students may not receive NJIT support or be employed on-campus during periods of practical training. International students must be in status with the United States Citizenship and Immigration Services (USCIS). International students are eligible only for merit-based NJIT financial support and not for need-based state or federal finds.

USCIS regulations require that international students attest to having funds sufficient to cover the expense of the entire course of study before they will grant a visa. Students are expected to demonstrate the availability of funds for the duration of studies at NJIT as a requirement for admission to the university.

# Government-Funded Support for Graduate Studies

## NSF and NRC Programs

The National Science Foundation (NSF) and the National Research Council (NRC) support doctoral stipends and tuition in a very competitive process. Application deadlines for these programs are one year in advance of anticipated study, usually in early fall. Visit the Office of Graduate Studies (http://www5.njit.edu/graduatestudies) website for information on these and other federal programs. NJIT participates in regional consortia for the Bridges to the Doctorate and Alliance for Graduate Education for the Professorate supported by the NSF.

## GEM

The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. supports graduate students within an industry and academe-based consortium. Contact the Office of Graduate Studies (http://www5.njit.edu/graduatestudies) for information on this and other industry programs.

## Federal Direct and Work-Study Programs

US citizens and permanent residents are eligible to apply for federal loans through the William D. Ford Federal Direct Loan and for federal work-study. To obtain a Federal Direct Loan, eligible applicants must file the Free Application for Federal Student Aid (FAFSA) with the Federal Student Aid Programs Processing Center. To be considered for federal work-study, eligible students must file the FAFSA no later than the March $15^{th}$ priority deadline. The amount of graduate tuition remission a student receives is considered when determining eligibility for loans and work-study. Before loans are disbursed, students must sign a promissory note and complete entrance counseling at studentloans.gov (https://studentloans.gov/myDirectLoan/index.action). The FAFSA is available at www.fafsa.gov (https://fafsa.ed.gov).

For further information, contact the **Office of Financial Aid** at finaid@njit.edu or (973) 596-3479.

# Terms and Conditions of Awards

## Award Selection

All NJIT awards are merit-based and are offered only to academically superior students who meet all selection requirements. Many things are considered in evaluating applications and nominations for NJIT awards. Among these are GPAs, GRE and GMAT scores, undergraduate and graduate academic performance, educational preparation, TOEFL scores for international students, skill and talent required for available positions, institutional priorities, availability of funds, special skills, and prior experience.

Students must take the GRE or GMAT and arrange to have official score reports to be sent to NJIT before they may become eligible to receive awards. Although there is no minimum eligibility score for the GRE or GMAT, NJIT may establish them for certain awards.

Graduate students who have not already received awards or had not been offered an award on admission must attain a minimum GPA of 3.5 for first-time support from internal funds and 3.0 for first-time support from external funds. Any graduate or undergraduate course taken by a student in graduate studies at NJIT is counted in the GPA (as calculated by the Office of Financial Aid Services) for evaluating selection criteria, including courses that were repeated or excluded. GPAs are checked at the beginning of each support period to verify that awards are warranted. GPAs only establish eligibility and neither guarantee nor entitle students to receive financial support.

The Office of Graduate Studies evaluates criteria for support from internal funds each year. The criteria reflect both average grade point performance levels and availability of funds. A student who has received support from NJIT funds for one degree cannot receive NJIT support for another degree of the same or lower level or type. Criteria and full details of terms and conditions of awards are available from the Office of Graduate Studies.

Need-based support programs administered by the Office of Financial Aid and by the Office of Student Employment have different criteria for selection. These offices should be consulted for further information. Funds distributed for hourly employment through the Office of Student Employment are not considered awards.

## Service-Based Awards

A service-based award is one in which the student is required to perform a service in return for a stipend. The following awards are service-based: graduate assistants, teaching assistants, research assistants, provost fellows, teaching fellows, graders, and others as noted.

## Terms and Conditions

By accepting an award, students agree to comply with the following terms and conditions unless exceptions are indicated in their award offer letter:

- Students are required to work, up to a maximum of 20 hours per week, for Fall and Spring semester awards. Students are therefore required to work during semester breaks, either for their supervisor or, with the consent of the supervisor, on their own research.
- Students not receiving the maximum award for their award category and degree status are required to work a prorated number of hours (less than 20) based on a comparison of their award to the stipend level allowed for that award. A maximum of 35 hours per week, with appropriate increase in support level, may be permitted for service during the two summer award periods.

- Full-time registration in one of NJIT's graduate degree programs must be maintained at all times throughout the period of an award. Full-time status is accorded to those who complete at least 9 credits per semester, or to those who are certified by the Office of Graduate Studies or designated as full-time students. Students should review "Refunds for Withdrawal" and "Enrollment Status" in the Tuition and Fees section and the Academic Policies and Procedures section respectively in this catalog to be assured that they are following full-time certification requirements.
- Students who initially register for a full-time load but withdraw during a semester and thus become part-time cannot receive tuition remission for that semester and may have their tuition award terminated and stipend award curtailed.
- No other work for compensation, whether on- or off-campus, may be undertaken during the period of the award unless approved by the Associate Provost for Graduate Studies. Students who do not comply with this requirement may be prohibited from receiving future support and have their current award terminated.
- Unsatisfactory performance, inadequate academic progress, or violation of any of the terms and conditions shall constitute grounds for the immediate cancellation of an award.
- Award offers must be accepted in writing, on an appropriate form, and must be received by the date indicated in the award offer.
- Students who resign, or are dismissed from an appointment during a semester, must repay any tuition remitted for that semester.
- Students must report to their supervisor no later than the first day of each semester. Students who fail to do so will be deemed to have resigned and will have their award cancelled.
- Appointments are made for the period specified in the award offer. Neither renewal nor summer support can be guaranteed.
- Support based on external grant, contract, scholarship or fellowship awards are subject to the limitations established by the external agency.
- Students may not receive an award from NJIT funds to pursue a second master's degree or second doctoral degree when the first degree has been earned at NJIT.
- Students who change to a master's degree program from a doctoral program will have the current award cancelled and no future awards will be permitted. Students who register in courses inappropriate to their program of record or unapproved by their advisor will have the award immediately terminated.

## Tuition Remission Awards

Tuition support has no service condition associated with it. Students accepting this support must not leave the program for which the support is offered without the approval of the support sponsor and the Associate Provost for Graduate Studies. Approval will be granted only for sound academic or other compelling reasons. Departure to accept employment is not considered a valid reason. All tuition support provided will be re-billed to the student if this condition is violated.

## Cancellation of Tuition Remission

NJIT reserves the right to cancel tuition remission awards when students do not meet requirements or violate the conditions of an award. NJIT also reserves the right to cancel tuition remission for ineligible courses or courses for which the grades of F, U, W, or I are received. Audited courses, courses outside the approved courses for the program, and excess courses not needed for program completion are ineligible for tuition remission. If tuition remission is cancelled, students are re-billed accordingly and are responsible for payment in full.

## Sick Leave

Students receiving awards are entitled to a total of three paid days of sick leave during the academic year. Additional days of sick leave may result in the cancellation of an award or a reduction in a stipend.

## Unsatisfactory Performance for Service Awards

A student's performance is considered unsatisfactory if it does not meet the criteria set by the award supervisor.

## Criteria for Maintaining Award

Students must earn at least a 3.0 GPA each semester, as well as maintain a cumulative GPA of 3.0 to keep receiving their awards. A 3.0 GPA will also maintain awards that initially required higher GPAs to receive them. Any graduate or undergraduate course taken by a graduate student is counted in the GPA for evaluating maintenance of awards and even includes courses that were repeated or excluded. Except for the specified period of the award offer, these criteria neither guarantee nor entitle students to receive continued financial support. Departments may set higher but reasonable standards (typically 3.5 or above cumulative GPA) for continuation of awards.

## Effect of Incomplete Grades and Grade Changes

Students whose transcripts show incomplete (I) grades in the semester before being selected or becoming eligible for an award must resolve them within the four weeks after grades are posted. This also applies to changes in grades that would affect eligibility.

Extension of the deadline to beyond the fourth week of the semester will be considered if the student and the instructor provide written justification. Otherwise, any award offer for that semester will be withdrawn and tuition remission cancelled. Students will be billed for tuition accordingly and will be responsible for payment in full.

## Award Duration and Renewal

Student eligibility for awards is evaluated each semester. Student performance is evaluated at least once a year for renewal of award offers. However, each award may have unique eligibility, funding, duration and renewal circumstances. Students are responsible for understanding and following the terms and conditions of the particular award offer made to them. The Office of Graduate Studies should be consulted to determine individual terms and conditions. Award duration is based on calendar time, not on whether awards are full or partial.

- Students enrolled in master of science or masters of arts programs may not receive NJIT-funded, full or partial, assistantship or fellowship support for more than one academic year except in the cases listed below for B.S./M.S. students, and for U.S. nationals and permanent residents who are members of underrepresented groups. The academic year is defined as two semesters and one summer. The summer includes two award periods.
- Students enrolled in doctoral degree programs may not receive NJIT-funded, full or partial, assistantship or fellowship support for more than four academic years. This is defined as eight semesters and four summers.
- Students enrolled in the 97-credit Master of Architecture program may not receive NJIT-funded, full or partial assistantship or fellowship support for more than three academic years. Three academic years are defined as six semesters and three summers.
- Students enrolled in the Master in Infrastructure Planning program are considered as master of science students for award duration.
- Full-time master's students in the B.S./M.S. program are eligible to receive three semesters and one summer of financial support from internal funds.
- U.S. nationals and permanent residents enrolled in master of science programs who are members of underrepresented groups are eligible for three semesters and one summer of financial support from internal funds.
- Doctoral students who fail their qualifying examinations may not receive further awards from NJIT funds until they pass. Departments may request a review and continuation of their financial support status if they pass some but not all parts of qualifying examinations.
- When eligibility for NJIT-funded awards is completed, students may receive additional support from external sources. Check with the Office of Graduate Studies to obtain further details.
- Master's students are eligible to receive awards for a maximum of four semesters and two summers from all sources. This does not apply to students in the Master of Architecture program. Doctoral students are eligible to receive awards for a maximum of 10 semesters and 5 summers from all sources.
- No student may receive support for more than 12 semesters and 6 summers from any combination of sources or for any number of degrees.
- The university expects that doctoral students receiving NJIT-funded support move off that type of support to external source support no later than two years after the initiation of NJIT-funded support.

## Resignations

Students who wish to resign from an award should inform their advisor and the Associate Provost for Graduate Studies at least one calendar month before the resignation is to take effect.

Students who resign during a semester will not be eligible for tuition remission for that semester. The semester in which the resignation is received is counted as a supported semester when determining award renewals.

## Taxation of Stipends and Awards

The Internal Revenue Service requires that stipends and awards be taxed at the source, even if students are eligible for a tax refund. All students are exempt from Social Security taxes. Tuition and fee remissions are not subject to tax withholding.

Students should contact the Payroll Office for tax information and information about exemption from Social Security taxes. International students should contact the Payroll Office and the Office of International Students for information on tax treaties.

# Tuition Remission

## Tuition Remission Processing

All students receive bills for tuition. The bill statements for students receiving tuition remission and fees, if applicable, are marked "Possible Tuition Remission." After expiration of the official withdrawal period, a credit for the tuition and fees should appear on the statement.

Students who pay tuition bills in full and then receive tuition remission can expect to receive a refund after expiration of the withdrawal period. Students receiving only partial tuition and fee awards are responsible for payment of the remaining tuition and fees and should pay these promptly. In particular, full-time students should ensure that they have continuous health insurance coverage by payment of appropriate fees. For full award recipients, awards should only cover tuition and eligible fees, and will not exceed the cost of tuition and fees with some exceptions for students on certain fellowships. Eligible fees do not include parking fees or matriculation fee.

Students who fail to pay their bills by the due date specified by the Bursar will be assessed a late penalty fee. For more information, go to njit.edu/bursar (http://www5.njit.edu/bursar).

## Credit Limitation

Awards do not cover tuition for courses that are not part of a student's degree program or courses not approved by their advisor. Students are responsible for payment for these courses.

Tuition remission is allowed for courses taken at other institutions in which there is a cross-registration agreement with NJIT. These courses must be part of the student's degree program and approved by the student's advisor.

A flat rate exists for a range of credits representative of full-time registration. Any credits over that range will not be included in tuition remission awards. Students will be billed for credits in excess of their awards.

## Graduate Cooperative Education

Graduate students have the opportunity to work off-campus while studying full-time through the cooperative education program administered by the Office of Career Development Services (CDS). Policies on eligibility, application for participation, procedures, and required regular and co-op course registrations are defined in a detailed statement developed by the Graduate Studies Office (GSO), CDS, and the Office of International Students (OIS). This opportunity is especially valuable for international students, pursuing the Master's degree, and for some PhD students lacking other forms of support. CDS should be contacted by students interested in this option. Each year, a large number of international graduate students are involved in cooperative education under Curricular Practical Training. Students pursuing this option are required to be registered in specifically numbered graduate courses for co-op as defined in each program's course listing.

# Tuition and Fees

## 2016-2017 Graduate Tuition & Fees

## Tuition and Fees Assessed (per Semester)

### In-State Tuition & Fees

| Credits | Tuition | Fees | Total |
|---|---|---|---|
| 1 | 1034.00 | 165.00 | 1199.00 |
| 1.5 | 1551.00 | 247.50 | 1798.50 |
| 2 | 2068.00 | 330.00 | 2398.00 |
| 3 | 3102.00 | 495.00 | 3597.00 |
| 4 | 4136.00 | 660.00 | 4796.00 |
| 5 | 3170.00 | 825.00 | 5995.00 |
| 6 | 6204.00 | 990.00 | 7194.00 |
| 7 | 7238.00 | 1155.00 | 8393.00 |
| 8 | 8272.00 | 1320.00 | 9592.00 |
| 9 | 9306.00 | 1485.00 | 10791.00 |
| 10 | 10340.00 | 1650.00 | 11990.00 |
| 11 | 11374.00 | 1815.00 | 13189.00 |
| 12-19 | 9504.00 | 1403.00 | 10907.00 |

### Out-of-State Tuition & Fees

| Credits | Tuition | Fees | Total |
|---|---|---|---|
| 1 | 1484.00 | 165.00 | 1649.00 |
| 1.5 | 2226.00 | 247.50 | 2473.50 |
| 2 | 2968.00 | 330.00 | 3298.00 |
| 3 | 4452.00 | 495.00 | 4947.00 |
| 4 | 5936.00 | 660.00 | 6596.00 |
| 5 | 7420.00 | 825.00 | 8245.00 |
| 6 | 8904.00 | 990.00 | 9894.00 |
| 7 | 10388.00 | 1155.00 | 11543.00 |
| 8 | 11872.00 | 1320.00 | 13192.00 |
| 9 | 13356.00 | 1485.00 | 14841.00 |
| 10 | 14840.00 | 1650.00 | 16490.00 |
| 11 | 16324.00 | 1815.00 | 18139.00 |

| | | | |
|---|---|---|---|
| 12-19 | 14046.00 | 1403.00 | 15449.00 |

e-Tuition Program - $1202.00 per credit (applicable to Non-Resident, Graduate students)

Executive Management Program - $57,500.00

Full-time students (9 credits or more) will be assessed a $1338.00 Health Insurance fee in the fall.

**Additional credits** above 19 are assessed at the appropriate per credit rate.

Full-Time status varies:  12 credits for billing purposes, 9 credits for academic and Financial Aid purposes.

The Schedule of Tuition and Fees has been carefully reviewed and has been subject of a public hearing as required by Law prior to the approval by NJIT's Board of Trustees. All fees are mandatory for Full-Time and Part-Time students and are considered non-negotiable.

**Summer / Winter Session Fees**
During the summer & winter sessions there is a flat fee of **$166.00** in lieu of the fees noted above. Full-time Tuition rates do not apply during the summer/winter sessions.

## Additional Fees

| Fee Amount | Fee Description |
|---|---|
| 75.00 | U/G Application/Readmit/N-Matric |
| 120.00 | Commencement Fee |
| 120.00 | Matriculation Fee |
| 500.00 | Late Payment Penalty Fee |
| 100.00 | Late Registration Fee |
| 50.00 | Maintaining Registration Fee |
| 75.00 | Master's Thesis |
| 100.00 | Dissertation Fee |
| 125.00 | International Student Fee |
| 100.00 | Payment Plan Set Up Fee |
| 285.00 | Full-time Commuter Parking (per semester) |
| 160.00 | Part-time Commuter Parking (per semester) |
| 430.00 | On-Campus Resident Parking (per semester) |
| 7%* | Commuter Parking Tax |
| 200.00 | Optional Practical Training Application Fee |

***** The State of New Jersey mandates a 7% sales tax for commuter students parking on campus

# Campus Life and Student Services

The Campus Center is the hub of cultural, educational, and social activities for the NJIT community. The Campus Center staff provides students, faculty and staff with a relaxing environment where they can enjoy a meal, attend a meeting, study, watch a film, play a variety of games, participate in the many cultural, social, and educational activities offered, or just socialize with friends.

**Student Services**

The **Division of Academic Support and Student Affairs** (http://www5.njit.edu/studentaffairs/division-academic-support-and-student-affairs) consists of a variety of offices and departments that offer a wealth of programming, services, and resources to NJIT students. The common thread that runs through Student Affairs is the commitment to enable all students in our community to fully participate in an engaging, healthy, active learning environment during their time at NJIT.

# Office of Graduate Studies

The Office of Graduate Studies provides assistance to graduate students in academic matters, approves Master’s thesis and Ph.D. dissertation formats, and offers information about the availability of university-level assistantships, fellowships, and scholarships.

For newly admitted and entering graduate students, we are the best source of information about any aspect of graduate study at NJIT. If you are not sure who to ask or where to go, try us first.

NJIT has many unique characteristics that are attractive to students from New Jersey, the United States, and from around the world. We offer a variety of options for students to pursue programs at the Master's and Doctoral levels. Our programs provide flexibility and choice of full-time or part-time study.

NJIT is committed to diversity among its students, faculty, and staff. Research activities of faculty and students focuses on cutting-edge technologies and their applications. Exciting opportunities for student research exist in the graduate degree granting departments of NJIT's five colleges.

- Newark College of Engineering (http://nce.njit.edu/nceprograms)
- College of Science and Liberal Arts (http://csla.njit.edu/cslaprograms/graduate.php)
- College of Computing Sciences (http://ccs.njit.edu/ccsprograms/graduate.php)
- School of Management (http://management.njit.edu/academics/graduate)
- College of Architecture and Design (http://design.njit.edu/coadprograms/graduate-programs)

NJIT is a community of modest size but with a major impact on technological graduate education. It ranks highly in diversity, research activity, quality of graduate programs and number of awarded master's and doctoral degrees. We are conveniently located near New York City, in the busiest transportation hub in the United States. We are the only public technological university in the New York-New Jersey metropolitan area and have many cooperative arrangements with other universities in the region.

For further information, please visit http://www5.njit.edu/graduatestudies/.

# Career Services

Career Development Services (http://www.njit.edu/cds) is a value–added contributor to the career planning and preparation of NJIT students and graduates. We are dedicated to continually improving our client services and to assuming leadership in the profession of career development.

## Our Mission is fulfilled through assisting:

- Students in gaining a clear understanding of their career options and workplace requirements, in obtaining experiential learning opportunities in the private and public sectors, in developing job search and interviewing skills, and obtaining employment upon graduation;
- Alumni in refining their job search and interviewing skills, career objectives, gaining a clear understanding of their career options and workplace requirements, and obtaining meaningful employment in a specialty consistent with their education, experience, and personal goals;
- Faculty/staff in understanding the needs of employers and of the academic preparation and associated skills necessary for graduates, and thus influencing curricula content and academic advisement;
- Employers in staffing their organizations with qualified students, graduates, and alumni capable of filling their workforce needs, and in developing closer and more effective relationships with university staff;
- The community in linking students, alumni, faculty, and staff directly to service and civic engagement activities with organizations committed to improving the quality of life for New Jersey residents.
- New Jersey's economic and workforce development efforts through ready access to a highly skilled workforce, thereby reducing company expenses for new employee recruitment, staffing, and training; facilitating the transfer of technological knowledge to the workplace; and through stimulating the creation of new jobs.

# The Digital Campus

Computing has become ubiquitous in 21st century life, changing the way we work and learn, and even the way we interact with each other. The importance and power of information technology are evident in every discipline at NJIT, particularly in the STEM disciplines, where cascading breakthroughs and advances in information technology, have created a new interdependence among engineering, the physical sciences, computer science and math, and the biomedical sciences. NJIT researchers are leveraging the power of computing and information technologies to meet tomorrow's challenges, to create the tools to help the digital world function, and to evaluate the impact of new technologies on society.

NJIT has built a 21$^{st}$ century digital campus to support teaching, learning research, and the administration of the university. At the heart of the digital campus is the NJIT Network, with over 19,000 connections throughout the campus' 38 buildings, supplemented with the NJIT Wireless Network that blankets the campus, connecting over 22,000 devices each semester. Both networks provide access to servers, storage arrays, a large software library (http://ist.njit.edu/software), and other IT services within the NJIT Cloud, enabling students to immerse themselves in design, discovery, simulation and modeling, and research questions previously inaccessible. Examples include:

- Simulating the interaction of biomolecules and identifying promising leads for drug development;
- Modeling the consequences of various transportation and energy systems;

- Studying global social networks;
- Designing and building the next generation of software and applications;
- Practicing computational science alongside traditional approaches;
- Designing buildings and other artifacts that are environmentally responsible and resource efficient.

Highlander Pipeline (http://my.njit.edu), the NJIT Portal, is the entry point for many NJIT Cloud services. Students conduct most routine business processes online (e.g. register for classes, accept financial aid, pay bills, etc.) via Highlander Pipeline. The NJIT Library (http://library.njit.edu) provides online access to 27 full-text databases, over 33,500 electronic journals and more than 27,700 electronic books. A centralized "search all" portal delivers a single search experience of all electronic library resources.

Classrooms and other learning spaces at NJIT are all network enabled and equipped with modern projection devices, display panels, and other collaborative technologies to facilitate engagement and collaboration among faculty and groups of students. Many classes leverage video conferencing, lecture archival, learning management, and online discussion systems, allowing faculty and students to participate independent of time and place – converging the physical and virtual classrooms.

Students can BYOD (“bring your own device”) or use any of the hundreds of workstations in public-access computer labs or specialized academic department facilities across the campus. A healthy mix of Windows, Mac, and Linux workstations support the diverse needs of a technological research university.

The Tartan High Performance Computing Initiative provides NJIT researchers the broad range of centralized computational and data storage resources necessary to conduct computationally-intensive research. With over 3,200 CPU cores and 26,000 GPU cores, Tartan provides researchers with local resources capable of supporting leading edge research. A separate Hadoop cluster provides the resources for managing and analyzing very large data sets, commonly referred to as “big data.”

For additional information on IT services available at NJIT, visit the Home page of the Information Services & Technology (IST) Division (http://ist.njit.edu).

# Library Services

The university's Robert W. Van Houten Library is located in a facility for study, researching, and browsing. The library collection comprises 160,000 volumes of books, conference proceedings, reports, dissertations and theses. In addition, the library receives approximately 1,000 current technical journal titles in printed format and provides customized electronic access to over 10,000 journals in electronic format. Access to journal literature in engineering, science, management, architecture, and other subject areas is provided by a variety of indexing and abstracting services.

In Fall 1997 the Van Houten Library opened the Information Commons, which has many workstations with access to the Internet. CompendexWeb, Proquest Direct, EbscoHost, Scifinder Scholar, IEEExplore, the ACM Digital Library and Medline are among the many databases that students, faculty and staff may search. These services may also be accessed remotely.

The library provides individualized reference services, literature searches, and instruction on the use of information resources. In addition, students may supplement NJIT library resources by borrowing material from the Newark Public Library and the libraries of Rutgers University--Newark Campus, the University of Medicine and Dentistry of New Jersey, and the eight state colleges of New Jersey. Interlibrary loan arrangements with more distant institutions are also available.

Included among the library's resources is a small museum containing items developed and manufactured by Edward Weston, a scientist, prolific inventor, and a founding member of the university’s Board of Trustees. Dr. Weston’s rare book collection is also maintained by the library and is available to scholars and other interested in the history of science and technology.

The Barbara and Leonard Littman Library (http://archlib.njit.edu), a department of the university’s Van Houten Library located in the College of Architecture and Design, maintains a core collection of architecture information materials including books, journals, maps, drawings, models and over 70,000 slides.

A team of highly trained information and research assistants, reference and instructional librarians bridge the gaps between research resources and users. They provide ad hoc assistance in person via the Research Helpdesk at the Van Houten Library and the service desk at the Littman Architecture Library, or by phone (973-596-3210 for Van Houten and 973-596-3083 for Littman), email, and instant messaging. The online library is available 24/7. More information about the library can be found at www.library.njit.edu (http://www.library.njit.edu) or by calling (973) 596-3210.

# Residence Life

Almost 2000 students live on campus in five coed residence halls and the Greek Village. More than 50 percent of first-year students live on campus. First-year students live in Cypress, Honors and Redwood Halls. Upper-class students live in every building. Rooms are fully furnished (bed, desk, chair, closet, dresser), air-conditioned, wireless and wired for Internet and offer cable TV including HBO and Residence Life Cinema (current movie offerings). Each hall has common areas and facilities including lounges, study areas, kitchens and laundry rooms. Snack and soda machines, recreational equipment (pool, pingpong, large screen televisions, etc.), and mail service Monday-Friday are also provided.

**Cypress Hall** is a coed facility that houses 418 first-year, upper-class, and graduate students in single and double rooms. Suites are comprised of two bedrooms and a shared bathroom and foyer.

**Greek Village** is a coed facility that houses 192 upper-class and graduate students in eight houses. Both fraternity and sorority members and nonmembers live in double rooms. Suites are comprised of two bedrooms and share bathroom. The buildings have a kitchen and dining and living area.

**Honors Residence** is a coed facility housing 360 first-year, upper-class and graduate students in single and double rooms. Suites have a shared bathroom. The building features a dining facility, convenience store and fitness center.

**Laurel Hall** is a coed facility that houses 580 upper-class and graduate students in two-room suites. Suites consist of students living in single and double rooms, sharing a bathroom and foyer.

**Oak Hall** is a coed apartment facility that houses 186 full-time upper-class and graduate students in both suite-style rooms and apartments. Each suite-style room is double occupancy with a kitchenette and shared bathroom. Each apartment has a kitchen, living room and bathroom. The eighth floor is designated for graduate students.

**Redwood Hall** is a coed facility that houses 185 first-year and upper-class students living in single and double rooms.

NJIT students use electronic cards for access to the residence halls. Desk attendants are on duty 24 hours a day and provide security for the residence halls by monitoring hall entrances and swiping resident IDs. All guests must have a valid photo ID and must be signed into the residence hall by a resident host. All guests must be accompanied by their hosts at all times.

Residence Life has staff on-duty in each hall during non-business hours. In addition, NJIT’s Department of Public Safety Office police and public safety officers patrol campus 24 hours a day. Patrols are conducted on foot, in cars and on bicycles. Additionally, campus emergency phones are located on campus. Rooftop surveillance cameras are mounted throughout campus and monitored around the clock.

Once you have been admitted to NJIT, you can complete the Housing Application and Contract: https://mis3.njit.edu/housingapplication/login.aspx. A $50 nonrefundable deposit may be required and can be paid by check/money order payable to NJIT. Check/money orders must be sent to the Residence Life Office, 180 Bleeker Street, Newark, NJ 07103-3514. You will receive a confirmation in your NJIT email immediately after you submit your application online.

Applications for first-year students received by May 1 are guaranteed housing. After May 1, housing is assigned based on the distance you live from campus, need, and date of application.

For additional information please view our website: http://www.njit.edu/reslife or contact us via email reslife@njit.edu or call 973.596.3039.

## Food Services

The Dining facilities are located in the Campus Center and the first floor of the Honors Residence. NJIT's private food services vendor, Gourmet Dining Services, operates all of the dining options on campus. Meal plan options include both Continuous Dining and Flex Dollar options. The Continuous Dining meal plans, A-E, features continuous dining with unlimited returns during all of the posted hours. Flex dollars can be used at Continuous Dining (for those without meal plans or only have flex), Korner Kilt C Store, Trattoria, Tech Café, Café Spice, Grains, Leafs, Taco Bell, The Grill, Highlander Pub, Village Market, and Warren Street Café. For hours and a complete listing of what is available via flex, please check http://www.gourmetdiningllc.com/campus/njit.

# Continuing Professional Education

NJIT's Continuing Professional Education provides enriching career-long learning opportunities through extension programs, Online Learning, graduate certificates, and professional development training for individuals and company employees.

Professional development programs include short courses, certificates and license reviews, with some leading to the award of continuing education units (CEUs). The CEU is used nationally to document the type, quality and duration of study. In general, a CEU is defined as being equal to classroom hours. All professional development courses can be adapted to meet a particular organization’s needs and conducted as a custom-designed training program at a company site. For more than 50 years, NJIT has been designing and conducting high-quality professional development programs that meet organizations’ business needs. Since 1990, NJIT has trained over 63,000 professionals as part of over 550 training initiatives for 300 different companies conducting business in New Jersey.

For further information contact the Division of Continuing Professional Education at (800) 624-9850 or http://cpe.njit.edu.

# Online Learning

## Online Learning

Online Learning offers numerous graduate degrees, select Graduate Certificates, and graduate courses in many disciplines including communication, computer science, information systems, information technology, humanities, management, and engineering management. Online Learning offerings can be viewed at http://www5.njit.edu/online.

Online Learning provides students the opportunity to earn college credit through enrollment in online electronic-based courses. These courses are virtual learning communities with instructor-led online classrooms that utilize various technologies such as Moodle (http://moodle.njit.edu) for presenting course material, online quizzes, asynchronous and synchronous communication.  Online courses are flexible and rigorous educational experiences suited to motivated students.

The program's reach is worldwide. Course material can be accessed through the Internet via learning management systems utilizing multimedia presentations.

Online Learning furnishes a convenient alternative to graduate distance learners and students who have scheduling conflicts. For more information, contact the Office of Graduate Studies at 973-596-3462 or email online@njit.edu.

# College of Architecture and Design

The College of Architecture and Design is comprised of the nationally known New Jersey School of Architecture and the newly created School of Art + Design. The College brings together under one roof Architects, Planners, Designers, and Artists.

Learning and collaborating with an award-winning faculty, this fosters a vibrant intellectual and creative atmosphere. We prize imagination and adventurous exploration.

There are ample opportunities for cross-pollination of ideas and interdisciplinary interaction. Using a nuanced blend of intuitive exploration and rigorous logic, students in the College of Architecture and Design work today to conceive and present new possibilities to help address tomorrow’s challenges.

## Programs

- Architecture - M.Arch. (p. 641)
- Architecture - M.S. (p. 641)
- Infrastructure Planning - M.I.P. (p. 647)

## **Double Majors** (p. 589)

- Architecture (professional, or post-professional) - M.Arch. and Infrastructure Planning - M.I.P. (p. 646)
- Architecture (professional, or post-professional) - M.Arch. and Management - M.S. (p. 645)
- Architecture (professional, or post-professional) - M.Arch. and Civil Engineering - M.S. (p. 642)

Urban Systems - Ph.D. (p. 648)

## College of Architecture and Design Courses

**ARCH 500G. Advanced Architectural Graphics. 3 credits, 3 contact hours.**
Introductory computer science with applications in computer graphics for architecture. Emphasizes programming methodology using a high-level language as the vehicle to illustrate concepts. Basic concepts of computer systems, software engineering, algorithm design, programming languages, and data abstraction, with applications.

**ARCH 501G. Architectural Design I. 6 credits, 12 contact hours.**
Prerequisite: graduate level standing. Core Studio. Fundamentals of architectural design. Sequence of projects explore two- and three-dimensional design. Choice of form and aesthetics is related to spatial resolution of function and context. Design as a representational medium is emphasized. Taken concurrently with ARCH 555G.

**ARCH 502G. Architectural Design II. 6 credits, 12 contact hours.**
Prerequisites: ARCH 501G, ARCH 528G, ARCH 541G, ARCH 555G. Core Studio. Extends the knowledge of design, basic concepts and ideas introduced in ARCH 501G. Emphasis is on developing technical drawing, and model-making skills. Also covered are two- and three-dimensional composition. Links to the history and theory sequence are made.

**ARCH 503G. Architectural Design III. 6 credits, 12 contact hours.**
Prerequisites: ARCH 500G, ARCH 502G, ARCH 529G, ARCH 543G, and ARCH 545G. Core Studio, Intermediate design studio. Introduction to structure. Properties of materials both physical and in the abstract. Builds on knowledge gained from construction and structures courses, spatial demands and design possibilities of different structural systems. Design of structure type, model and context, and comparisons of building typology for rational structure. Drawing and its role in design thinking.

**ARCH 504G. Architectural Design IV. 6 credits, 12 contact hours.**
Prerequisites: ARCH 503G, ARCH 542G, ARCH 544G. ARCH 548G. Corequisite:547G. Second semester intermediate design studio. Design of buildings and integration of systems, physical and conceptual. Design methodology generates new information on buildings as coherent assemblies of systems. Also covers analysis and synthesis of form and introduction to applications of computer-assisted design (CAD). Preparation of design portfolio will complete core studio sequence.

**ARCH 505G. Advanced Design Options I. 6 credits, 12 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 506. Advanced Design Options II. 5 credits, 13 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 506G. Advanced Design Options II. 6 credits, 12 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 507G. Advanced Design Options III. 6 credits, 13 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 510. Co-op Work Experience. 0 credits, 3 contact hours.**
Restriction: Approval of the school and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Students are required to complete and present miterm and final projects and/or reports. A designated faculty member monitors and evaluates the student's work and project.

**ARCH 513G. Structures III. 3 credits, 3 contact hours.**
Prerequisite: ARCH 512G. Review of methods and procedures for choosing structural systems. Overview of differences among wood, steel and concrete systems. Students are introduced to complex structural behavior, prestressed concrete and new structural technology.

**ARCH 527G. Situating Prac:Thrshds of Arch. 3 credits, 3 contact hours.**
Restriction: Enrolment in Masters of Architecture Program or by permission of instructor. Western architectural theory dating from Vitruvius to the present time. Examines critical texts and studies related building and projects.

**ARCH 528G. History of Architecture I. 3 credits, 3 contact hours.**
Restriction: graduate level standing. Introduction to the history of architecture. Emphasis on classical architecture from antiquity to the modern period. Evolution of the various themes and theories that underlie western architecture is presented chronologically.

**ARCH 529G. History of Architecture II. 3 credits, 3 contact hours.**
Prerequisite: ARCH 528G. Continuation of ARCH 528G. Introduces concepts of modernism and brings the history of western architecture to the contemporary period.

**ARCH 530. Methodologies of Architectural History, Theory and Criticism. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. A seminar examining the salient methodologies of architectural history, theory and criticism. Structured around a series of critical texts, with each set of core readings intended to provide a basis for analyzing and assessing the approach in question.

**ARCH 531A. History of Renaissance Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An examination of the development of Renaissance architecture and urban design in Italy and elsewhere in Europe. The re-emergence of the classical tradition is considered within the context of social, political and economic developments as well as formal intentions.

**ARCH 531B. History of Baroque Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An investigation of architectural development from the 17th and 18th centuries in Europe and Latin America, including consideration of stylistic variations, social and political factors, and trends in garden and urban design.

**ARCH 531C. History of Modern Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. A study of major tendencies of architectural theory and practice from the mid-19th to the mid-20th centuries. Formal and stylistic transformation is considered in relation to theoretical intentions as well as social, cultural, and technical developments.

**ARCH 531D. History of American Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An investigation of the guiding ideals and dominant stylistic trends in American architecture and planning from colonial times to the mid-20th century. Critical shifts in conception and scope of architectural production considered in relation to the prevailing cultural, socio-economic, and technical contexts out of which they evolved.

**ARCH 531E. History of Non-Western Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An examination of major architectural traditions of China, Japan, Southeastern Asia, India, and the Middle East. Each area is considered with reference to a conceptual, iconographic and stylistic paradigm that evolved from a particular historical context.

**ARCH 531F. Thresholds of Architectural Theory. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. A seminar that investigates key thresholds of Western architectural theory, from Vitruvius to Robert Venturi, with emphasis on examining the corresponding critical theoretical texts and related didactic buildings and projects.

**ARCH 531H. Aspects of Urban Form. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An examination of the major forms and patterns of urban development from classical antiquity to the 20th century, considered in relation to the changing conceptions of the city as well as cultural, socio-economic, and political development.

**ARCH 533. Case Studies in Architectural Creativity. 3 credits, 3 contact hours.**
Prerequisite: ARCH 364. Considers creativity in architecture from psychological, philosophical and autobiographical perspectives. The buildings, writings and lives of contemporary architects are discussed in the context of general theories of creativity. Each student chooses an individual architect noted for creative accomplishments and prepares a case study of his or her life.

**ARCH 534. History of Architectural Technology. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. Survey of the development of building methods and materials. Impact of structural and environmental technology on architectural form and the design process. The role of technology in contemporary architectural theory and practice, including the modern movement, is emphasized.

**ARCH 535. History of Architectural Ideas. 3 credits, 3 contact hours.**
Prerequisite: ARCH 382. Discusses seminal architectural ideas in the western world from Vitruvius to the present day. Read books written by leading architectural theorists and analyze them in detail.

**ARCH 536. Landscape and American Culture. 3 credits, 3 contact hours.**
As in architecture, the parallel discipline of landscape architecture involves artistic intention set in conjunction with utilitarian concerns. As such, designs on the land include the integration of the arts and sciences of human culture with nature. Discusses landscape as a manifestation of American culture.

**ARCH 537. Advanced Structures. 3 credits, 3 contact hours.**
Covers advanced material in structures related to steel and wood design including: steel industrial buildings, rigid frames and earthquake design, wood structures under axial loads, and combined bending and axial loads.

**ARCH 538. Sustainable Architecture. 3 credits, 3 contact hours.**
Follows two precepts: accepting responsibility for the consequences of design decisions upon human well-being, and the long-term viability of natural systems. Topics include sustainable site design and development, environmentally sensitive building materials, lifecycle cost benefit analysis of building systems, and adaptive reuse.

**ARCH 540. Acoustics. 3 credits, 3 contact hours.**
Prerequisites: ARCH 241, ARCH 242, ARCH 342. Architectural acoustics: how we hear, physics of sound and materials, aesthetics of design and the processes of construction. Audible sounds, their interaction, perception of echo and directional hearing are applied to interior and exterior building transmission, room acoustics, and setting acceptable acoustical environments.

**ARCH 541. Material Systems in Design. 3 credits, 4 contact hours.**
Prerequisite:4th year undergraduate standing or approval from instructor This seminar will allow students to exam material systems that give design agency to matter as a creative and technical force in the making of architecture. In doing so, it will provide students an opportunity to understand and explore the role material matters play in comtemporary architectural theory and praxis. focused on the exploration and understanding og material systems, this course will provide students with the intellectual underpinnings for the re-conceptionalization of matter within thier own design processes.

**ARCH 541G. Construction I. 3 credits, 3 contact hours.**
This course is an introductory survey of the general principles and application of Sustainable Design, Site Systems, Structural Systems, Environmental Systems, Envelope Systems, Materials and Assembly Systems. This course will primarily focus on low-rise wood and steel structures.

**ARCH 542G. Integrated Building Technologies. 3 credits, 3 contact hours.**
Prerequisites: ARCH 541G This course is an introductory survey of the interrelationship of the principles and applications of Sustainable Design, Site Design, Structural Systems, Environmental Systems, Envelope Systems and Materials and Assembly Systems. This course will primarily focus on low and medium-rise concrete and masonry structures and is coordinated with a studio design/build experience.

**ARCH 543. Lighting. 3 credits, 3 contact hours.**
Prerequisites: ARCH 327 or INT 222. Explores, through modeling and calculation, the means by which architectural form and detail influence the luminous environment. Perceptual responses such as visual comfort and delight are examined. Topics include daylighting footprints, model design and testing, and computer-assisted light level analysis. Areas of investigation include the relationship between daylight and electric light in architecture; the variations of light with time; analysis of seasonal and weather differences; role of task in lighting strategies; and means of control for light quantity and quality.

**ARCH 543G. Environmental Control Systems I. 3 credits, 3 contact hours.**
An introductory survey of the basic principles of building, environmental control, and service systems as these relate to the building envelope. This course will primarily cover thermal enclosure, climate modification, environmental systems, energy use, and sustainable design. It also introduces the principles of health and safety in the design of buildings.

**ARCH 544G. Environmental Control Systems II. 3 credits, 3 contact hours.**
This is an intermediate course focusing on the understanding of the principles, performance criteria, and applications of environmental and building service systems including lighting, acoustical, plumbing, electrical, vertical transportations, egress, communication, security, and fire protection systems.

**ARCH 545. Case Studies in Architectural Technology. 3 credits, 3 contact hours.**
Prerequisite: senior standing. Technological systems involved in the construction and use of buildings. Students conduct in-depth investigation of technology-related problems in architecture and construction. Case study method is used. Construction documents and reports are analyzed. Field visits are required.

**ARCH 545G. Structures I. 3 credits, 3 contact hours.**
This is an intermediate course focusing on the principles of structural behavior in withstanding gravity and lateral forces and on the evolution, range, and appropriate application of structural systems and the criteria for selecting various structural systems in contemporary architecture. Specific architectural procedents from the 20th century are used as validating examples.

**ARCH 546. Designing and Optimizing the Building Enclosure. 3 credits, 3 contact hours.**
Prerequisites: CS 104 and (ARCH 327 or INT 222). Considers the building envelope, the boundary dividing the inside of a structure from the outside environment. Study and design optimal enclosures considering energy exchange, the relationship between energy and light, and life cycle costs.

**ARCH 546G. Structures: High Rise and Special Applications. 3 credits, 3 contact hours.**
Prerequisite: 545G. This is an advanced course focusing on the integration of all building systems including new materials and methods as they relate to high-rise structures and other specialty building types.

**ARCH 547. Special Topics in Computer Applications. 3 credits, 3 contact hours.**
Prerequisite: senior standing. Evaluation, utilization, and development of computer programs for analysis, simulation and information management. Programs range from energy analysis, building structures analysis, and mechanical systems design to spatial allocation, graphics and computer-aided design. Different theories of information transformation and delivery used in terms of architectural applications. Course hardware ranges from computer-aided design and drafting systems, through micro and mini, to mainframe computers.

**ARCH 547G. 4D Integration. 3 credits, 3 contact hours.**
Prerequisite: ARCH 542G, ARCH 544G, ARCH 548G. Corecquisite: ARCH 504G. This is a required, advanced design course that uses in-depth, detailed case studies of various construction types, from small scale to large, from simple to complex, to illustrate the totality of building systems integration. In conjunction with site visits, coursework will employ software to examine construction sequences, building components and shop drawings and their relationship to the design processes.

**ARCH 548G. Structures II. 3 credits, 3 contact hours.**
Prerequisite: ARCG 545G. This is an advanced course dealing with structural computation that will conclude with rigorous case study investigation of hybrid and complex structural systems.

**ARCH 549. Life Safety Issues in Contemporary Buildings. 3 credits, 3 contact hours.**
Prerequisites: ARCH 327 or INT 222. A variety of life safety and comfort situations studied in terms of specific building types. Topics include building evacuation, compartmentalization, fire fighting and suppression, evaluation and testing of new building materials and systems, systems control and management. Special emphasis is on such building types as multi-use, high-density, schools, hospitals, and other institutional categories.

**ARCH 552. Real Estate Analysis for Architects. 3 credits, 3 contact hours.**
Restriction: completion of the third year. Introduction to the economic, financial and political aspects of real estate and their effect on architectural decision-making. Topics include needs assessment, real estate appraisal, financial instruments, regulations and real estate, design as value-adding, and the effect of tax policies on real estate development.

**ARCH 555G. Architectural Graphics. 3 credits, 5 contact hours.**
Restriction: graduate level standing. Documentary, descriptive and denotative media are introduced. Also covers methods of representation, delineation and reproduction. Skills are developed in technical drawing, perspective construction, projections, and format design. Taken concurrently with ARCH 501G.

**ARCH 556. Systems Approach to Design and Construction. 3 credits, 3 contact hours.**
Restriction: completion of the third year. Lectures, case studies and student projects on understanding human aspiration and needs through design. Topics include land, finance, management, technology, and labor.

**ARCH 557. Problems in Modern Housing. 3 credits, 3 contact hours.**
Prerequisite: ARCH 382 Historical approach places housing in its social, economic, and political context. Attempts to provide decent, affordable and well-designed housing for broad segments of society are examined. Dwelling is examined through analysis of proto-typical design solutions in urban environments.

**ARCH 558. Professional Architectural Practice. 3 credits, 3 contact hours.**
Prerequisite: ARCH 364. A forum for examination of the structure and practices of the profession of architecture. The formal and informal relationships between architects, and between architects and clients, government officials, and consultants are studied. Basic principles of office management for the small and large architectural firm are introduced.

**ARCH 559. Social Issues in Housing. 3 credits, 3 contact hours.**
Lecture/seminar explores the historical, economic, social, technological, and political basis for current American housing policy and practice. Examines government, community-based and private sector attempts, both failed and successful, at providing decent, affordable, and well-designed housing for broad segments of society. Student teams analyze and discuss, in a series of classroom debates, the housing and planning implications of controversial social problems from homelessness and racial segregation to caring for the elderly and people with HIV/AIDS with an emphasis on the role of the architect.

**ARCH 561. Integrated Studio Seminar. 3 credits, 3 contact hours.**
Prerequisite: ARCH 463. Corequisite: ARCH 564. Held in design studio each week, the lab consists of presentations by the instructor on relevant technical, building code, and life safety-issues as well as student exercises applying these principles to their integrated design studio project or to existing buildings.

**ARCH 563. Comprehensive Studio I. 5 credits, 12 contact hours.**
Prerequisites: ARCH 464, ARCH 423, ARCH 327 and ARCH 429. Studio methodology allows students to select from various building programs, the nature of design dealing with technology, environment and the social order.

**ARCH 564. Comprehensive Studio II. 5 credits, 12 contact hours.**
Prerequisite: ARCH 463 Corequisite: ARCH 565 This Studio focuses on the student's ability to produce a comprehensive architectural project based on a building program and site that includes development of programmed spaces demonstrating an understanding of structural and environmental systems, building envelop systems, life-safety provisions, wall sections and building assemblies and the principles of sustainability. Lecture hour coordinates with studio subject matter. Course materials purchase required.

**ARCH 565. Comprehensive Studio Lab. 1 credit, 1 contact hour.**
Prerequisite: ARCH 464 Corequisite: ARCH 563 or ARCH 564 Held in design studio each week the lab consists of presentations by the instructor on relevant technical and life safety issues and student excercises applying these principles to thier currecnt design studio project or to existing buildings.

**ARCH 566. Advanced Architectural Design Studio. 5 credits, 12 contact hours.**
Prerequisite: ARCH 564. This is an advanced architectural design studio, post Comprehensive Studio, studying contemporary design theories, design methods and construction technologies. Emphasis is placed upon independent design research as it relates to the broad range of architectural practice. Exploratory and experimental architectural projects are the focus of the course.

**ARCH 569G. Building and Development. 3 credits, 3 contact hours.**
Familiarization with the larger process of building production, of which architecture is one important part. Focus on the role of the architect in the areas of current building development: an examination of how redefinition or change might improve the process. Lectures deal with all factors of the building process and interviews with the various actors involved in designing, approving, financing and making buildings. Students have various assignments including a major term project.

**ARCH 571. Everyday Life in the Public Realm. 3 credits, 3 contact hours.**
A significant portion of everyday life takes place in the public realm of streets, sidewalks, parks, transit stations, government buildings, commercial establishments, and cultural institutions. Focuses on recent descriptions and critiques of public space and proposals for change.

**ARCH 572. Architecture and Social Change. 3 credits, 3 contact hours.**
Restriction: senior standing. Architectural form is analyzed in relation to political, economic and technological change, and change in social values. Buildings and other designed environments such as parks, streets and neighborhoods are studied relative to the social processes and institutions that generate and transform them. The role of the design professions in initiating or supporting change also is considered.

**ARCH 573. Technologies for Community and Urban Design. 3 credits, 3 contact hours.**
Restriction: senior standing. Advanced and traditional technologies analyzed with regard to their role in community and city design, construction and reconstruction. Emphasis on technological systems influencing location, configuration and use. Examples are infrastructures, communication systems and construction technologies. Develops skills in using methods to evaluate alternative technologies relative to their social, economic and physical promise, problems and feasibility.

**ARCH 574. Case Studies in Community and Urban Design. 3 credits, 3 contact hours.**
Restriction: senior standing. In-depth investigation of specific real-world problems of urban or community design carried out using case method approach. Current practices in the U.S. and other countries studied using interviews with designers, developers, community groups and government agencies. Site visits, reports and other documents provide important sources of information. Final report with supporting documentation required.

**ARCH 576. The Architecture of Utopia. 3 credits, 3 contact hours.**
Restriction: senior standing. Seminar for the review of utopian projects that have attempted to embody and strengthen social ideas through transformations in the structuring of space. Architectural implications of different literary and philosophical utopias analyzed with an emphasis on those experimental proposals which were realized, in whole or in part, in built form.

**ARCH 579G. Professional Architectural Practice. 3 credits, 3 contact hours.**
Restriction: completion of M.Arch. core sequence. Review of the formal, informal, legal, and ethical obligations of the professional architect. Traditional relationships among the architect, clients, engineers and other participants in the design and building industry are studied. Principles of office management and problems of liability are introduced. Also fulfills core requirement of dual degree option for M.Arch./Master of Science in Management.

**ARCH 583. ST:. 3 credits, 3 contact hours.**
Group investigation of problem of special interest in architecture.

**ARCH 588. Architoons. 3 credits, 3 contact hours.**
Prerequisite: ARCH 364. Through the medium of film, applies literary devices to architectural contexts, including caricature, parody, lampoon, satire and farce. Studies historical and contemporary animations and short films for their treatment of meaning, story line and sequence, timing, environmental and psychological mood, atmosphere and emotion. Using 3-D modeling and animation software, each student produces an animated short subject illustrating an architectural principle or providing a humorous look at architectural history and theory.

**ARCH 591. Independent Study. 1 credit, 1 contact hour.**

**ARCH 592. Independent Study. 2 credits, 2 contact hours.**

**ARCH 593. Independent Study. 3 credits, 3 contact hours.**

**ARCH 619. Architectural Photography. 3 credits, 3 contact hours.**
Prerequisites: ARCH 501G, ARCH 502G, ARCH 503G. Photography for architectural presentations and portfolios. Lectures include orientation on light and space, slide presentations, and the use of text to reinforce photographic material. Demonstrations include basic darkroom techniques, and methods to encourage experimentation in photography.

**ARCH 630. Methodology of Architectural History, Theory and Criticism. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. This seminar is structured around notable readings on architectural history, theory and criticism to provide students with a sound basis for critical analysis and assessment. It is recommended for students who select history and theory as their area of concentration.

**ARCH 631A. History of Renaissance Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Development of architecture and urban design in Italy and elsewhere in Europe during the Renaissance: re-emergence of the classical Greek and Roman architectural tradition; social, political and economic developments; formal intentions and transformations in the 16th and 17th centuries.

**ARCH 631B. History of Baroque Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. The emergence of baroque architecture and urban design in Rome in the 17th century; analysis of the works of Bernini, Borromini, Cortona and their contemporaries and successors through 1750. Development of baroque architecture elsewhere in Italy and Europe; late baroque and rococo; the advent of neo-classicism.

**ARCH 631C. History of Modern Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Major tendencies in architectural theory and practice from the mid-19th to the mid-20th centuries. Formal and stylistic transformation considered in relation to theory, social, cultural, and technical developments.

**ARCH 631D. History of American Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Aesthetic, social, cultural and technical developments in American architecture and planning, from colonial times to the mid-20th century.

**ARCH 631E. History of Non-Western Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Examination of major architectural traditions and styles of China, Japan, Southeast Asia, India and the Middle East.

**ARCH 634. History of Architectural Technology. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Survey of the development of building methods and materials. Impact of structural and environmental technology on architectural form and the design process. The role of technology in contemporary architectural theory and practice including the modern movement is emphasized. Recommended for students who select building science as their area of concentration.

**ARCH 636. Methods of Urban History. 3 credits, 3 contact hours.**
Prerequisites: Graduate status The seminar examines methods for conducting historically driven, interdisciplinary research on the built environment (with a focus on cities and suburbs) through the lens of architecture, landscape, geography, and material culture. Methodology is studied to inform the production of urban history and to frame historical perspectives on contemporary urban issues. Historiography and critical theory are key aspects of the study of urban history's methodologies. In addition to traditional historical methodologies, the course examines emerging digital humanities methodologies.

**ARCH 637. Teaching Sem:Arch Pedagogies. 3 credits, 3 contact hours.**
Prerequisites: Graduate status This course is a graduate seminar that introduces students to key issues in contemporary pedagogy, understood as the art, craft, theory and practice of teaching. The course examines principles and constructs of teaching and education, as well as their pragmatics and practicalities. The main focus of the course is architectural education with discussions informed by diverse issues such as technology and the information revolution and multiculturalism and globalism.

**ARCH 640. Acoustics. 3 credits, 3 contact hours.**
Restriction: completion of core sequence or equivalent. Architectural acoustics: how we hear, physics of sound and materials, aesthetics of design and the processes of construction. Audible sounds, their interaction, perception of echo and directional hearing are applied to interior and exterior building transmission, room acoustics, and setting acceptable acoustical environments.

**ARCH 641. Experiments in Structural Form. 3 credits, 3 contact hours.**
Restriction: completion of core sequence or equivalent. Architectural form through model design, construction and testing of minimum structures, including elements of soap film study, orthogonal and diagonal grids, design of tension grids through deflection loading, photoelastic models and calculation. Also compares geometric systems, patterning and proportion, symmetry, asymmetry, relative size, nesting, linearity and spiral orders, rectilinear patterns, and randomness in architectural structure and form.

**ARCH 642. Digital Modeling & Fabrication. 3 credits, 3 contact hours.**
Prerequisites: ARCH 501G This is a 3-credit seminar course for graduate students exploring advanced 3-dimensional computer modeling techniques and data export for assembly and fabrication to various computer numerically controlled (CNC) hardware available at the School of Architecture. Specifically, students engage in NURBS and solid modeling using Rhinoceros 3D and export data through various Rhino plug-ins including RhinoCAM, which writes G- and M- Codes for 2 and 3D milling operations.

**ARCH 643. Lighting. 3 credits, 4 contact hours.**
Prerequisites: ARCH 501G and ARCH 502G. Through modeling and calculation, influence of the luminous environment on architectural form and detail. Perceptions of visual comfort and daylight are examined. Topics include daylighting footprints, model design and testing, and computer-assisted, light-level analysis. Relationship between daylight and artificial light in architecture, variations of light with time, analysis of seasonal and weather differences, role of task in lighting strategies, and means of control for light quantity and quality.

**ARCH 645. Case Studies in Architectural Technology. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. Case-study method used for in-depth investigation of the relationship among various technological systems in a building and technologically-related problems in architecture and construction.

**ARCH 646. Designing and Optimizing the Building Enclosure. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. Considers the "building envelope," the boundary dividing the inside of a structure from the outside environment. Students study and design optimal enclosures considering energy exchange, the relationship between energy and lighting, and life cycle costs.

**ARCH 647. Special Topics in Computer Applications. 3 credits, 5 contact hours.**
Restriction: completion of core sequence. Evaluation and use of computer graphics hardware and software for architectural applications. Focus is on computers as tools, operating systems and methods of data manipulation. Two- and three-dimensional modeling software are discussed, and assignments using such software are given to provide understanding of the modeling of built environments.

**ARCH 649. Life Safety Issues in Contemporary Buildings. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. A variety of life safety and comfort situations are studied in different building types. Topics include building evacuation, compartmentalizing, fire fighting and suppression, evaluation and testing of new building materials and systems, systems control and management. Special attention is placed on multi-use, high-density buildings.

**ARCH 650. Economy of Building. 3 credits, 3 contact hours.**
Restriction: completion of core sequence or equivalent. Economic consequences of design decisions. Topics include: relationship among economy, efficiency and quality; life-cycle cost of design; improving the economy of building processes and products through innovation; and environmental concerns. This course is required for the dual degree M.Arch./Master of Science in Management program. It can also be used as an elective in the M.Arch. program.

**ARCH 651. Real Estate Analysis for Architects. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. Introduction to the economic, financial and political aspects of real estate and their effect on architectural decision-making. Topics include: needs assessment, real estate appraisal, financial instruments, regulations and real estate, design as value-adding, and the effect of tax policies on real estate development. This course is required for the dual degree M.Arch./Master of Science in Management program. It can also be used as an elective in the M.Arch. program.

**ARCH 652. Architectural Project Management. 3 credits, 3 contact hours.**
Prerequisite: ARCH 579G. Restriction: completion of core sequence. Management of architectural projects: project costs, timing, personnel, documentation, professional ethics and resource management. This course is required for the dual degree M.Arch./Master of Science in Management program. It may be used as an elective in the M.Arch. program.

**ARCH 660. Direct Study In Arch II. 3 credits, 3 contact hours.**

**ARCH 661. Directed Studies of Architecture. 3 credits, 3 contact hours.**
Restriction: completion of core, two elective courses, and approval from the graduate advisor. Independent, in-depth research on an analytical, theoretical or technical area of architecture. Student prepares formal research proposal with permission of faculty advisor and approval of graduate advisor. Required as pre-thesis research. See also course description for MARC 701.

**ARCH 662. Special Topics in Architecture. 3 credits, 3 contact hours.**
Topics vary each semester. Refer to the School of Architecture bulletin during university registration periods for a list of current topics and possible prerequisites.

**ARCH 663. Introduction to Sustainable Architecture. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Environment design of buildings. The five characteristics of green buildings: sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. The US Green Building Council's Green Building Rating System, review of several major buildings of exemplary design.

**ARCH 664. Indoor Environmental Quality in Sustainable Design Buildings. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Supportive ambient conditions, including thermal comfort and acceptable indoor air quality, visual comfort, and appropriate acoustical quality, overall physical and psychological well-being for workplace quality, performance and productivity.

**ARCH 665. Sustainable Design of Energy Efficient Buildings. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Evaluation of heating and cooling loads, impact on fuel consumption, energy software analysis for design and efficiency. Technology of passive solar design and building integrated photovoltaics.

**ARCH 666. Sustainable Design with Efficient Materials and Resources. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Environmentally sensitive site design; issues of wildlife habitat, erosion, ground water recharge, and threats to water quality of surface water bodies and aquifers. Water reclamation, materials and energy conservation, waste reduction and recycling.

**ARCH 672. Architecture and Social Change. 3 credits, 3 contact hours.**
Prerequisite: graduate level standing. Analysis of architectural form with respect to political, economic and technological change. The built environment is studied in relation to society and culture. The role of design professions in initiating or supporting change is also considered.

**ARCH 675. Elements of Infrastructure Planning. 3 credits, 3 contact hours.**
Introductory survey of the basic principles, operation and design of physical infrastructure systems including roads, public transportation, community facilities, public open space, surface drainage, and electric, gas, water, waste disposal, and telecommunications services. Same as MIP 675.

**ARCH 676. The Architecture of Utopia. 3 credits, 3 contact hours.**
Restriction: graduate level standing. Seminar looks at several ideas of utopia from literature and philosophy and how they embody transformations in the structure of space, and their architectural implications.

**ARCH 678. Graduate Problems in Modern Housing. 3 credits, 3 contact hours.**
Restriction: graduate level standing. Students learn to analyze political, technical and economic aspects of contemporary housing policy and practice. Attempts to provide well-designed, affordable housing responsive to the needs of large numbers of people are examined. Examples of housing from the mid-19th century to the present day are outlined.

**ARCH 679. Envisioning Newark. 3 credits, 3 contact hours.**
This seminar combines classroom discussion based on historical, analytical and literary texts; field visits to Newark's districts and neighborhoods; and meetings with leaders in government, business, art, education, and community-based organizations. The objective is to introduce students to the redevelopment process underway in Newark, and to use the city as a springboard for a broader investigation of the theory and practice of urban development.

**ARCH 680. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: completion of core sequence, permission from graduate advisor and Division of Career Development Services. Students gain work experience and reinforcement of their academic programs. An architecture faculty Co-op advisor monitors and evaluates student work and project. Co-op work experiences may be acceptable equivalents for apprenticeships mandated by the New Jersey State Board of Architects and for eligibility to take the architecture licensing examination. This course is required for participation in the Housing Scholars Program. Course does not fulfill degree requirements.

**ARCH 681. Co-Op Work Experience. 3 credits, 3 contact hours.**
Restriction: completion of core sequence, permission of graduate advisor and Division of Career Development Services. Used for extended summer-fall (681) or spring-summer (682) work experience. Does not fulfill degree requirements.

**ARCH 682. Co-Op Work Experience III. 0 credits, 0 contact hours.**
Restriction: completion of core sequence, permission of graduate advisor and Division of Career Development Services. Used for extended summer-fall (681) or spring-summer (682) work experience. Does not fulfill degree requirements.

**ARCH 683. Graduate Coop Work Exper IV. 0 credits, 3 contact hours.**

**ARCH 686. Research Methods for Environmental Design. 3 credits, 3 contact hours.**
Introduction to methods of inquiry useful to professionals planning and designing buildings, communities and cities. Skills developed in problem definition and phenomena: measurement, modeling, testing and evaluation. Open to undergraduates with permission of instructor.

**ARCH 701B. Master's Thesis. 3.5 credits, 3.5 contact hours.**

**ARCH 701C. Masters Thesis. 6 credits, 0 contact hours.**

**ARCH 770. Development of the American City. 3 credits, 3 contact hours.**
Restriction: Enrollment in the Urban Systems PhD program or permission of the instructor.Introduction to research in urban history, focusing on the American city. Key texts that deal with the development of the American city will be studied in depth, with particular emphasis on the approaches, methodologies, and sources. Each student will conduct bibliographic research on a city or urban sector from a defined perspective.

**ARCH 771. Pathology of Urban Systems. 3 credits, 3 contact hours.**
Restriction: Enrollment in the Urban System PhD program or permission of the instructor. Definition of pathology of urban systems as large-scale disasters that have resulted in major destruction of the urban fabric and called for radical re-planning projects. Investigation of historic case studies. The aftermath of natural and man-made disasters including war; contemporary case studies.

**MARC 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: Arch 506G, Arch 661, and approval from graduate advisor. Alternative to Arch 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during Arch 661.

**MARC 701A. Master'S Thesis. 1.5 credit, 3 contact hours.**
Prerequisites: ARCH 506G, ARCH 661, and approval from graduate advisor. Alternative to ARCH 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during ARCH 661.

**MARC 701B. Master's Thesis. 3 credits, 3 contact hours.**
Prerequisites: ARCH 506G, ARCH 661, and approval from graduate advisor. Alternative to ARCH 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during ARCH 661.

**MARC 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisites: ARCH 506G, ARCH 661, and approval from graduate advisor. Alternative to ARCH 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during ARCH 661.

**MIP 601. Interdisciplinary Infrastructure Studio I. 6 credits, 13 contact hours.**
Collaborative work on realistic infrastructure projects by teams of students with different professional backgrounds under the supervision of interdisciplinary faculty. A project manager coordinates and ensures that working conditions in practice are simulated in the studio. Projects include analytical, financial and design components and emphasize planning strategies and the coordinating function of the design process. Studio products are presented orally in reviews and documented in written and illustrated reports.

**MIP 602. Interdisciplinary Infrastructure Studio II. 6 credits, 13 contact hours.**
A comprehensive planning and design project emphasizing infrastructure technologies and information management. CAD and other computer applications are used to produce computer-generated graphics and multi-media presentations. Although subjects and approaches will vary, the work of the studio is intended to develop the students' ability to deal with all facets of infrastructure planning regardless of previous academic background. The final products must include a full written and illustrated report on the project and the research on which it is based.

**MIP 612. Introduction to Environmental Policy Studies. 3 credits, 3 contact hours.**
Introduction to six areas essential to a comprehensive understanding of environmental policy: concepts of environmental policy; tools (law, economics, planning, science, engineering, ethics) for environmental policy; the U.S. perspective (NEPA, clean air and water acts, CERCLA, etc.); the international perspective (Club of Rome models, 1972 UNEP, 1992 Rio, etc.); industrial perspective (pollution prevention/life cycle engineering, privatization, etc.); and the local perspective (New Jersey DEP, NGOs, local industry, shoreline, etc.). Same as EPS 612.

**MIP 618. Public and Private Financing of Urban Areas. 3 credits, 3 contact hours.**
Ties government's budget, tax, policy, allocation of resources between public and private sectors, with the structure, development, and growth needs of urban metropolitan areas. Focuses on problems of poverty, transportation, land-use, economic base, relation between central cities and suburban areas, and alternative engineering and economic solutions. Same as Fin 618 and Tran 604.

**MIP 631. History and Theory of Infrastructure. 3 credits, 3 contact hours.**
The historical role of infrastructure in the formation of cities and the relation of planning theories to urban culture. Case studies are used to develop effective ways of learning urban design; method and substance are equally emphasized. Concentration on the social, economic, political, technological and topographic factors that affect urban form; analysis of urban design schemata and their relation to patterns of use; and the critical appraisal of planning ideologies and strategies. Same as ARCH 631H.

**MIP 652. Geographic Information Systems. 3 credits, 3 contact hours.**
Prerequisite: course or working knowledge of CADD or permission of instructor. Geographical/Land Information System (GIS/LIS) is a computerized system capable of storing, manipulating and using spatial data describing location and significant properties of the earth's surface. GIS is an interdisciplinary technology used for studying and managing land uses, land resource assessment, environmental monitoring and hazard/toxic waste control, etc. Introduces this emerging technology and its applications. Same as CE 602 and Tran 602.

**MIP 655. Land Use Planning. 3 credits, 3 contact hours.**
Spatial relations of human behavior patterns to land use: methods of employment and population studies are evaluated; location and spatial requirements are related to land use plans; and concepts of urban renewal and recreational planning are investigated by case studies. Same as TRAN 655 and CE 655.

**MIP 673. Infrastructure Planning in Practice. 3 credits, 3 contact hours.**
Infrastructure planning principles, methods and tools. Through selected examples, acquaintance with infrastructure planning theories and models, quantitative methods of research and analysis, information management, decision making, and implementation techniques. Same as ARCH 673.

**MIP 674. Infrastructure and Architecture. 3 credits, 3 contact hours.**
Examination of areas of overlap and continuity between architecture, landscape architecture, urban design, building science and infrastructure. Topics include the typology, programming and design of public facilities; the housing fabric; the relation between built form, urban space and infrastructure. Same as ARCH 674.

**MIP 675. Elements of Infrastructure Planning. 3 credits, 3 contact hours.**
Introductory survey of the basic principles, operation and design of physical infrastructure systems including roads, public transportation, community facilities, public open space, surface drainage, and electric, gas, water, waste disposal, and telecommunications services. Same as ARCH 675.

**USYS 702. Evolution American Metropolis. 3 credits, 3 contact hours.**
This course introduces the morphological and cultural evolution of the US metropolis, historical and economic, political, geographic, contemporary perspectives. The emphasis is on the intersection of social, and environmental conditions that gave rise to distinct urban areas and that have influenced urban populations for over three centuries. A chronological overview of the settlement, growth, decline and revitalization of American cities is combined with detailed case studies.

**USYS 711. The Good City:Env Des& Qual. 3 credits, 3 contact hours.**
Prerequisites: Enrolment in Urban Systems Program or by permission of instructor. This course introduces urban systems doctoral students to the various ways in which architects, urban designers, and planners have sought and continue to seek to improve the quality of everyday life in urban and suburban environments through the design of the built environment, both at the scale of neighborhoods and communities and at the scale of buildings. The emphasis is on manipulation of built form, transportation, and public space as responses to perceived problems. Key topic area are housing and neighborhoods, public space, transportation, schools, and hospitals.

**USYS 721. Aspects of Urban Form. 3 credits, 3 contact hours.**
Prerequisites: Enrollment in Urban Systems PhD Program or by permission of instructor. This seminar course investigates formal aspects of cities, ranging from streets to squares, parks, monuments, residential fabrics, infrastructure, and the overall image. The case studies are draw from historic and contemporary cities and cover a wide geographical area. The inclusion of ?Western? and ?non-Western? examples allows for a cross-cultural perspective. While the physicality of urban elements constitutes the starting point, they will be examined in reference to the political, social cultural, and economic issues and situated in their historic contexts.

**USYS 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisites: Permission of Track Director. This designation covers courses for Urban Systems students prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Student may not register for this course more than once with the same supervising faculty member.

**USYS 726. Independent Study II. 3 credits, 3 contact hours.**
Prerequisites: Permission of Track Director. This designation covers courses for Urban Systems students prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Student may not register for this course more than once with the same supervising faculty member.

**USYS 788. Special Topics in Urban Systems. 3 credits, 3 contact hours.**
Special-area given when suitable interest develops. Advance notice of forthcoming topics in Urban Systems will be given.

**USYS 790. Dissertation Research. 0 credits, 0 contact hours.**

**USYS 790A. Dissertation Research. 1 credit, 1 contact hour.**

**USYS 790B. Dissertation Research. 3 credits, 3 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester until a written dissertation is approved.

**USYS 790C. Dissertation Research. 6 credits, 6 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**USYS 790D. Dissertation Research. 9 credits, 9 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**USYS 790E. Dissertation Research. 12 credits, 12 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**USYS 792. Dissertation Research. 3 credits, 3 contact hours.**
Prerequisites: Permission of Track Director. For students admitted to the Doctor of Philosophy Program in Urban Systems who have not yet passed the qualifying examination. Research is carried out under the supervision of designed Urban Systems faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied to the 24 credits required under USYS 790.

# Architecture

Graduate architectural education exposes students to the broad intellectual inquiry of the academy and the specific technical knowledge required in the world of professional practice. Sustainable design is a basic attitude which informs our entire curriculum. Communication skills move from basic visual literacy to instruction in the principles and techniques of digital design: computer-aided design (CAD), computer-aided manufacturing (CAM), three-dimensional digital rendering, and digital animation. Students gain experience through individual design studio projects that range from the small-scale design and manufacture of a single object to a large-scale design of communities.

Our location-five minutes from Newark Penn Station by subway, and thirty minutes from Midtown Manhattan-gives students access to a faculty drawn from the largest concentration of design professionals in the country, and enables those faculty to treat design as a diverse series of real projects on real sites in a vital metropolitan region. In combination with the unparalleled internship opportunities available in New York and Northern New Jersey and the availability of dual degree programs, this approach allows students to both prepare for a career in architecture and to find a direction within the field. The architect envisions and imagines both what is possible, and what ought to be. As a process, design gives form to society and the economic and technological aspects of environmental order.

For students in the Professional M.Arch. Program, partnerships through dual degree tracks in infrastructure planning, management and civil engineering can broaden a general education in architecture. Post-professional opportunities for specialized career directions, scholarly inquiry and research are also offered through degree programs in architectural studies and infrastructure planning.

The faculty comprises practitioners and scholars whose expertise and professional reputation are based on both breadth and depth of achievement. Their work directly engages the architectural discourse through research, publication, public lectures, symposia and professional practice. Many members have received scholarly recognition and design awards.

The New Jersey School of Architecture offers the only publicly supported professional program in New Jersey and is committed to NJIT's reputation as a nationally recognized technological university.

To become registered as a licensed architect in the State of New Jersey, you must earn a degree accredited by the National Architectural Accrediting Board (NAAB). NJIT's M.Arch. degree program is one of only two NAAB-accredited degree programs in the State of New Jersey.

The following statement is taken from the current edition of NAAB's *Conditions and Procedures for Professional Degree Programs in Architecture*: "In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on its degree of conformance with established educational standards.

Master's degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree."

The NJIT Master of Architecture (M.Arch.) is a professional degree fully accredited by the NAAB.

## Master of Architecture (M.Arch.)

There are two degree options in the M.Arch. program: professional M.Arch. and post-professional M.Arch.

**Professional M.Arch.:** For students with undergraduate or graduate degrees who do not have previous architectural design courses or experience; the full-time program of study comprises six semesters and meets the education requirements for the Architecture Registration Examination (ARE). It is also appropriate for students who have undergraduate degrees in architecture or related fields, those who have a non-NAAB accredited architecture degree, and all international students who would enter the program with advanced placement. Advanced placement, which reduces the 102-credit degree requirement, is determined at the time of admission through an evaluation of previous academic work.

**Post-professional M.Arch.:** For students who have an NAAB-accredited professional Bachelor of Architecture (B.Arch.) or an equivalent international degree. International students who intend to pursue professional licensure in the U.S. should apply to the Professional M.Arch Program.

**Dual Degree M.Arch. and Master of Infrastructure Planning (M.I.P.):** Open only to students in the M.Arch. program options studio sequence, the dual degree program permits students to earn credits towards both M.Arch and M.I.P degrees simultaneously and obtain an M.I.P. in substantially less time than if taken separately. Also see the program description under "**Infrastructure Planning**" in this catalog.

**Dual Degree M.Arch. and M.S. in Management:** Open only to students in the M.Arch. program studio options sequence, the dual degree program permits students to obtain an M.S. in Management in substantially less time. Also see the program description under "**Management**" in this catalog.

**Dual Degree M.Arch. and M.S. in Civil Engineering:** Open only to students in the M.Arch. program studio options sequence. The dual degree program permits students to obtain an M.S. in Civil Engineering in substantially less time. Also see the program description under "**Civil Engineering**" in this catalog.

### Admission Requirements for all M.Arch. Programs

In addition to completing the application required by NJIT's Office of University Admissions, M.Arch. applicants must also submit School of Architecture supplementary materials forms. To ensure prompt consideration, students should request the forms when they apply for admission to the university.

Applicants are expected to have a minimum undergraduate GPA of 3.0. GRE (general test) scores are required. Applicants to the M.Arch./M.S. in Management degree option may submit GRE scores in lieu of the GMAT scores which are normally required for admission to the M.S. in Management program. Exclusive of the GMAT/GRE requirements, dual degree applicants must satisfy admission requirements for both the School of Architecture and the School of Management.

Admission to the M.Arch. program is based on the applicant's personal statement, letters of recommendation, design portfolio, and previous academic and work experience. Applicants should have completed a minimum of one semester each of college-level physics and calculus; students who lack such a background will be expected to take equivalent course work before entering the second year of the M.Arch. program. Applicants from non-architectural backgrounds are strongly advised that coursework in design, drawing, and/or studio art is useful preparation for graduate study in architecture, and helpful in the process of generating work for inclusion in the portfolio required as an element in all applications. International students with professional degrees in architecture are required to have transcripts evaluated by Educational Credential Evaluators (information is included with School of Architecture supplementary materials). Aggregate TOEFL scores of 80 or higher are required for all international students.

**Graduate Certificate Programs:** A 12-credit graduate certificate in Sustainable Architecture is available as a step toward either the Post-Professional M.Arch. or the MSArch degree. Students in the Professional M.Arch. Program may use some or all of the courses in this certificate program to satisfy upper-level architecture and free electives. See **Graduate Certificates** in this catalog for further information. For more information on continuing and distance education, contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

# Master of Science in Architecture (MSARCH)

A non-professional, non-design degree program for careers in architectural research and scholarship. Studies often involve interdisciplinary course work.

## Admission Requirements

Applicants are expected to have either an NAAB-accredited B.Arch., or a bachelor's degree in architecture or disciplines related to production, operation or use of buildings.

In addition to completing the application required by NJIT's Office of University Admissions, M.S.ARCH applicants must also submit School of Architecture supplementary materials forms. To ensure prompt consideration, students should request the forms when they apply for admission to the university.

Applicants are expected to have a minimum undergraduate GPA of 3.0. GRE (general test) scores are required.

Through interdisciplinary teaching, research and practice made possible by NJIT's resources in architecture, civil and environmental engineering, transportation, management, and environmental policy studies, the program addresses the global need to train planning and design professionals capable of acting across the spectrum of disciplines involved in infrastructure development.

Infrastructure is defined as the whole built fabric of public spaces, institutions, facilities and services that shapes and sustains daily life. Collaboration between the disciplines concerned with different infrastructure components is necessary to develop holistic strategies for building more livable and efficient urban environments. The goal of the M.I.P. program is to gain a coherent understanding of the interrelationships between those components and to develop the potential of integrally planned and designed infrastructure systems to deal more effectively with the critical problems confronting our cities.

Using a variety of project settings, the program focuses on the natural environment and on public space, roads, transportation, services and utilities as interacting physical and spatial systems, as well as on parks, schools, housing and civic institutions. The purpose is to develop operational strategies that integrate the broadest possible range of planning and design policies, methods and actions for improving human settlements; and to resolve in environmental terms the larger social and political issues that affect the quality of life in our communities.

Capitalizing on NJIT 's multidisciplinary resources and location at the center of the nation's greatest regional concentration of urban infrastructure, the M.I.P. program incorporates applied research and realistic problem solving in its curriculum and also offers internships and research assistantships. M.I.P. faculty, drawn from the university's four academic divisions, is supplemented by eminent infrastructure planning practitioners. Collaborative relationships have been established with complementary academic programs at Rutgers University and with regional, national and international institutions concerned with infrastructure. At NJIT, a number of notable research facilities are engaged in specialized work related to infrastructure planning and design.

# Master in Infrastructure Planning

A unique interdisciplinary program in infrastructure planning and design directed at students with previous degrees in architecture, landscape architecture, urban planning or civil engineering.

**Dual Degree Programs:** Dual M.Arch./M.I.P. or M.S. in Civil Engineering/M.I.P. degree options that reduce the number of credits required to obtain the two degrees separately are available to students with superior academic records who hold bachelor's degrees in architecture or engineering from NJIT or equivalent degrees from other universities; or who are prospective graduates of the professional M.Arch. program at NJIT. See "Architecture" for the M.Arch./M.I.P dual degree program description. See the graduate advisor for the M.S. in Civil Engineering/M.I.P. dual degree program description.

## Admission Requirements

Applicants must have a bachelor's or a master's degree in architecture, landscape architecture, urban planning, or engineering. A GPA of at least 3.0 is expected and evidence of potential for graduate study is to be demonstrated by a portfolio, letters of recommendation, GRE scores, and TOEFL scores of 550 (pencil and paper) and 213 (computer-based) in the case of international students.

*Bridge Program:* Students not sufficiently experienced in design will be required to take an intensive bridge course in design prior to entering the program. This course does not count toward degree credit.

# NJIT Faculty

## A

Alcala, Jose M., University Lecturer

## B

Bales, Ervin, Research Professor

Bess, Mark E., University Lecturer

Brothers, David A., Senior University Lecturer

Burgermaster, Matthew A., Assistant Professor

## C

Cays, John M., Associate Dean for Academics, College of Architecture and Design

Celik, Zeynep, Distinguished Professor

## D

Dart, James, University Lecturer

Decker, Martina, Assistant Professor

De Sousa Santos, Antonio P., Professor Emeritus

## E

Elwell, David H., Associate Professor Emeritus

Esperdy, Gabrielle, Associate Professor

## F

Franck, Karen A., Professor

## G

Garber, Richard J., Associate Professor

Garcia Figueroa, Julio C., University Lecturer

Gauchat, Urs P., Professor

Goldman, Glenn, Professor

Greenfield, Sanford R., Professor Emeritus

## H

Harp, Cleveland J., University Lecturer

Hurtado De Mendoza Wahrolen, Maria A., Associate Professor

## K

Krumwiede, Keith A., Associate Professor

### L

LeCavalier, Jesse, Assistant Professor

### M

Moore, Sandy, Associate Professor

Mostoller, G. Michael, Distinguished Professor

### N

Narahara, Taro, Assistant Professor

Navin, Thomas R., University Lecturer

### O

Ogorzalek, Thomas, University Lecturer

### P

Papademetriou, Peter C., Professor Emeritus

### R

Russo, John Rhett, Associate Professor

### S

Schuman, Anthony W., Associate Professor

Siegel, Joy W., University Lecturer

Sollohub, Darius T., Associate Professor

### T

Taher, Rima, Senior University Lecturer

Theodore, Georgeen, Associate Professor

### W

Wall, Donald R., Associate Professor Emeritus

Weisman, Leslie K., Professor Emeritus

Wendell, Augustus E., University Lecturer

West, Troy, Associate Professor Emeritus

Wood, Timothy Daniel, University Lecturer

### Z

Zarzycki, Andrzej, Associate Professor

Zdepski, Michael, S., Associate Professor

## Programs

- Architecture - M.Arch. (p. 641)
- Architecture - M.S. (p. 641)
- Infrastructure Planning - M.I.P. (p. 647)

## **Double Majors** (p. 589)

- Architecture (professional, or post-professional) - M.Arch. and Infrastructure Planning - M.I.P. (p. 646)
- Architecture (professional, or post-professional) - M.Arch. and Management - M.S. (p. 645)

- Architecture (professional, or post-professional) - M.Arch. and Civil Engineering - M.S. (p. 642)
- Urban Systems - Ph.D. (p. 648)

# New Jersey School of Architecture Courses

**ARCH 500G. Advanced Architectural Graphics. 3 credits, 3 contact hours.**
Introductory computer science with applications in computer graphics for architecture. Emphasizes programming methodology using a high-level language as the vehicle to illustrate concepts. Basic concepts of computer systems, software engineering, algorithm design, programming languages, and data abstraction, with applications.

**ARCH 501G. Architectural Design I. 6 credits, 12 contact hours.**
Prerequisite: graduate level standing. Core Studio. Fundamentals of architectural design. Sequence of projects explore two- and three-dimensional design. Choice of form and aesthetics is related to spatial resolution of function and context. Design as a representational medium is emphasized. Taken concurrently with ARCH 555G.

**ARCH 502G. Architectural Design II. 6 credits, 12 contact hours.**
Prerequisites: ARCH 501G, ARCH 528G, ARCH 541G, ARCH 555G. Core Studio. Extends the knowledge of design, basic concepts and ideas introduced in ARCH 501G. Emphasis is on developing technical drawing, and model-making skills. Also covered are two- and three-dimensional composition. Links to the history and theory sequence are made.

**ARCH 503G. Architectural Design III. 6 credits, 12 contact hours.**
Prerequisites: ARCH 500G, ARCH 502G, ARCH 529G, ARCH 543G, and ARCH 545G. Core Studio, Intermediate design studio. Introduction to structure. Properties of materials both physical and in the abstract. Builds on knowledge gained from construction and structures courses, spatial demands and design possibilities of different structural systems. Design of structure type, model and context, and comparisons of building typology for rational structure. Drawing and its role in design thinking.

**ARCH 504G. Architectural Design IV. 6 credits, 12 contact hours.**
Prerequisites: ARCH 503G, ARCH 542G, ARCH 544G. ARCH 548G. Corequisite:547G. Second semester intermediate design studio. Design of buildings and integration of systems, physical and conceptual. Design methodology generates new information on buildings as coherent assemblies of systems. Also covers analysis and synthesis of form and introduction to applications of computer-assisted design (CAD). Preparation of design portfolio will complete core studio sequence.

**ARCH 505G. Advanced Design Options I. 6 credits, 12 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 506. Advanced Design Options II. 5 credits, 13 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 506G. Advanced Design Options II. 6 credits, 12 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 507G. Advanced Design Options III. 6 credits, 13 contact hours.**
Prerequisites: ARCH 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions.

**ARCH 510. Co-op Work Experience. 0 credits, 3 contact hours.**
Restriction: Approval of the school and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Students are required to complete and present miterm and final projects and/or reports. A designated faculty member monitors and evaluates the student's work and project.

**ARCH 513G. Structures III. 3 credits, 3 contact hours.**
Prerequisite: ARCH 512G. Review of methods and procedures for choosing structural systems. Overview of differences among wood, steel and concrete systems. Students are introduced to complex structural behavior, prestressed concrete and new structural technology.

**ARCH 527G. Situating Prac:Thrshds of Arch. 3 credits, 3 contact hours.**
Restriction: Enrolment in Masters of Architecture Program or by permission of instructor. Western architectural theory dating from Vitruvius to the present time. Examines critical texts and studies related building and projects.

**ARCH 528G. History of Architecture I. 3 credits, 3 contact hours.**
Restriction: graduate level standing. Introduction to the history of architecture. Emphasis on classical architecture from antiquity to the modern period. Evolution of the various themes and theories that underlie western architecture is presented chronologically.

**ARCH 529G. History of Architecture II. 3 credits, 3 contact hours.**
Prerequisite: ARCH 528G. Continuation of ARCH 528G. Introduces concepts of modernism and brings the history of western architecture to the contemporary period.

**ARCH 530. Methodologies of Architectural History, Theory and Criticism. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. A seminar examining the salient methodologies of architectural history, theory and criticism. Structured around a series of critical texts, with each set of core readings intended to provide a basis for analyzing and assessing the approach in question.

**ARCH 531A. History of Renaissance Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An examination of the development of Renaissance architecture and urban design in Italy and elsewhere in Europe. The re-emergence of the classical tradition is considered within the context of social, political and economic developments as well as formal intentions.

**ARCH 531B. History of Baroque Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An investigation of architectural development from the 17th and 18th centuries in Europe and Latin America, including consideration of stylistic variations, social and political factors, and trends in garden and urban design.

**ARCH 531C. History of Modern Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. A study of major tendencies of architectural theory and practice from the mid-19th to the mid-20th centuries. Formal and stylistic transformation is considered in relation to theoretical intentions as well as social, cultural, and technical developments.

**ARCH 531D. History of American Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An investigation of the guiding ideals and dominant stylistic trends in American architecture and planning from colonial times to the mid-20th century. Critical shifts in conception and scope of architectural production considered in relation to the prevailing cultural, socio-economic, and technical contexts out of which they evolved.

**ARCH 531E. History of Non-Western Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An examination of major architectural traditions of China, Japan, Southeastern Asia, India, and the Middle East. Each area is considered with reference to a conceptual, iconographic and stylistic paradigm that evolved from a particular historical context.

**ARCH 531F. Thresholds of Architectural Theory. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. A seminar that investigates key thresholds of Western architectural theory, from Vitruvius to Robert Venturi, with emphasis on examining the corresponding critical theoretical texts and related didactic buildings and projects.

**ARCH 531H. Aspects of Urban Form. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. An examination of the major forms and patterns of urban development from classical antiquity to the 20th century, considered in relation to the changing conceptions of the city as well as cultural, socio-economic, and political development.

**ARCH 533. Case Studies in Architectural Creativity. 3 credits, 3 contact hours.**
Prerequisite: ARCH 364. Considers creativity in architecture from psychological, philosophical and autobiographical perspectives. The buildings, writings and lives of contemporary architects are discussed in the context of general theories of creativity. Each student chooses an individual architect noted for creative accomplishments and prepares a case study of his or her life.

**ARCH 534. History of Architectural Technology. 3 credits, 3 contact hours.**
Prerequisites: ARCH 382. Survey of the development of building methods and materials. Impact of structural and environmental technology on architectural form and the design process. The role of technology in contemporary architectural theory and practice, including the modern movement, is emphasized.

**ARCH 535. History of Architectural Ideas. 3 credits, 3 contact hours.**
Prerequisite: ARCH 382. Discusses seminal architectural ideas in the western world from Vitruvius to the present day. Read books written by leading architectural theorists and analyze them in detail.

**ARCH 536. Landscape and American Culture. 3 credits, 3 contact hours.**
As in architecture, the parallel discipline of landscape architecture involves artistic intention set in conjunction with utilitarian concerns. As such, designs on the land include the integration of the arts and sciences of human culture with nature. Discusses landscape as a manifestation of American culture.

**ARCH 537. Advanced Structures. 3 credits, 3 contact hours.**
Covers advanced material in structures related to steel and wood design including: steel industrial buildings, rigid frames and earthquake design, wood structures under axial loads, and combined bending and axial loads.

**ARCH 538. Sustainable Architecture. 3 credits, 3 contact hours.**
Follows two precepts: accepting responsibility for the consequences of design decisions upon human well-being, and the long-term viability of natural systems. Topics include sustainable site design and development, environmentally sensitive building materials, lifecycle cost benefit analysis of building systems, and adaptive reuse.

**ARCH 540. Acoustics. 3 credits, 3 contact hours.**
Prerequisites: ARCH 241, ARCH 242, ARCH 342. Architectural acoustics: how we hear, physics of sound and materials, aesthetics of design and the processes of construction. Audible sounds, their interaction, perception of echo and directional hearing are applied to interior and exterior building transmission, room acoustics, and setting acceptable acoustical environments.

**ARCH 541. Material Systems in Design. 3 credits, 4 contact hours.**
Prerequisite:4th year undergraduate standing or approval from instructor This seminar will allow students to exam material systems that give design agency to matter as a creative and technical force in the making of architecture. In doing so, it will provide students an opportunity to understand and explore the role material matters play in comtemporary architectural theory and praxis. focused on the exploration and understanding og material systems, this course will provide students with the intellectual underpinnings for the re-conceptionalization of matter within thier own design processes.

**ARCH 541G. Construction I. 3 credits, 3 contact hours.**
This course is an introductory survey of the general principles and application of Sustainable Design, Site Systems, Structural Systems, Environmental Systems, Envelope Systems, Materials and Assembly Systems. This course will primarily focus on low-rise wood and steel structures.

**ARCH 542G. Integrated Building Technologies. 3 credits, 3 contact hours.**
Prerequisites: ARCH 541G This course is an introductory survey of the interrelationship of the principles and applications of Sustainable Design, Site Design, Structural Systems, Environmental Systems, Envelope Systems and Materials and Assembly Systems. This course will primarily focus on low and medium-rise concrete and masonry structures and is coordinated with a studio design/build experience.

**ARCH 543. Lighting. 3 credits, 3 contact hours.**
Prerequisites: ARCH 327 or INT 222. Explores, through modeling and calculation, the means by which architectural form and detail influence the luminous environment. Perceptual responses such as visual comfort and delight are examined. Topics include daylighting footprints, model design and testing, and computer-assisted light level analysis. Areas of investigation include the relationship between daylight and electric light in architecture; the variations of light with time; analysis of seasonal and weather differences; role of task in lighting strategies; and means of control for light quantity and quality.

**ARCH 543G. Environmental Control Systems I. 3 credits, 3 contact hours.**
An introductory survey of the basic principles of building, environmental control, and service systems as these relate to the building envelope. This course will primarily cover thermal enclosure, climate modification, environmental systems, energy use, and sustainable design. It also introduces the principles of health and safety in the design of buildings.

**ARCH 544G. Environmental Control Systems II. 3 credits, 3 contact hours.**
This is an intermediate course focusing on the understanding of the principles, performance criteria, and applications of environmental and building service systems including lighting, acoustical, plumbing, electrical, vertical transportations, egress, communication, security, and fire protection systems.

**ARCH 545. Case Studies in Architectural Technology. 3 credits, 3 contact hours.**
Prerequisite: senior standing. Technological systems involved in the construction and use of buildings. Students conduct in-depth investigation of technology-related problems in architecture and construction. Case study method is used. Construction documents and reports are analyzed. Field visits are required.

**ARCH 545G. Structures I. 3 credits, 3 contact hours.**
This is an intermediate course focusing on the principles of structural behavior in withstanding gravity and lateral forces and on the evolution, range, and appropriate application of structural systems and the criteria for selecting various structural systems in contemporary architecture. Specific architectural procedents from the 20th century are used as validating examples.

**ARCH 546. Designing and Optimizing the Building Enclosure. 3 credits, 3 contact hours.**
Prerequisites: CS 104 and (ARCH 327 or INT 222). Considers the building envelope, the boundary dividing the inside of a structure from the outside environment. Study and design optimal enclosures considering energy exchange, the relationship between energy and light, and life cycle costs.

**ARCH 546G. Structures: High Rise and Special Applications. 3 credits, 3 contact hours.**
Prerequisite: 545G. This is an advanced course focusing on the integration of all building systems including new materials and methods as they relate to high-rise structures and other specialty building types.

**ARCH 547. Special Topics in Computer Applications. 3 credits, 3 contact hours.**
Prerequisite: senior standing. Evaluation, utilization, and development of computer programs for analysis, simulation and information management. Programs range from energy analysis, building structures analysis, and mechanical systems design to spatial allocation, graphics and computer-aided design. Different theories of information transformation and delivery used in terms of architectural applications. Course hardware ranges from computer-aided design and drafting systems, through micro and mini, to mainframe computers.

**ARCH 547G. 4D Integration. 3 credits, 3 contact hours.**
Prerequisite: ARCH 542G, ARCH 544G, ARCH 548G. Corecquisite: ARCH 504G. This is a required, advanced design course that uses in-depth, detailed case studies of various construction types, from small scale to large, from simple to complex, to illustrate the totality of building systems integration. In conjunction with site visits, coursework will employ software to examine construction sequences, building components and shop drawings and their relationship to the design processes.

**ARCH 548G. Structures II. 3 credits, 3 contact hours.**
Prerequisite: ARCG 545G. This is an advanced course dealing with structural computation that will conclude with rigorous case study investigation of hybrid and complex structural systems.

**ARCH 549. Life Safety Issues in Contemporary Buildings. 3 credits, 3 contact hours.**
Prerequisites: ARCH 327 or INT 222. A variety of life safety and comfort situations studied in terms of specific building types. Topics include building evacuation, compartmentalization, fire fighting and suppression, evaluation and testing of new building materials and systems, systems control and management. Special emphasis is on such building types as multi-use, high-density, schools, hospitals, and other institutional categories.

**ARCH 552. Real Estate Analysis for Architects. 3 credits, 3 contact hours.**
Restriction: completion of the third year. Introduction to the economic, financial and political aspects of real estate and their effect on architectural decision-making. Topics include needs assessment, real estate appraisal, financial instruments, regulations and real estate, design as value-adding, and the effect of tax policies on real estate development.

**ARCH 555G. Architectural Graphics. 3 credits, 5 contact hours.**
Restriction: graduate level standing. Documentary, descriptive and denotative media are introduced. Also covers methods of representation, delineation and reproduction. Skills are developed in technical drawing, perspective construction, projections, and format design. Taken concurrently with ARCH 501G.

**ARCH 556. Systems Approach to Design and Construction. 3 credits, 3 contact hours.**
Restriction: completion of the third year. Lectures, case studies and student projects on understanding human aspiration and needs through design. Topics include land, finance, management, technology, and labor.

**ARCH 557. Problems in Modern Housing. 3 credits, 3 contact hours.**
Prerequisite: ARCH 382 Historical approach places housing in its social, economic, and political context. Attempts to provide decent, affordable and well-designed housing for broad segments of society are examined. Dwelling is examined through analysis of proto-typical design solutions in urban environments.

**ARCH 558. Professional Architectural Practice. 3 credits, 3 contact hours.**
Prerequisite: ARCH 364. A forum for examination of the structure and practices of the profession of architecture. The formal and informal relationships between architects, and between architects and clients, government officials, and consultants are studied. Basic principles of office management for the small and large architectural firm are introduced.

**ARCH 559. Social Issues in Housing. 3 credits, 3 contact hours.**
Lecture/seminar explores the historical, economic, social, technological, and political basis for current American housing policy and practice. Examines government, community-based and private sector attempts, both failed and successful, at providing decent, affordable, and well-designed housing for broad segments of society. Student teams analyze and discuss, in a series of classroom debates, the housing and planning implications of controversial social problems from homelessness and racial segregation to caring for the elderly and people with HIV/AIDS with an emphasis on the role of the architect.

**ARCH 561. Integrated Studio Seminar. 3 credits, 3 contact hours.**
Prerequisite: ARCH 463. Corequisite: ARCH 564. Held in design studio each week, the lab consists of presentations by the instructor on relevant technical, building code, and life safety-issues as well as student exercises applying these principles to their integrated design studio project or to existing buildings.

**ARCH 563. Comprehensive Studio I. 5 credits, 12 contact hours.**
Prerequisites: ARCH 464, ARCH 423, ARCH 327 and ARCH 429. Studio methodology allows students to select from various building programs, the nature of design dealing with technology, environment and the social order.

**ARCH 564. Comprehensive Studio II. 5 credits, 12 contact hours.**
Prerequisite: ARCH 463 Corequisite: ARCH 565 This Studio focuses on the student's ability to produce a comprehensive architectural project based on a building program and site that includes development of programmed spaces demonstrating an understanding of structural and environmental systems, building envelop systems, life-safety provisions, wall sections and building assemblies and the principles of sustainability. Lecture hour coordinates with studio subject matter. Course materials purchase required.

**ARCH 565. Comprehensive Studio Lab. 1 credit, 1 contact hour.**
Prerequisite: ARCH 464 Corequisite: ARCH 563 or ARCH 564 Held in design studio each week the lab consists of presentations by the instructor on relevant technical and life safety issues and student excercises applying these principles to thier currecnt design studio project or to existing buildings.

**ARCH 566. Advanced Architectural Design Studio. 5 credits, 12 contact hours.**
Prerequisite: ARCH 564. This is an advanced architectural design studio, post Comprehensive Studio, studying contemporary design theories, design methods and construction technologies. Emphasis is placed upon independent design research as it relates to the broad range of architectural practice. Exploratory and experimental architectural projects are the focus of the course.

**ARCH 569G. Building and Development. 3 credits, 3 contact hours.**
Familiarization with the larger process of building production, of which architecture is one important part. Focus on the role of the architect in the areas of current building development: an examination of how redefinition or change might improve the process. Lectures deal with all factors of the building process and interviews with the various actors involved in designing, approving, financing and making buildings. Students have various assignments including a major term project.

**ARCH 571. Everyday Life in the Public Realm. 3 credits, 3 contact hours.**
A significant portion of everyday life takes place in the public realm of streets, sidewalks, parks, transit stations, government buildings, commercial establishments, and cultural institutions. Focuses on recent descriptions and critiques of public space and proposals for change.

**ARCH 572. Architecture and Social Change. 3 credits, 3 contact hours.**
Restriction: senior standing. Architectural form is analyzed in relation to political, economic and technological change, and change in social values. Buildings and other designed environments such as parks, streets and neighborhoods are studied relative to the social processes and institutions that generate and transform them. The role of the design professions in initiating or supporting change also is considered.

**ARCH 573. Technologies for Community and Urban Design. 3 credits, 3 contact hours.**
Restriction: senior standing. Advanced and traditional technologies analyzed with regard to their role in community and city design, construction and reconstruction. Emphasis on technological systems influencing location, configuration and use. Examples are infrastructures, communication systems and construction technologies. Develops skills in using methods to evaluate alternative technologies relative to their social, economic and physical promise, problems and feasibility.

**ARCH 574. Case Studies in Community and Urban Design. 3 credits, 3 contact hours.**
Restriction: senior standing. In-depth investigation of specific real-world problems of urban or community design carried out using case method approach. Current practices in the U.S. and other countries studied using interviews with designers, developers, community groups and government agencies. Site visits, reports and other documents provide important sources of information. Final report with supporting documentation required.

**ARCH 576. The Architecture of Utopia. 3 credits, 3 contact hours.**
Restriction: senior standing. Seminar for the review of utopian projects that have attempted to embody and strengthen social ideas through transformations in the structuring of space. Architectural implications of different literary and philosophical utopias analyzed with an emphasis on those experimental proposals which were realized, in whole or in part, in built form.

**ARCH 579G. Professional Architectural Practice. 3 credits, 3 contact hours.**
Restriction: completion of M.Arch. core sequence. Review of the formal, informal, legal, and ethical obligations of the professional architect. Traditional relationships among the architect, clients, engineers and other participants in the design and building industry are studied. Principles of office management and problems of liability are introduced. Also fulfills core requirement of dual degree option for M.Arch./Master of Science in Management.

**ARCH 583. ST:. 3 credits, 3 contact hours.**
Group investigation of problem of special interest in architecture.

**ARCH 588. Architoons. 3 credits, 3 contact hours.**
Prerequisite: ARCH 364. Through the medium of film, applies literary devices to architectural contexts, including caricature, parody, lampoon, satire and farce. Studies historical and contemporary animations and short films for their treatment of meaning, story line and sequence, timing, environmental and psychological mood, atmosphere and emotion. Using 3-D modeling and animation software, each student produces an animated short subject illustrating an architectural principle or providing a humorous look at architectural history and theory.

**ARCH 591. Independent Study. 1 credit, 1 contact hour.**

**ARCH 592. Independent Study. 2 credits, 2 contact hours.**

**ARCH 593. Independent Study. 3 credits, 3 contact hours.**

**ARCH 619. Architectural Photography. 3 credits, 3 contact hours.**
Prerequisites: ARCH 501G, ARCH 502G, ARCH 503G. Photography for architectural presentations and portfolios. Lectures include orientation on light and space, slide presentations, and the use of text to reinforce photographic material. Demonstrations include basic darkroom techniques, and methods to encourage experimentation in photography.

**ARCH 630. Methodology of Architectural History, Theory and Criticism. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. This seminar is structured around notable readings on architectural history, theory and criticism to provide students with a sound basis for critical analysis and assessment. It is recommended for students who select history and theory as their area of concentration.

**ARCH 631A. History of Renaissance Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Development of architecture and urban design in Italy and elsewhere in Europe during the Renaissance: re-emergence of the classical Greek and Roman architectural tradition; social, political and economic developments; formal intentions and transformations in the 16th and 17th centuries.

**ARCH 631B. History of Baroque Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. The emergence of baroque architecture and urban design in Rome in the 17th century; analysis of the works of Bernini, Borromini, Cortona and their contemporaries and successors through 1750. Development of baroque architecture elsewhere in Italy and Europe; late baroque and rococo; the advent of neo-classicism.

**ARCH 631C. History of Modern Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Major tendencies in architectural theory and practice from the mid-19th to the mid-20th centuries. Formal and stylistic transformation considered in relation to theory, social, cultural, and technical developments.

**ARCH 631D. History of American Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Aesthetic, social, cultural and technical developments in American architecture and planning, from colonial times to the mid-20th century.

**ARCH 631E. History of Non-Western Architecture. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Examination of major architectural traditions and styles of China, Japan, Southeast Asia, India and the Middle East.

**ARCH 634. History of Architectural Technology. 3 credits, 3 contact hours.**
Prerequisites: ARCH 528G, ARCH 529G. Survey of the development of building methods and materials. Impact of structural and environmental technology on architectural form and the design process. The role of technology in contemporary architectural theory and practice including the modern movement is emphasized. Recommended for students who select building science as their area of concentration.

**ARCH 636. Methods of Urban History. 3 credits, 3 contact hours.**
Prerequisites: Graduate status The seminar examines methods for conducting historically driven, interdisciplinary research on the built environment (with a focus on cities and suburbs) through the lens of architecture, landscape, geography, and material culture. Methodology is studied to inform the production of urban history and to frame historical perspectives on contemporary urban issues. Historiography and critical theory are key aspects of the study of urban history's methodologies. In addition to traditional historical methodologies, the course examines emerging digital humanities methodologies.

**ARCH 637. Teaching Sem:Arch Pedagogies. 3 credits, 3 contact hours.**
Prerequisites: Graduate status This course is a graduate seminar that introduces students to key issues in contemporary pedagogy, understood as the art, craft, theory and practice of teaching. The course examines principles and constructs of teaching and education, as well as their pragmatics and practicalities. The main focus of the course is architectural education with discussions informed by diverse issues such as technology and the information revolution and multiculturalism and globalism.

**ARCH 640. Acoustics. 3 credits, 3 contact hours.**
Restriction: completion of core sequence or equivalent. Architectural acoustics: how we hear, physics of sound and materials, aesthetics of design and the processes of construction. Audible sounds, their interaction, perception of echo and directional hearing are applied to interior and exterior building transmission, room acoustics, and setting acceptable acoustical environments.

**ARCH 641. Experiments in Structural Form. 3 credits, 3 contact hours.**
Restriction: completion of core sequence or equivalent. Architectural form through model design, construction and testing of minimum structures, including elements of soap film study, orthogonal and diagonal grids, design of tension grids through deflection loading, photoelastic models and calculation. Also compares geometric systems, patterning and proportion, symmetry, asymmetry, relative size, nesting, linearity and spiral orders, rectilinear patterns, and randomness in architectural structure and form.

**ARCH 642. Digital Modeling & Fabrication. 3 credits, 3 contact hours.**
Prerequisites: ARCH 501G This is a 3-credit seminar course for graduate students exploring advanced 3-dimensional computer modeling techniques and data export for assembly and fabrication to various computer numerically controlled (CNC) hardware available at the School of Architecture. Specifically, students engage in NURBS and solid modeling using Rhinoceros 3D and export data through various Rhino plug-ins including RhinoCAM, which writes G- and M- Codes for 2 and 3D milling operations.

**ARCH 643. Lighting. 3 credits, 4 contact hours.**
Prerequisites: ARCH 501G and ARCH 502G. Through modeling and calculation, influence of the luminous environment on architectural form and detail. Perceptions of visual comfort and daylight are examined. Topics include daylighting footprints, model design and testing, and computer-assisted, light-level analysis. Relationship between daylight and artificial light in architecture, variations of light with time, analysis of seasonal and weather differences, role of task in lighting strategies, and means of control for light quantity and quality.

**ARCH 645. Case Studies in Architectural Technology. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. Case-study method used for in-depth investigation of the relationship among various technological systems in a building and technologically-related problems in architecture and construction.

**ARCH 646. Designing and Optimizing the Building Enclosure. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. Considers the "building envelope," the boundary dividing the inside of a structure from the outside environment. Students study and design optimal enclosures considering energy exchange, the relationship between energy and lighting, and life cycle costs.

**ARCH 647. Special Topics in Computer Applications. 3 credits, 5 contact hours.**
Restriction: completion of core sequence. Evaluation and use of computer graphics hardware and software for architectural applications. Focus is on computers as tools, operating systems and methods of data manipulation. Two- and three-dimensional modeling software are discussed, and assignments using such software are given to provide understanding of the modeling of built environments.

**ARCH 649. Life Safety Issues in Contemporary Buildings. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. A variety of life safety and comfort situations are studied in different building types. Topics include building evacuation, compartmentalizing, fire fighting and suppression, evaluation and testing of new building materials and systems, systems control and management. Special attention is placed on multi-use, high-density buildings.

**ARCH 650. Economy of Building. 3 credits, 3 contact hours.**
Restriction: completion of core sequence or equivalent. Economic consequences of design decisions. Topics include: relationship among economy, efficiency and quality; life-cycle cost of design; improving the economy of building processes and products through innovation; and environmental concerns. This course is required for the dual degree M.Arch./Master of Science in Management program. It can also be used as an elective in the M.Arch. program.

**ARCH 651. Real Estate Analysis for Architects. 3 credits, 3 contact hours.**
Restriction: completion of core sequence. Introduction to the economic, financial and political aspects of real estate and their effect on architectural decision-making. Topics include: needs assessment, real estate appraisal, financial instruments, regulations and real estate, design as value-adding, and the effect of tax policies on real estate development. This course is required for the dual degree M.Arch./Master of Science in Management program. It can also be used as an elective in the M.Arch. program.

**ARCH 652. Architectural Project Management. 3 credits, 3 contact hours.**
Prerequisite: ARCH 579G. Restriction: completion of core sequence. Management of architectural projects: project costs, timing, personnel, documentation, professional ethics and resource management. This course is required for the dual degree M.Arch./Master of Science in Management program. It may be used as an elective in the M.Arch. program.

**ARCH 660. Direct Study In Arch II. 3 credits, 3 contact hours.**

**ARCH 661. Directed Studies of Architecture. 3 credits, 3 contact hours.**
Restriction: completion of core, two elective courses, and approval from the graduate advisor. Independent, in-depth research on an analytical, theoretical or technical area of architecture. Student prepares formal research proposal with permission of faculty advisor and approval of graduate advisor. Required as pre-thesis research. See also course description for MARC 701.

**ARCH 662. Special Topics in Architecture. 3 credits, 3 contact hours.**
Topics vary each semester. Refer to the School of Architecture bulletin during university registration periods for a list of current topics and possible prerequisites.

**ARCH 663. Introduction to Sustainable Architecture. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Environment design of buildings. The five characteristics of green buildings: sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. The US Green Building Council's Green Building Rating System, review of several major buildings of exemplary design.

**ARCH 664. Indoor Environmental Quality in Sustainable Design Buildings. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Supportive ambient conditions, including thermal comfort and acceptable indoor air quality, visual comfort, and appropriate acoustical quality, overall physical and psychological well-being for workplace quality, performance and productivity.

**ARCH 665. Sustainable Design of Energy Efficient Buildings. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Evaluation of heating and cooling loads, impact on fuel consumption, energy software analysis for design and efficiency. Technology of passive solar design and building integrated photovoltaics.

**ARCH 666. Sustainable Design with Efficient Materials and Resources. 3 credits, 3 contact hours.**
Prerequisite: ARCH 543G or ARCH 227. Environmentally sensitive site design; issues of wildlife habitat, erosion, ground water recharge, and threats to water quality of surface water bodies and aquifers. Water reclamation, materials and energy conservation, waste reduction and recycling.

**ARCH 672. Architecture and Social Change. 3 credits, 3 contact hours.**
Prerequisite: graduate level standing. Analysis of architectural form with respect to political, economic and technological change. The built environment is studied in relation to society and culture. The role of design professions in initiating or supporting change is also considered.

**ARCH 675. Elements of Infrastructure Planning. 3 credits, 3 contact hours.**
Introductory survey of the basic principles, operation and design of physical infrastructure systems including roads, public transportation, community facilities, public open space, surface drainage, and electric, gas, water, waste disposal, and telecommunications services. Same as MIP 675.

**ARCH 676. The Architecture of Utopia. 3 credits, 3 contact hours.**
Restriction: graduate level standing. Seminar looks at several ideas of utopia from literature and philosophy and how they embody transformations in the structure of space, and their architectural implications.

**ARCH 678. Graduate Problems in Modern Housing. 3 credits, 3 contact hours.**
Restriction: graduate level standing. Students learn to analyze political, technical and economic aspects of contemporary housing policy and practice. Attempts to provide well-designed, affordable housing responsive to the needs of large numbers of people are examined. Examples of housing from the mid-19th century to the present day are outlined.

**ARCH 679. Envisioning Newark. 3 credits, 3 contact hours.**
This seminar combines classroom discussion based on historical, analytical and literary texts; field visits to Newark's districts and neighborhoods; and meetings with leaders in government, business, art, education, and community-based organizations. The objective is to introduce students to the redevelopment process underway in Newark, and to use the city as a springboard for a broader investigation of the theory and practice of urban development.

**ARCH 680. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: completion of core sequence, permission from graduate advisor and Division of Career Development Services. Students gain work experience and reinforcement of their academic programs. An architecture faculty Co-op advisor monitors and evaluates student work and project. Co-op work experiences may be acceptable equivalents for apprenticeships mandated by the New Jersey State Board of Architects and for eligibility to take the architecture licensing examination. This course is required for participation in the Housing Scholars Program. Course does not fulfill degree requirements.

**ARCH 681. Co-Op Work Experience. 3 credits, 3 contact hours.**
Restriction: completion of core sequence, permission of graduate advisor and Division of Career Development Services. Used for extended summer-fall (681) or spring-summer (682) work experience. Does not fulfill degree requirements.

**ARCH 682. Co-Op Work Experience III. 0 credits, 0 contact hours.**
Restriction: completion of core sequence, permission of graduate advisor and Division of Career Development Services. Used for extended summer-fall (681) or spring-summer (682) work experience. Does not fulfill degree requirements.

**ARCH 683. Graduate Coop Work Exper IV. 0 credits, 3 contact hours.**

**ARCH 686. Research Methods for Environmental Design. 3 credits, 3 contact hours.**
Introduction to methods of inquiry useful to professionals planning and designing buildings, communities and cities. Skills developed in problem definition and phenomena: measurement, modeling, testing and evaluation. Open to undergraduates with permission of instructor.

**ARCH 701B. Master's Thesis. 3.5 credits, 3.5 contact hours.**

**ARCH 701C. Masters Thesis. 6 credits, 0 contact hours.**

**ARCH 770. Development of the American City. 3 credits, 3 contact hours.**
Restriction: Enrollment in the Urban Systems PhD program or permission of the instructor.Introduction to research in urban history, focusing on the American city. Key texts that deal with the development of the American city will be studied in depth, with particular emphasis on the approaches, methodologies, and sources. Each student will conduct bibliographic research on a city or urban sector from a defined perspective.

**ARCH 771. Pathology of Urban Systems. 3 credits, 3 contact hours.**
Restriction: Enrollment in the Urban System PhD program or permission of the instructor. Definition of pathology of urban systems as large-scale disasters that have resulted in major destruction of the urban fabric and called for radical re-planning projects. Investigation of historic case studies. The aftermath of natural and man-made disasters including war; contemporary case studies.

**MARC 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: Arch 506G, Arch 661, and approval from graduate advisor. Alternative to Arch 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during Arch 661.

**MARC 701A. Master'S Thesis. 1.5 credit, 3 contact hours.**
Prerequisites: ARCH 506G, ARCH 661, and approval from graduate advisor. Alternative to ARCH 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during ARCH 661.

**MARC 701B. Master's Thesis. 3 credits, 3 contact hours.**
Prerequisites: ARCH 506G, ARCH 661, and approval from graduate advisor. Alternative to ARCH 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during ARCH 661.

**MARC 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisites: ARCH 506G, ARCH 661, and approval from graduate advisor. Alternative to ARCH 507G. Under the supervision of a faculty advisor, independent study of issues in the student's area of concentration developed during ARCH 661.

**MIP 601. Interdisciplinary Infrastructure Studio I. 6 credits, 13 contact hours.**
Collaborative work on realistic infrastructure projects by teams of students with different professional backgrounds under the supervision of interdisciplinary faculty. A project manager coordinates and ensures that working conditions in practice are simulated in the studio. Projects include analytical, financial and design components and emphasize planning strategies and the coordinating function of the design process. Studio products are presented orally in reviews and documented in written and illustrated reports.

**MIP 602. Interdisciplinary Infrastructure Studio II. 6 credits, 13 contact hours.**
A comprehensive planning and design project emphasizing infrastructure technologies and information management. CAD and other computer applications are used to produce computer-generated graphics and multi-media presentations. Although subjects and approaches will vary, the work of the studio is intended to develop the students' ability to deal with all facets of infrastructure planning regardless of previous academic background. The final products must include a full written and illustrated report on the project and the research on which it is based.

**MIP 612. Introduction to Environmental Policy Studies. 3 credits, 3 contact hours.**
Introduction to six areas essential to a comprehensive understanding of environmental policy: concepts of environmental policy; tools (law, economics, planning, science, engineering, ethics) for environmental policy; the U.S. perspective (NEPA, clean air and water acts, CERCLA, etc.); the international perspective (Club of Rome models, 1972 UNEP, 1992 Rio, etc.); industrial perspective (pollution prevention/life cycle engineering, privatization, etc.); and the local perspective (New Jersey DEP, NGOs, local industry, shoreline, etc.). Same as EPS 612.

**MIP 618. Public and Private Financing of Urban Areas. 3 credits, 3 contact hours.**
Ties government's budget, tax, policy, allocation of resources between public and private sectors, with the structure, development, and growth needs of urban metropolitan areas. Focuses on problems of poverty, transportation, land-use, economic base, relation between central cities and suburban areas, and alternative engineering and economic solutions. Same as Fin 618 and Tran 604.

**MIP 631. History and Theory of Infrastructure. 3 credits, 3 contact hours.**
The historical role of infrastructure in the formation of cities and the relation of planning theories to urban culture. Case studies are used to develop effective ways of learning urban design; method and substance are equally emphasized. Concentration on the social, economic, political, technological and topographic factors that affect urban form; analysis of urban design schemata and their relation to patterns of use; and the critical appraisal of planning ideologies and strategies. Same as ARCH 631H.

**MIP 652. Geographic Information Systems. 3 credits, 3 contact hours.**
Prerequisite: course or working knowledge of CADD or permission of instructor. Geographical/Land Information System (GIS/LIS) is a computerized system capable of storing, manipulating and using spatial data describing location and significant properties of the earth's surface. GIS is an interdisciplinary technology used for studying and managing land uses, land resource assessment, environmental monitoring and hazard/toxic waste control, etc. Introduces this emerging technology and its applications. Same as CE 602 and Tran 602.

**MIP 655. Land Use Planning. 3 credits, 3 contact hours.**
Spatial relations of human behavior patterns to land use: methods of employment and population studies are evaluated; location and spatial requirements are related to land use plans; and concepts of urban renewal and recreational planning are investigated by case studies. Same as TRAN 655 and CE 655.

**MIP 673. Infrastructure Planning in Practice. 3 credits, 3 contact hours.**
Infrastructure planning principles, methods and tools. Through selected examples, acquaintance with infrastructure planning theories and models, quantitative methods of research and analysis, information management, decision making, and implementation techniques. Same as ARCH 673.

**MIP 674. Infrastructure and Architecture. 3 credits, 3 contact hours.**
Examination of areas of overlap and continuity between architecture, landscape architecture, urban design, building science and infrastructure. Topics include the typology, programming and design of public facilities; the housing fabric; the relation between built form, urban space and infrastructure. Same as ARCH 674.

**MIP 675. Elements of Infrastructure Planning. 3 credits, 3 contact hours.**
Introductory survey of the basic principles, operation and design of physical infrastructure systems including roads, public transportation, community facilities, public open space, surface drainage, and electric, gas, water, waste disposal, and telecommunications services. Same as ARCH 675.

**USYS 702. Evolution American Metropolis. 3 credits, 3 contact hours.**
This course introduces the morphological and cultural evolution of the US metropolis, historical and economic, political, geographic, contemporary perspectives. The emphasis is on the intersection of social, and environmental conditions that gave rise to distinct urban areas and that have influenced urban populations for over three centuries. A chronological overview of the settlement, growth, decline and revitalization of American cities is combined with detailed case studies.

**USYS 711. The Good City:Env Des& Qual. 3 credits, 3 contact hours.**
Prerequisites: Enrolment in Urban Systems Program or by permission of instructor. This course introduces urban systems doctoral students to the various ways in which architects, urban designers, and planners have sought and continue to seek to improve the quality of everyday life in urban and suburban environments through the design of the built environment, both at the scale of neighborhoods and communities and at the scale of buildings. The emphasis is on manipulation of built form, transportation, and public space as responses to perceived problems. Key topic area are housing and neighborhoods, public space, transportation, schools, and hospitals.

**USYS 721. Aspects of Urban Form. 3 credits, 3 contact hours.**
Prerequisites: Enrollment in Urban Systems PhD Program or by permission of instructor. This seminar course investigates formal aspects of cities, ranging from streets to squares, parks, monuments, residential fabrics, infrastructure, and the overall image. The case studies are draw from historic and contemporary cities and cover a wide geographical area. The inclusion of ?Western? and ?non-Western? examples allows for a cross-cultural perspective. While the physicality of urban elements constitutes the starting point, they will be examined in reference to the political, social cultural, and economic issues and situated in their historic contexts.

**USYS 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisites: Permission of Track Director. This designation covers courses for Urban Systems students prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Student may not register for this course more than once with the same supervising faculty member.

**USYS 726. Independent Study II. 3 credits, 3 contact hours.**
Prerequisites: Permission of Track Director. This designation covers courses for Urban Systems students prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Student may not register for this course more than once with the same supervising faculty member.

**USYS 788. Special Topics in Urban Systems. 3 credits, 3 contact hours.**
Special-area given when suitable interest develops. Advance notice of forthcoming topics in Urban Systems will be given.

**USYS 790. Dissertation Research. 0 credits, 0 contact hours.**

**USYS 790A. Dissertation Research. 1 credit, 1 contact hour.**

**USYS 790B. Dissertation Research. 3 credits, 3 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester until a written dissertation is approved.

**USYS 790C. Dissertation Research. 6 credits, 6 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**USYS 790D. Dissertation Research. 9 credits, 9 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**USYS 790E. Dissertation Research. 12 credits, 12 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**USYS 792. Dissertation Research. 3 credits, 3 contact hours.**
Prerequisites: Permission of Track Director. For students admitted to the Doctor of Philosophy Program in Urban Systems who have not yet passed the qualifying examination. Research is carried out under the supervision of designed Urban Systems faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied to the 24 credits required under USYS 790.

# M.S. in Architecture

The program consists of 30 credits of required and elective courses and may be taken either full- or part-time. Students in preparation for further study at the doctoral level may be required to complete an additional 6 credit thesis. Students are required to design their programs in consultation with the graduate advisor and lead faculty member in the area of specialization. Among the available areas of concentration are Sustainable Architecture, Resilient Architecture, Architectural History, Digital Design, and Urban Systems.

To remain in good academic standing, students must maintain a cumulative GPA of 3.0 in graduate courses.

# Master of Architecture

## Degree Requirements for Professional M.Arch.

This 102-credit program consists of a 72-credit core and an options sequence of 30 credits including 12 studio and 18 elective credits. Students are expected to complete the core sequence in a minimum of two years. Before registering for courses, all students must consult with the graduate advisor to plan an appropriate course of study.

Students must submit a portfolio of design work at completion of the core courses. The portfolio will be reviewed in connection with advising students on their further program of study.

Core courses in the M.Arch. program represent the minimum background necessary to meet NAAB standards. If students demonstrate that they have previously completed equivalent course work, degree credit requirements may be reduced to less than the 102 credits required for the program.To remain in good academic standing, students must maintain a cumulative GPA of 3.0 in graduate courses. Students must repeat any design studio course in which they receive a grade of C. A grade of C+ in any design studio must be followed by a subsequent grade sufficient to raise the annual cumulative design studio GPA to 2.75. Incomplete (I) grades for studio and prerequisite courses must be removed before students will be permitted to register for continuing course work in the program.

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| ARCH 500G | Advanced Architectural Graphics | 3 |
| ARCH 501G | Architectural Design I | 6 |
| ARCH 502G | Architectural Design II | 6 |
| ARCH 503G | Architectural Design III | 6 |
| ARCH 504G | Architectural Design IV | 6 |
| ARCH 541G | Construction I | 3 |
| ARCH 542G | Integrated Building Technologies | 3 |
| ARCH 543G | Environmental Control Systems I | 3 |
| ARCH 544G | Environmental Control Systems II | 3 |
| ARCH 545 | Case Studies in Architectural Technology | 3 |
| ARCH 548G | Structures II | 3 |
| ARCH 547G | 4D Integration | 3 |
| ARCH 528G | History of Architecture I | 3 |
| ARCH 529G | History of Architecture II | 3 |
| ARCH 555G | Architectural Graphics | 3 |
| ARCH 569G | Building and Development | 3 |
| ARCH 579G | Professional Architectural Practice | 3 |

| | | |
|---|---|---|
| Two courses in architectural history [1,2] | | 6 |
| One course in contemporary architectural theory [2] | | 3 |
| **Option Sequence** | | |
| Select two of the following: | | 12 |
| ARCH 505G | Advanced Design Options I | |
| ARCH 506G | Advanced Design Options II | |
| ARCH 507G | Advanced Design Options III | |
| MARC 701 | Master'S Thesis | |
| ARCH XXX | Electives [2] | 9 |
| Electives [2] | | 9 |
| **Total Credits** | | **102** |

1. Including one course in non-western, regional, or vernacular architecture.
2. To be selected in consultation with the graduate advisor.

With the exception of History/Theory Selectives, ARCH 569G Building and Development and ARCH 579G Professional Architectural Practice, all core courses must be completed before proceeding to the options sequence.

# Master of Architecture and M.S. in Civil Engineering

This dual degree option is a specific tailoring of the construction engineering and management specialization in the M.S. in Civil Engineering program and is only available to students pursuing the M.Arch. degree.

The dual degree program permits students to obtain both an M.Arch. and a M.S. in Civil Engineering in substantially less time than if each degree was pursued separately. A maximum of 15 credits may be used to satisfy requirements of both degrees.

Students take courses shown below to fulfill requirements for the M.S. in Civil Engineering, or their equivalent. There is no thesis requirement. Students without a bachelor's degree in civil engineering must complete the bridge program; these courses do not count toward degree requirements. **See the undergraduate catalog for descriptions of these courses.**

At the time of admission to the dual degree program, the civil engineering graduate advisor will determine if any M.S. in Civil Engineering course requirements can be waived.

The requirements to obtain the M.S. in Civil Engineering degree are:

## M.Arch. and M.S. in Civil Engineering (civil engineering bachelor's degree)

### M.Arch. Requirements

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| ARCH 500G | Advanced Architectural Graphics | 3 |
| ARCH 501G | Architectural Design I | 6 |
| ARCH 502G | Architectural Design II | 6 |
| ARCH 503G | Architectural Design III | 6 |
| ARCH 504G | Architectural Design IV | 6 |
| ARCH 541G | Construction I | 3 |
| ARCH 542G | Integrated Building Technologies | 3 |
| ARCH 543G | Environmental Control Systems I | 3 |
| ARCH 544G | Environmental Control Systems II | 3 |
| ARCH 545 | Case Studies in Architectural Technology | 3 |
| ARCH 548G | Structures II | 3 |
| ARCH 547G | 4D Integration | 3 |
| ARCH 528G | History of Architecture I | 3 |
| ARCH 529G | History of Architecture II | 3 |
| ARCH 555G | Architectural Graphics | 3 |
| ARCH 569G | Building and Development | 3 |
| ARCH 579G | Professional Architectural Practice | 3 |

| | | |
|---|---|---|
| Two courses in architectural history [1,2] | | 6 |
| One course in contemporary architectural theory [2] | | 3 |
| **Option Sequence** | | |
| Select two of the following: | | 12 |
| ARCH 505G | Advanced Design Options I | |
| ARCH 506G | Advanced Design Options II | |
| ARCH 507G | Advanced Design Options III | |
| MARC 701 | Master'S Thesis | |
| ARCH XXX | Electives [2] | 9 |
| Electives [2] | | 9 |
| **Total Credits** | | **102** |

1 Including one course in non-western, regional, or vernacular architecture.

2 To be selected in consultation with the graduate advisor.

With the exception of History/Theory Selectives, ARCH 569G Building and Development and ARCH 579G Professional Architectural Practice, all core courses must be completed before proceeding to the options sequence.

## M.S. in Civil Engineering Requirements

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 610 | Construction Management | 3 |
| CE 611 | Project Planning and Control | 3 |
| CE 616 | Construction Cost Estimating | 3 |
| EM 632 | Legal Aspects in Construction | 3 |
| **Required Courses** | | |
| ARCH 650 | Economy of Building | 3 |
| ARCH 652 | Architectural Project Management | 3 |
| ARCH 675 | Elements of Infrastructure Planning | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Electives** | | |
| Select two of the following: | | 6 |
| CE 615 | Infrastructure and Facilities Remediation | |
| CE 631 | Advanced Reinforced Concrete Design | |
| CE 642 | Foundation Engineering | |
| CE 702 | Special Topics in Civil Engineering | |
| CE 711 | Methods Improvement in Construction | |
| ENE 662 | Site Remediation | |
| ENE 671 | Environmental Impact Analysis | |
| **Total Credits** | | **30** |

## M.Arch. and M.S. in Civil Engineering (no civil engineering bachelor's degree)

### M.Arch. Requirements

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| ARCH 500G | Advanced Architectural Graphics | 3 |
| ARCH 501G | Architectural Design I | 6 |
| ARCH 502G | Architectural Design II | 6 |
| ARCH 503G | Architectural Design III | 6 |
| ARCH 504G | Architectural Design IV | 6 |
| ARCH 541G | Construction I | 3 |
| ARCH 542G | Integrated Building Technologies | 3 |
| ARCH 543G | Environmental Control Systems I | 3 |

| | | |
|---|---|---|
| ARCH 544G | Environmental Control Systems II | 3 |
| ARCH 545 | Case Studies in Architectural Technology | 3 |
| ARCH 548G | Structures II | 3 |
| ARCH 547G | 4D Integration | 3 |
| ARCH 528G | History of Architecture I | 3 |
| ARCH 529G | History of Architecture II | 3 |
| ARCH 555G | Architectural Graphics | 3 |
| ARCH 569G | Building and Development | 3 |
| ARCH 579G | Professional Architectural Practice | 3 |
| Two courses in architectural history [1,2] | | 6 |
| One course in contemporary architectural theory [2] | | 3 |
| **Option Sequence** | | |
| Select two of the following: | | 12 |
| ARCH 505G | Advanced Design Options I | |
| ARCH 506G | Advanced Design Options II | |
| ARCH 507G | Advanced Design Options III | |
| MARC 701 | Master'S Thesis | |
| ARCH XXX | Electives [2] | 9 |
| Electives [2] | | 9 |
| **Total Credits** | | **102** |

[1] Including one course in non-western, regional, or vernacular architecture.

[2] To be selected in consultation with the graduate advisor.

With the exception of History/Theory Selectives, ARCH 569G Building and Development and ARCH 579G Professional Architectural Practice, all core courses must be completed before proceeding to the options sequence.

## M.S. in Civil Engineering Requirements

| | | |
|---|---|---|
| **Bridge Courses** [1] | | |
| CE 200 | Surveying | 3 |
| CE 200A | Surveying Laboratory | 1 |
| CE 501 | Introduction to Soil Behavior | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 119 | | |
| **Total Credits** | | **10** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 610 | Construction Management | 3 |
| CE 611 | Project Planning and Control | 3 |
| CE 616 | Construction Cost Estimating | 3 |
| EM 632 | Legal Aspects in Construction | 3 |
| **Required Courses** | | |
| ARCH 650 | Economy of Building | 3 |
| ARCH 652 | Architectural Project Management | 3 |
| ARCH 675 | Elements of Infrastructure Planning | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Electives** | | |
| Select two of the following: | | 6 |
| CE 615 | Infrastructure and Facilities Remediation | |
| CE 631 | Advanced Reinforced Concrete Design | |
| CE 642 | Foundation Engineering | |
| CE 702 | Special Topics in Civil Engineering | |
| CE 711 | Methods Improvement in Construction | |

| | | |
|---|---|---|
| ENE 662 | Site Remediation | |
| ENE 671 | Environmental Impact Analysis | |
| **Total Credits** | | **30** |

[1] Courses do not count toward degree requirements.

**Co-op Work Experience in Architecture** and the **Housing Scholars Program** give students an opportunity to gain additive credits and salaried employment.

To become eligible to take the architecture registration examination in New Jersey, professional M.Arch. Graduates must complete three years of practical work experience apprenticeship that meet specific criteria set by the New Jersey State Board of Architects. Co-op internship work experiences in architecture meeting these criteria are acceptable equivalents for such apprenticeships, and are available to NJIT students. Students become eligible after completing the first year of M.Arch core courses.

The Housing Scholars Program provides college students with paid summer internships at non-profit, community-based affordable housing organizations, and is jointly administered by NJIT's Division of Career Development Services and the New Jersey Department of Community Affairs. Housing Fellows are placed with community-based, non-profit organizations that initiate affordable housing and related projects. Graduate students who have completed at least 28 credits of core courses and who have an overall cumulative GPA of 3.2 or above are eligible to participate. Scholars are selected through a competitive application to the Division of Career Development Services and an interview process throughout February and March, and begin their internship in early June.

Students should consult the School of Architecture co-op advisor for details on work experience and the Housing Scholars program.

# Master of Architecture and M.S. in Management

The dual degree option is only available to students pursuing the M.Arch. The dual degree program permits students to obtain both an M.Arch. and a M.S. in Management in substantially less time; in some cases in only one more semester of full-time study. A maximum of 15 credits may be used to satisfy the requirements of both degrees.

Students take additional credits shown below to fulfill requirements for the M.S. in Management. There is no thesis requirement.

At the time of admission to the dual degree program, the School of Management graduate advisor will determine if any M.S. in Management course requirements can be waived.

## M.Arch. Requirements

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| ARCH 500G | Advanced Architectural Graphics | 3 |
| ARCH 501G | Architectural Design I | 6 |
| ARCH 502G | Architectural Design II | 6 |
| ARCH 503G | Architectural Design III | 6 |
| ARCH 504G | Architectural Design IV | 6 |
| ARCH 541G | Construction I | 3 |
| ARCH 542G | Integrated Building Technologies | 3 |
| ARCH 543G | Environmental Control Systems I | 3 |
| ARCH 544G | Environmental Control Systems II | 3 |
| ARCH 545 | Case Studies in Architectural Technology | 3 |
| ARCH 548G | Structures II | 3 |
| ARCH 547G | 4D Integration | 3 |
| ARCH 528G | History of Architecture I | 3 |
| ARCH 529G | History of Architecture II | 3 |
| ARCH 555G | Architectural Graphics | 3 |
| ARCH 569G | Building and Development | 3 |
| ARCH 579G | Professional Architectural Practice | 3 |
| Two courses in architectural history [1,2] | | 6 |
| One course in contemporary architectural theory [2] | | 3 |
| **Option Sequence** | | |
| Select two of the following: | | 12 |

| | | |
|---|---|---|
| ARCH 505G | Advanced Design Options I | |
| ARCH 506G | Advanced Design Options II | |
| ARCH 507G | Advanced Design Options III | |
| MARC 701 | Master'S Thesis | |
| ARCH XXX | Electives [2] | 9 |
| Electives [2] | | 9 |
| **Total Credits** | | **102** |

[1] Including one course in non-western, regional, or vernacular architecture.
[2] To be selected in consultation with the graduate advisor.

With the exception of History/Theory Selectives, ARCH 569G Building and Development and ARCH 579G Professional Architectural Practice, all core courses must be completed before proceeding to the options sequence.

## M.S. in Management Requirements

| | | |
|---|---|---|
| **Core Courses** [1] | | |
| ARCH 650 | Economy of Building | 3 |
| ARCH 651 | Real Estate Analysis for Architects | 3 |
| ARCH 652 | Architectural Project Management | 3 |
| FIN 516 | Principles of Financial Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| MGMT 680 | Entrepreneurial Strategy | 3 |
| or MGMT 692 | Strategic Management | |
| **Required Course** | | |
| FIN 618 | Public and Private Financing of Urban Areas | 3 |
| **Electives** | | |
| Select three of the following: | | 9 |
| ACCT 615 | Management Accounting | |
| FIN 624 | Corporate Finance II | |
| MGMT 640 | New Venture Management | |
| MGMT 645 | New Venture Finance | |
| MIS 645 | Information Systems Principles | |
| MRKT 630 | Models of Consumer Behavior | |
| MRKT 638 | Sales Management for Technical Professionals | |
| **Total Credits** | | **30** |

[1] ARCH 579G Professional Architectural Practice fulfills MGMT 691 Legal and Ethical Issues required for the M.S. in Management.

# Master of Architecture and Master of Infrastructure Planning

This dual degree option is available to students in the M.Arch. degree program. The dual degree program permits students to obtain the M.Arch. and the M.I.P. in substantially less time than if each degree was pursued separately. M.Arch. students may partially fulfill M.I.P. course work while completing the M.Arch. program of study. A maximum of 15 credits may be used to satisfy requirements of both degrees.

For more information about the M.I.P. program, see Master in Infrastructure Planning (p. 647) in this catalog.

## M.Arch. Requirements

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| ARCH 500G | Advanced Architectural Graphics | 3 |
| ARCH 501G | Architectural Design I | 6 |
| ARCH 502G | Architectural Design II | 6 |
| ARCH 503G | Architectural Design III | 6 |
| ARCH 504G | Architectural Design IV | 6 |

| | | |
|---|---|---|
| ARCH 541G | Construction I | 3 |
| ARCH 542G | Integrated Building Technologies | 3 |
| ARCH 543G | Environmental Control Systems I | 3 |
| ARCH 544G | Environmental Control Systems II | 3 |
| ARCH 545 | Case Studies in Architectural Technology | 3 |
| ARCH 548G | Structures II | 3 |
| ARCH 547G | 4D Integration | 3 |
| ARCH 528G | History of Architecture I | 3 |
| ARCH 529G | History of Architecture II | 3 |
| ARCH 555G | Architectural Graphics | 3 |
| ARCH 569G | Building and Development | 3 |
| ARCH 579G | Professional Architectural Practice | 3 |
| Two courses in architectural history [1,2] | | 6 |
| One course in contemporary architectural theory [2] | | 3 |
| **Option Sequence** | | |
| Select two of the following: | | 12 |
| ARCH 505G | Advanced Design Options I | |
| ARCH 506G | Advanced Design Options II | |
| ARCH 507G | Advanced Design Options III | |
| MARC 701 | Master'S Thesis | |
| ARCH XXX | Electives [2] | 9 |
| Electives [2] | | 9 |
| **Total Credits** | | **102** |

1. Including one course in non-western, regional, or vernacular architecture.
2. To be selected in consultation with the graduate advisor.

With the exception of History/Theory Selectives, ARCH 569G Building and Development and ARCH 579G Professional Architectural Practice, all core courses must be completed before proceeding to the options sequence.

## M.I.P. Requirements

| | | |
|---|---|---|
| **Required Courses** | | |
| MIP 631 | History and Theory of Infrastructure | 3 |
| MIP 652 | Geographic Information Systems | 3 |
| MIP 673 | Infrastructure Planning in Practice | 3 |
| MIP 674 | Infrastructure and Architecture | 3 |
| MIP 675 | Elements of Infrastructure Planning | 3 |
| **Additional Requirements** | | |
| MIP 601 | Interdisciplinary Infrastructure Studio I | 6 |
| MIP 602 | Interdisciplinary Infrastructure Studio II | 6 |
| MIP 612 | Introduction to Environmental Policy Studies | 3 |
| EPS 622 | Sustainable Politics and Policy | 3 |
| MIP 655 | Land Use Planning | 3 |
| **Total Credits** | | **36** |

# Master of Infrastructure Planning

Students must complete 36 course credits through full- or part-time study. Up to 6 credits toward the degree may be waived based on previous academic study. Additional elective courses may be taken in disciplines related to infrastructure planning, but do not count toward degree credit.

## Required Courses

The following courses are required, subject to those waived in individual cases; however, no waivers will be given for studio courses. A typical full-time study plan over two semesters is shown below.

| First Year | | | |
|---|---|---|---|
| **1st Semester** | | | **Term Credits** |
| MIP 601 | Interdisciplinary Infrastructure Studio I | | 6 |
| MIP 631 | History and Theory of Infrastructure | | 3 |
| MIP 647 | | 3 | |
| MIP 652 | Geographic Information Systems | | 3 |
| MIP 675 | Elements of Infrastructure Planning | | 3 |
| | **Term Credits** | | **18** |
| **2nd Semester** | | | |
| MIP 602 | Interdisciplinary Infrastructure Studio II | | 6 |
| MIP 618 | Public and Private Financing of Urban Areas [1] | | 3 |
| MIP 655 | Land Use Planning [1] | | 3 |
| MIP 673 | Infrastructure Planning in Practice | | 3 |
| MIP 674 | Infrastructure and Architecture | | 3 |
| | **Term Credits** | | **18** |
| | **Total Credits** | | **36** |

[1] Or substitute selected with the approval of Graduate Advisor.

# Ph.D. in Urban Systems

## The Program

The jointly offered PhD Program in Urban Systems is built upon the unique strengths of New Jersey's three senior public research institutions: New Jersey Institute of Technology, the University of Medicine and Dentistry of New Jersey, and Rutgers, The State University of New Jersey at Newark. The program is designed to prepare students to develop research-based knowledge in urban systems and to participate in the development, implementation, and evaluation of policy and services for urban populations. Students in the program have full access to library, computing, and other student services at all three campuses.

The program core is designed as a 48-credit course sequence with three major specializations:

1. urban health systems
2. urban environment studies
3. urban educational policy

## Admission to the Program

The criteria for admission to the PhD Program in Urban Systems include academic achievement, scholarship, professional character, scientific inquisitiveness, accountability, dependability, and interpersonal skills. A completed master's degree is required of all applicants, with the sole exception of students applying directly from a Bachelor's degree program who have a cumulative undergraduate gpa of 3.75 or higher.

## Application Submission

- Completed Application to the PhD Program in Urban Systems.
- Scores from the Graduate Record Examination (GRE).
- International students, and all students whose first language is not English, must provide competitive scores on the Test of English as a Foreign Language (TOEFL).
- Official transcripts of all prior academic work.
- Three letters of recommendation (faculty preferred).
- Written Statement of Purpose, including statement of proposed research concentration.
- Interview (Optional, at the discretion of the relevant Track Director).

Applications for admission to the program may be obtained from the Office of University Admissions, New Jersey Institute of Technology, University Heights, Newark, New Jersey 07102, from the NJIT Office of Graduate Admissions web pages, or by calling 973-596-3300.

**For General Information or Admissions-related Questions, Click here or contact:**

Fred Little (little@njit.edu)
Graduate Program & Admissions Coordinator, New Jersey School of Architecture
973.642.7576

**For Questions regarding specific Program Tracks, contact:**

Urban Environment
Karen Franck (kafranck@earthlink.net), PhD
Program Director
973-972-0748 or 3876

Urban Health:
Dula Pacquiao (pacquidf@umdnj.edu), (parietes@UMDNJ.EDU) PhD
Track Director
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Urban Education Policy:
Alan Sadovnik (sadovnik@andromeda.rutgers.edu), PhD
Track Director
973.353.1216 or 5434

## Degree Requirements

The curriculum consists of an 18-credit core curriculum, a 9-credit research core, a 21-credit specialization component, and a 24-credit dissertation sequence. Following completion of the Core Curriculum and Research Core, students must take and pass Qualifying Examinations in both areas in order to advance to Doctoral Candidacy and Dissertation. Admission to the Urban Systems PhD Program is not a guarantee of success on the Qualifying Examinations, or a guarantee of advancement to Doctoral Candidacy.

### Core Curriculum

| | |
|---|---|
| Urban Systems I: History and Future of the Metropolis | 3 credits |
| Urban Systems II: Urban Populations: Demography and Trends | 3 credits |
| Urban Systems II: Cities in World Perspective | 3 credits |
| Determinants & Consequences of Urban Health | 3 credits |
| The Good City: Environmental Design & the Quality of Metropolitan Life | 3 credits |
| Urban Educational Policy | 3 credits |

### Research Core

| | |
|---|---|
| Geographic Information Systems | 3 credits |
| Research Seminar I: Quantitative Methods | 3 credits |
| Research Seminar II: Qualitative Methods | 3 credits |

### Specialization

| **Urban Environment Studies**[1] | |
|---|---|
| Development of the American City | 3 credits |
| Architecture & Health: The Pathology of Urban Studies | 3 credits |
| Architecture Perspectives in Urban Research | 3 credits |
| Electives -- selected in consultation with Dissertation Advisor | 12 credits |

### Specialization

| **Urban Health Systems**[2] | |
|---|---|
| Health Status of Urban Population | 3 credits |
| Health Beliefs and Practices of Urban Populations | 3 credits |
| Survey of Health Informatics | 3 credits |
| Electives -- selected in consultation with Dissertation Advisor | 12 credits |

### Specialization

| **Urban Educational Policy**[3] | |
|---|---|
| Sociology of Urban Education | 3 credits |
| Educational Policy and Urban School Development | 3 credits |
| History of Urban Education | 3 credits |

| | |
|---|---|
| Electives -- selected in consultation with Dissertation Advisor | 12 credits |

**[1] Specialization in Urban Environment**

Students in the Urban Environment specialization complete 21 credits in this area, nine credits of which are required and 12 credits of which are electives chosen in consultation with their dissertation advisors. The Urban Environment specialization provides students with the unique opportunity to examine the physical and spatial complexities of the built domain and the forces that gave rise to specific urban manifestations such as rapid social change, frequent demographic shifts, technological innovations, and shifting public policies. Reflecting the interdisciplinary nature of the environmental field, the curriculum comprises a set of courses drawn from the related disciplines of architecture, architectural history, urbanism, and city planning. The course work exposes students not only to extensive scholarship and rigorous analysis of architectural and planning theory and practice, but it also creates linkages to other urban systems.

***Ph.D. Faculty -- Urban Environment***

Erv Bales, Assistant Professor of Architecture, University of Illinois, PhD, 1967

Maurie Cohen, Associate Professor of Environmental Policy, NYU, B.S., 1984; Columbia University, M.S., 1987, University of Pennsylvania, Ph.D. 1993.

Zeynep Celik, Professor of Architecture, Istanbul Technical University, BArch, 1975; Rice University, MArch, 1978; University of California--Berkeley, PhD, 1984

Gabrielle Esperdy, Associate Professor of Architecture, Smith College, BA; City University of New York, MA, PhD

Karen Franck, Professor of Architecture, Bennington College, BA 1970; City University of New York, PhD 1981

David Hawk, AIA, R.A., Professor of Architecture, Iowa State University, B.Arch. 1971; University of Pennsylvania, M.Arch., M. City Planning, 1974; PhD, 1979

Richard Olsen, Director, Environments for Health & Aging, Center for Architecture & Building Science; Catholic University of America, B.A.1970; City University of New York, PhD, 1978

Donald Wall, Associate Professor of Architecture, B.Arch Program Director; University of Manitoba, B.Arch., 1958; Cornell University, M.Arch., 1959; Catholic University of America, DArch, 1970

**[2] Specialization in Urban Health Systems**

Students in the Urban Health Systems specialization will complete 21 credits in this area, nine credits of which are required and six credits are elective. A systems approach, explicit in the urban health systems specialization, utilizes knowledge from diverse disciplines to study the complex web of health care delivery to urban populations, explores economically viable alternatives to traditional delivery, establishes ethical implications for that delivery that are human-centered, proposes research-generated health policy solutions, and assesses outcomes. Coursework exposes students to research related to the health status of urban populations, health beliefs and practices, health informatics, and theories related to public policy, planning, health economics, evaluation methods, health and other related topics. Students in the Urban Health Systems specialization will complete 15 credits in this area, nine credits of which are required and six credits are elective. A systems approach, explicit in the urban health systems specialization, utilizes knowledge from diverse disciplines to study the complex web of health care delivery to urban populations, explores economically viable alternatives to traditional delivery, establishes ethical implications for that delivery that are human-centered, proposes research-generated health policy solutions, and assesses outcomes. Coursework exposes students to research related to the health status of urban populations, health beliefs and practices, health informatics, and theories related to public policy, planning, health economics, evaluation methods, health and other related topics

**[3] Specialization in Urban Educational Policy**

Students in the Urban Educational Policy specialization complete 21 credits in this area, nine credits of which are required and six credits are elective. The specialization in Urban Educational policy is designed to prepare students to develop research-based knowledge of urban educational systems and policies. Through an interdisciplinary approach to understanding urban educational systems and problems, students are prepared to think critically about systemic, urban school improvement. Based on the belief that urban education cannot be understood outside the larger context of urban systems, the program is designed to help students connect the study of urban education to the history, sociology, politics, and economics of urban life. Through course work, research, and internships, students will engage in-depth examinations of urban educational policy and practice. Using New Jersey's historic Abbott v. Burke case as a foundation for understanding national trends, students will examine urban educational reforms in the state's thirty urban Abbott districts resulting from this decision, including whole school reform, mandated early childhood education, and equity financing. Based on their research, students will explore the limits and possibilities of urban educational policy in improving schools for all children. Graduates will be prepared to take positions as university faculty, educational researchers and policy makers at the national, state, local and foundation levels, or to work as policy analysts in school systems.

***Ph.D. Faculty -- Urban Educational Policy***

- Jean Anyon, Professor BS University of Pennsylvania; M.S.; PhD New York University

- Jeffrey Kidder, Assistant Professor BS Edinboro University of PA; MS; PhD Cornell University
- Jamie Lew, Assistant Professor BA Washington University, St. Louis; MA, PhD Teachers College, Columbia University
- Alan Sadovnik, Professor of Education and Sociology; Chair BA Queens College; MA; PhD New York University

## How can I learn more?

- Download a brochure on our PhD in Urban Systems program (http://architecture.njit.edu/architecture/docs/phd-urbansystems-brochure.pdf) (PDF, 931 KB)
- Request more info from our Graduate Admissions Office (http://www.njit.edu/admissions/inquiry/graduate.php)

# Ying Wu College of Computing

The mission of the Ying Wu College of Computing, which was established in 2001, is to bring education in a broad range of computing disciplines to students on campus and at a distance to carry out cutting-edge research while working closely in the industry. Ying Wu College of Computing offers bachelor’s, master’s and doctoral degrees in multiple fields of computing science, Web and information systems and a multidisciplinary undergraduate degree in information technology.

Ying Wu College of Computing resides on one of the most computing-intensive campuses in the world, helping NJIT educate one of the largest groups of information technology students in the nation in the applications of new technologies as learning tools. Not coincidentally, New Jersey is one of the leading states for computing and high technology businesses. Thirty of the nation's fastest-growing technology companies are based in the state, and New Jersey ranks seventh in the nation as a cyberstate and eighth for venture capital investment— $3.5 billion—in information technology and software. Additionally, New Jersey offers the second-highest wages in the nation for technology workers. Ying Wu College of Computing graduates frequently land creatively satisfying and intellectually challenging jobs at major companies like IBM, Mercedes-Benz and Pfizer.

## Programs

- Bioinformatics - M.S. (p. 674)
- Business & Information Systems - M.S. (p. 694)
- Computer Science - M.S. (p. 675)
- Computing and Business - M.S. (p. 679)
- Cyber Security and Privacy - M.S. (p. 680)
- Information Systems - M.S. (p. 701)
- Information Technology and Administration Security - M.S. (p. 708)
- Software Engineering - M.S. (p. 683)

## Programs

- Computing Sciences - Ph.D. (p. 684)
- Information Systems - Ph.D. (p. 704)

Network Security and Information Assurance - Cert.

Data Mining - Cert.

IT Administration - Cert.

Information Security - Cert.

Software Engineering, Analysis, and Design - Cert.

Big Data Essentials - Cert.

Business and Information Systems - Cert.

Web Systems Development - Cert.

## Ying Wu College of Computing Courses

**BNFO 601. Foundations of Bioinformatics I. 3 credits, 3 contact hours.**
Introduction to script programming and basic biomolecular sequence analysis. Topics covered include sequence alignment, dynamic programming algorithms, hidden Markov models, and their implementation with a scripting language.

**BNFO 602. Foundations of Bioinformatics II. 3 credits, 3 contact hours.**
Topics in bioinformatics such as phylogeny reconstruction, genome-wide association study analysis, structure and sequence analysis, and machine learning and statistical approaches. Focus of the course is on a hands-on project on a contemporary bioinformatics problem.

**BNFO 615. Data Analysis in Bioinformatics. 3 credits, 3 contact hours.**
Data structures, algorithms, and statistical approaches in bioinformatics. The course emphasis is on statistical models, algorithms, and data structures with relevant biological background and motivation.

**BNFO 620. Genomic Data Analysis. 3 credits, 3 contact hours.**
This course will introduce students to the practice of analyzing large-scale genomic data generated by recent high throughput bio-techniques. It will cover microarray data and short-read sequencing data. It presents widely used analytical methods and software. The course includes several case studies on real large-scale genomics datasets. Students will gain practical experience in large-scale data analysis, which is highly desirable by both industry and academia employers.

**BNFO 644. Data Mining and Management in Bioinformatics. 3 credits, 3 contact hours.**
Concepts and principles of data management in bioinformatics. Presents methods for indexing, querying, and mining data obtained from molecular and evolutionary biology. Provides hands-on experience in designing a simple information system for querying and mining genomic data using ORACLE or MySQL.

**BNFO 698. ST:. 3 credits, 3 contact hours.**

**BNFO 700B. Masters Project. 3 credits, 3 contact hours.**

**BNFO 701B. Masters Thesis. 3 credits, 3 contact hours.**

**BNFO 725. Independent Study. 3 credits, 3 contact hours.**

**BNFO 726. Independent Study II. 3 credits, 0 contact hours.**

**CS 505. Programming, Data Structures, and Algorithms. 3 credits, 4 contact hours.**
Prerequisite: knowledge of at least one procedure-oriented language such as PASCAL or C. Computer science students cannot use this course for graduate degree credit. Intensive introduction to computer science principles: a procedure-oriented language such as C++; program design techniques; introductory data structures (linked lists, stacks, sets, trees, graphs); and algorithms (sorting, searching, etc.) and their analysis. Programming assignments are included.

**CS 506. Foundations of Computer Science. 3 credits, 3 contact hours.**
Prerequisite: knowledge of C/PASCAL. Corequisite: CS 505. Cannot be used for graduate credit towards the M.S. in Computer Science. Introduction to the concepts of iteration, asymptotic performance analysis of algorithms, recursion, recurrence relations, graphs, automata and logic, and also surveys the main data models used in computer science including trees, lists, sets, and relations. Programming assignments are given.

**CS 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: students must have the approval of the co-op advisor for the CIS department. Provides on-the-job reinforcement and application of concepts presented in the undergraduate computer science curriculum. Work assignments are identified by the co-op office and developed and approved by the CIS department in conjunction with the student and employer. Students must submit, for CIS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of each semester's work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in computer science.

**CS 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: students must have the approval of the co-op advisor for the CIS department. Provides on-the-job reinforcement and application of concepts presented in the undergraduate computer science curriculum. Work assignments are identified by the co-op office and developed and approved by the CIS department in conjunction with the student and employer. Students must submit, for CIS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in computer science.

**CS 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: graduate standing, and acceptance by the CIS department and the Division of Career Development Services. Students must have the approval of the co-op advisor for the CIS department. Provides on-the-job reinforcement and application of concepts presented in the undergraduate or graduate computer science curriculum. Work assignments are identified by the co-op office and developed and approved by the CIS department in conjunction with the student and employer. Students must submit, for CIS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in computer science.

**CS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CS 602. Java Programming. 3 credits, 3 contact hours.**
Prerequisite: advanced Web-based programming with an emphasis on the Java language and platform. No prior knowledge of Java is required but students are expected to have a good understanding of object-oriented programming concepts such as encapsulation, inheritance, and polymorphism, experience with C++. Basic constructs and syntax and then the core advanced features. Topics include: networking and sockets, remote method invocation (RMI), database connectivity (JDBC), Java Beans, multi-threading and lighweight components (Swing). Common gateway interface (CGI) languages and browser scripting (JavaScript and VBScript) are discussed when used as a complement to the functionality of the Java language. Emphasis is on the latest version of Java, both deprecated methods and newly introduced features are discussed.

**CS 608. Cryptography and Security. 3 credits, 3 contact hours.**
This course involves computational methods providing secure Internet communication. Among the topics covered are: Security threats in communication systems; conventional cryptography: substitution and transposition codes; distribution of secret key over the Internet; principles of public-key cryptography; RSA and other public-key cryptographic methods; and digital signature protocol.

**CS 610. Data Structures and Algorithms. 3 credits, 3 contact hours.**
Prerequisite: CS 114 or CS 241 or equivalents (see undergraduate catalog for description). Intensive study of the fundamentals of data structures and algorithms. Presents the definitions, representations, processing algorithms for data structures, general design and analysis techniques for algorithms. Covers a broad variety of data structures, algorithms and their applications including linked lists, various tree organizations, hash tables, strings, storage allocation, algorithms for searching and sorting, and a selected collection of other algorithms. Programs are assigned to give students experience in algorithms, data structure design and implementation.

**CS 611. Introduction to Computability and Complexity. 3 credits, 3 contact hours.**
Prerequisite: CS 610. Introduces the theoretical fundamentals of computing, and provides an understanding of both the inherent capabilities and limitations of computation. The main models of computation are deterministic and non-deterministic Turing machines. Auxiliary models include partial and total recursive functions, first order logic, recursive and recursively enumerable sets, and symbol systems. Covers the essentials of computational theory: first order logic, Russel's Paradox, completeness and consistency, Goedel's Theorem, Church's Thesis, countable and uncountable sets, simulation and computation, diagonalization, dove-tailing, decidable and undecidable problems, reduction, recursion theory, Rice's Theorem, Recursion Theorem, execution time measures, P and NP, polynomial-time reduction, NP-completeness and NP-hardness and formal correctness semantics of programs.

**CS 621. Numerical Analysis I. 3 credits, 3 contact hours.**
Prerequisite: MATH 511 (see undergraduate catalog for description) or an introductory course in numerical methods. An introduction to computational aspects of scientific and engineering problems. Time-dependent phenomena and corresponding quantitative models. Numerical stability and conditioning. Approximation of functions. Interpolation, integration. Solution of nonlinear equations. Ordinary differential equations of the first order. Finite and iterative algorithms for solution of systems of linear equations. Emphasis on computer implementation of algorithms and application to variety of engineering problems.

**CS 630. Operating System Design. 3 credits, 3 contact hours.**
Prerequisites: CS 332, CS 432 (see undergraduate catalog for descriptions) and CS 505. An intensive study of computer operating system design including multiprogramming, time-sharing, real-time processing, job and task control, synchronization of concurrent processes and processors, resource scheduling, protection, and management of hierarchical storage.

**CS 631. Data Management System Design. 3 credits, 3 contact hours.**
Prerequisite: knowledge of C and data structures. Acquaintance with fundamental notions of relational database technology. Mathematical properties and usage of database programming languages. Methods of database design and conceptual modeling. Methods of physical storage for database information. Fundamental notions of concurrency control and recovery in database systems.

**CS 632. Advanced Database System Design. 3 credits, 3 contact hours.**
Prerequisites: CS 631 and good knowledge of a high-level programming language. Covers the rapidly changing concepts and principles of modern database systems and database programming based on SQL. Additional topics may include: advanced data modeling, OODBs, parallel and distributed database systems, XML and NO-SQL databases, Web-database systems, active databases, multimedia and text databases, database security, query optimization, indexing techniques, concurrency control, system performance, and data warehaousing.

**CS 633. Distributed Systems. 3 credits, 3 contact hours.**
Prerequisite: completion of bridge requirements. Fundamental topics concerning the design and implementation of distributed computing systems are covered, including interprocess communication, remote procedure calls, authentication, protection, distributed file systems, distributed transactions, replicated data, reliable broadcast protocols, and specifications for distributed programs. All topics will be illustrated with case studies. Optional topics may include synchronization, deadlocks, virtual time, and load balancing.

**CS 634. Data Mining. 3 credits, 3 contact hours.**
This course covers the principles of data mining system design and implementation. It presents methods for association and dependency analysis as well as classification, prediction, and clustering. Optional topics may include time series and graph mining, current trends in data mining, and data mining for scientific, medical and engineering applications.

**CS 635. Computer Programming Languages. 3 credits, 3 contact hours.**
Prerequisites: CS 505 and CS 510. The theory and design of computer language systems; the formal theory of syntax and language classification; a survey of procedure and problem-oriented computer programming languages, their syntax rules, data structures, and operations; control structures and the appropriate environments and methods of their use; a survey of translator types.

**CS 636. Data Analytics with R Program. 3 credits, 3 contact hours.**
Prerequisites: Entry-level courses in programming, probability and statistics (e.g. MATH333, CS280), or permission of the instructor. This course teaches data analytics with R programming. The student will learn and gain basic analytic skills via this high-level language. The course covers fundamental knowledge in R programming. Popular R packages for data science will be introduced as working examples. The course also includes case studies on data analytics projects. As a core course in data science, it provides skills that are highly desirable for both industry and academic employers.

**CS 639. Elec. Medical Records: Med Terminologies and Comp. Imp.. 3 credits, 3 contact hours.**
This course presents a graduate introduction to Medical Informatics for Computer Science students covering (1) the design, use and auditing of medical terminologies, such as the Unified Medical Language System (UMLS) and the Systematized Nomenclature of Medicine (SNOMED); and (2) principles of Electronic Medical Records (EMR), Electronic Health Records (EHR) and Personal Health Records (PHR), including issues of privacy and security.

**CS 640. Recursive Function Theory. 3 credits, 3 contact hours.**
Prerequisite: CS 540 or equivalent. Review of basic computability theory. Topics include Church's thesis; unsolvability results; creative, productive, and simple sets; computational complexity; P=NP problem; and classification of solvable problems according to their complexity.

**CS 643. Cloud Computing. 3 credits, 3 contact hours.**
Prerequisites: CS 633 or CS 656. This course presents a top-down view of cloud computing, from applications and administration to programming and infrastructure. Its main focus is on parallel programming techniques for cloud computing and large scale distributed systems which form the cloud infrastructure. The topics include: overview of cloud computing, cloud systems, parallel processing in the cloud, distributed storage systems, virtualization, secure distributed computing, and multicore programming.

**CS 644. Introduction to Big Data. 3 credits, 3 contact hours.**
Prerequisites: permission of the instructor. This course provides an in-depth coverage of various topics in big data from data generation, storage, management, transfer, to analytics, with focus on the state-of-the-art technologies, tools, architectures, and systems that constitute big-data computing solutions in high-performance networks. Real-life big-data applications and workflows in various domains (particularly in the sciences) are introduced as use cases to illustrate the development, deployment, and execution of a wide spectrum of emerging big-data solutions.

**CS 645. Security and Privacy in Computer Systems. 3 credits, 3 contact hours.**
Prerequisite: Students are expected to enter this course with a basic knowledge of operating systems, networking, algorithms, and data structures. Also, students should be able to program in Java and C/C++. The course covers fundamental principles of building secure systems and techniques to ensure data security and privacy. Topics include access control mechanisms, operating systems security, malicious code threats and software security, trusted computing, content protection, and database security . The course will also study existing technical approaches to protecting privacy, including Web anonymizers and ant-censorship tools, as well as policy and legal aspects of privacy.

**CS 646. Network Protocols Security. 3 credits, 3 contact hours.**
Prerequisites: CS 656 or ECE 637, and ability to program in Java and C/C++. This course covers the security of network protocols currently used on the internet. It seeks to familiarize students with common threats and network attacks, and provides an in-depth study of methods used to secure network communication. The course includes an applied component, which will help students gain practical experience in attacking and defending networked systems. Topics include authentication systems, and routing security, firewalls, intrusion detection, honeypots, wireless network security, malware, propagation and detection, and web security.

**CS 647. Counter Hacking Techniques. 3 credits, 3 contact hours.**
Prerequisites: CS 645 or CS 646 or CS 696 or ECE 638 or approval of the instructor. This course covers advanced techniques that can be used for offensive or defensive goals in network, computer systems and applications. The course follows a ?learning by doing? teaching approach through extensive use of virtual machines with vulnerable operating systems and applications. Topics covered include system memory organizations, CPU registers, assembly language fundamentals, GNU and Immunity debuggers, fuzzing based security testing development of local and remote Linux and Windows exploits, shellcode development, stealthy attacks, bypassing memory protection techniques, network and wireless hacking techniques, and ethical and legal implications of cyber-attacks.

**CS 650. Computer Architecture. 3 credits, 3 contact hours.**
Prerequisites: CS 251 (see undergraduate catalog for description) and CS 510. Exploiting instruction level parallelism (ILP) is central to designing modern computers. Presents design techniques used for such computers as IBM Power architectures, DEC Alpha, MIPS R4600, Intel P6, etc. Introduction of Instruction SET Architecture (ISA), various functional units, basic principles of pipelined computers. Modern techniques to ILP including superscalar, super-pipelining, software pipelining, loop unrolling, and VLIW. Memory hierarchy, including instruction cache, data cache, second level cache, and memory interleaving. Advanced computer architectures, including vector, array processors, interconnection technology, and ATM network of workstations. Hands-on experience designing a simple pipelined computer on screen and using CAD tools such as Cadence or ViewLogic.

**CS 651. Data Communications. 3 credits, 3 contact hours.**
Prerequisite: MATH 333 (see undergraduate catalog for description). Intensive study of the analytic tools required for the analysis and design of data communication systems. Topics include: birth-death queuing systems, Erlang's distribution, bulk-arrival and bulk-service systems, design and analysis of concentrators and multiplexers, elements of Renewal Theory, M/G/1 system, analysis of Time Division Multiplexing, priority queues, analysis of random access systems, time reversibility, open and closed queuing networks, mean value analysis, flow and congestion, control mechanisms, routing algorithms, flow models, and network topological design.

**CS 652. Computer Networks-Architectures, Protocols and Standards. 3 credits, 3 contact hours.**
Prerequisite: A high level programming language, MATH 333 (see undergraduate catalog for description), or instructor approved equivalents. Intensive study of various network architecture and protocol standards; with emphasis on the Open Systems Interconnetion (OSI) model. Topics include: analog and digital transmission, circuit and packet switching, the Integrated Services Digital Network (ISDN), Frame Relay, Broadband ISDN, Cell Relay, SONET, Local Area Networks (CSMA/CD, Token Bus, Token Ring, switched and isochronous Ethernets), Metropolitan Area Networks (FDDI, FDDI-II, DQDB), wireless and satellite networks, synchronization and error control, routing and congestion control, X.25 standard.

**CS 656. Internet and Higher-Layer Protocols. 3 credits, 3 contact hours.**
The course introduces the protocols and standards of the TCP/IP suite that govern the functioning of the Internet. The material covered in class is a top-down approach on introduction, discussion, and analysis of protocols from the data-link layer to the application layer. Alternative protocols to the TCP/IP suite and new protocols adopted by this suite are discussed. Numerical examples related to network planning and proocol functioning are analyzed.

**CS 657. Principles of Interactive Computer Graphics. 3 credits, 3 contact hours.**
Prerequisites: CS 505 or familiarity with the organization of at least one computer system, and knowledge of a structured programming language such as C. Graduate-level introduction to computer graphics concepts, algorithms, and systems. Includes 2-D raster graphics, algorithms, 2-D and 3-D geometric transformations, 3-D viewing, curves and surfaces. Emphasis on PC-based graphics programming projects. Principles of interactive graphics systems in terms of the hardware, software and mathematics required for interactive image production.

**CS 659. Image Processing and Analysis. 3 credits, 3 contact hours.**
Prerequisite: CS 505. Fundamentals of image processing, analysis and understanding. Topics include image representation, image data compression, image enhancement and restoration, feature extraction and shape analysis, region analysis, image sequence analysis and computer vision.

**CS 660. Digital Watermarking. 3 credits, 3 contact hours.**
Digital watermarking and steganography is important to ensure data security because of widely used digital multimedia and rapid growth of the Internet. Digital watermarking is a suitable tool to identify the source, creator, owner, distributor, or authorized consumer of a document or an image. Digital steganography aims at hiding digital information into covert channels, so one can conceal the information and prevent detection. This course intends to provide students an overview on different aspects of mechanisms and techniques for digital watermarking and steganography.

**CS 661. Systems Simulation. 3 credits, 3 contact hours.**
Prerequisite: an undergraduate or graduate course in probability theory and statistics, and working knowledge of at least one higher-level language. An introduction to the simulation of systems, with emphasis on underlying probabilistic and statistical methodologies for discrete-event simulations. Design of simulation applications, and simulation programming in a high-level language. Algorithms for the generation of pseudorandom numbers. Algorithmic methodologies for the simulation of discrete and continuous probabilistic processes. Use of statistical tools. Simulation of queuing systems. Applications of simulation to a variety of system studies. The special purpose simulation language GPSS is studied in detail.

**CS 665. Algorithmic Graph Theory. 3 credits, 3 contact hours.**
Prerequisite: CS 610. The elements of the theory of graphs and directed graphs with motivating examples from communication networks, data structures, etc; shortest paths, depth first search, matching algorithms, parallel algorithms, minimum spanning trees, basic complexity theory, planarity, and other topics. Programming assignments are included.

**CS 666. Simulation for Finance. 3 credits, 3 contact hours.**
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/MATH 666.

**CS 667. Design Techniques for Algorithms. 3 credits, 3 contact hours.**
Prerequisite: CS 610. An introduction to the principles of major design techniques in algorithms. Examples from a variety of topics and problems in computer science are used to demonstrate these design techniques and their appropriate application.

**CS 668. Parallel Algorithms. 3 credits, 3 contact hours.**
Prerequisites: CS 610 and CS 650. This course examines a variety of parallel algorithms and architectures. Shared memory algorithms and algorithms for special architectures (tree processors, grids, systolic arrays, butterflies) are considered. The basic theory of algorithm/architecture performance will be described.

**CS 670. Artificial Intelligence. 3 credits, 3 contact hours.**
Prerequisite: CS 610. Fundamental concepts and general techniques in artificial intelligence. Main topics include goal tree search, logic and deduction, adduction, uncertainty, fuzzy logic, knowledge representations, machine learning, vision, and action planning. The LISP programming language is used extensively. Students are required to do programming assignments, complete a programming term project, and review case studies.

**CS 673. Software Design and Production Methodology. 3 credits, 3 contact hours.**
Prerequisite: CS 631. Modern techniques and methods employed in the development of large software systems, including a study of each of the major activities occurring during the lifetime of a software system, from conception to obsolescence and replacement. Topics include cost/performance evaluation, documentation requirements, system design and production techniques, system verification techniques, automated aids to system development, and project organization and management.

**CS 675. Machine Learning. 3 credits, 3 contact hours.**
Pre-requisites: Basic probability, linear algebra, computer programming, and graduate or undergraduate senior standing, OR approval of instructor. This course is an introduction to machine learning and contains both theory and applications. Students will get exposure to a broad range of machine learning methods and hands on practice on real data. Topics include Bayesian classification, perceptron, neural networks, logistic regression, support vector machines, decision trees, random forests, boosting, dimensionality reduction, unsupervised learning, regression, and learning new feature spaces. There will be several programming assignments, one course project, one mid-term and one final exam.

**CS 680. Linux Kernel Programming. 3 credits, 3 contact hours.**
An in-depth study of how the Linux operating system is built from scratch. AS a hands-on course, students will perform intensive programming using Linux Kernel. The contents include machine booting, segmentation and paging memory management, creating and destroying processes, process switching and scheduling, handling exceptions and hardware interrupts, software interrupts, creating system calls, creating file systems, networking with TCP/IP, device driver writing and module programming, etc. At the end of the course, students will be able to modify Linux operating system to create their own.

**CS 681. Computer Vision. 3 credits, 3 contact hours.**
This course introduces computational models of computer vision and their implementation on computers, and focuses on material that is fundamental and has a broad scope of application. Topics include comtemporary developments in all mainstream areas of computer vision e.g., Image Formation, Feature Detection/Representation, Classification and Recognition, Motion Analysis, Camera Calibration, 3D/Stero Vision, Shape From X (motion, shading, texture, etc.), and typical applications such as Biometrics.

**CS 683. Software Project Management. 3 credits, 3 contact hours.**
This course gives the student the necessary background to allow her/him to manage software projects; this includes economic, managerial and organizational aspects. The essence of software engineering is not only to introduce a valuable software product, but to do so economically and competitively. Like any engineering discipline, software engineering depends critically on managerial, economic and organizational considerations. Students will learn software management technique, various software costing techniques including COCOMO and ROI, team organization and management, and various methods of software development including Cleanroom and Agile.

**CS 684. Software Testing and Quality Assurance. 3 credits, 3 contact hours.**
This course discusses software faults and techniques to reduce faults and improve software quality. Software systems are some of the most complex human artifacts ever built and also some of the most critical means to ensure our safety, well being, and prosperity. This course teaches techniques to ensure software systems perform their function correctly. Topics include software specifications, goals of testing, techniques of test data selection, test oracle design, test data analysis, test lifecycle and quality impacts of testing.

**CS 685. Software Architecture. 3 credits, 3 contact hours.**
The software architecture defines the structure and interactions of software modules. This course provides a working knowledge of the terms, principles and methods of software architecture and module design. It explains the constraints on the design and the properties of capacity, response time, and consistency. The "4+1" architecture model is taught with architectural styles, interface isolation, decoupling, reuse, agile design with software patterns, data structures, queuing effects, design simplification and refactoring. The non-functional requirements of reliability, performance and power consumption, component based design and good industry practices for documenting and managing the architectural process are taught.

**CS 696. Network Management and Security. 3 credits, 3 contact hours.**
Prerequisites: CS 652 or CS 656 or ECE 637 or ECE 683 Thorough introduction to current network management technology and techniques, and emerging network management standards. In-depth study of the existing network security technology and the various practical techniques that have been implemented for protecting data from disclosure, for guaranteeing authenticity of messages, and for protecting systems from network-based attacks. SNMP family of standards including SNMP, SNMPv2, and RMON (Remote Monitoring), OSI systems management. Various types of security attacks (such as intruders, viruses, and worms). Conventional Encryption and Public Key Cryptology. Various security services and standards (such as Kerberos, Digital Signature Standard, Pretty Good Privacy, SNMPv2 security facility). Same as ECE 638.

**CS 698. ST:. 3 credits, 3 contact hours.**

**CS 700. Master'S Project. 0 credits, 0 contact hours.**

**CS 700B. Master's Project. 3 credits, 3 contact hours.**

**CS 701. Master's Thesis. 0 credits, 0 contact hours.**

**CS 701B. Master's Thesis. 3 credits, 3 contact hours.**

**CS 701C. Master's Thesis. 6 credits, 3 contact hours.**

**CS 704. Sequencing and Scheduling. 3 credits, 3 contact hours.**
Advanced sequencing and scheduling for job shops, flow lines, and other general manufacturing and production systems are discussed in this course. Both deterministic and stochastic scheduling models are covered in detail. Heuristics and worst case analysis for "unsolvable" hard scheduling problems (NP-C problems) are introduced.

**CS 708. Advanced Data Security and Privacy. 3 credits, 3 contact hours.**
Prerequisites: CS 608, CS 645, CS 696, or instructor approval. In-depth study of the security and privacy issues associated with the massive amount of data that is collected, stored, shared and distributed in today's society. New paradigms are needed to address the security/privacy challenges when data is outsourced at untrusted servers (such as in cloud computing), when data is anonymized in order to be shared among untrusted parties, or when copyrighted data needs to be protected from unauthorized use.

**CS 725. Independent Study in Computer Science I, II. 3 credits, 3 contact hours.**
Restriction: graduate standing and department consent.

**CS 726. Independent Research II. 3 credits, 3 contact hours.**

**CS 731. Applications of Database Systems. 3 credits, 3 contact hours.**
Prerequisites: CS 631. Restricted to students who are specializing in computer and information systems management. Comparative study of different models of database management systems and their applications. Emphasis on the functions of the database administrator. Includes a survey of physical and logical organization of data, methods of accessing data, characteristics of different models of generalized database management systems, and case studies using these systems from various applications. Student teams design database systems for class projects.

**CS 732. Advanced Machine Learning. 3 credits, 3 contact hours.**
Prerequisites: CS 634 or CS 670. This course presents advanced topics in the machine learning field, with a focus on recent learning techniques developed for analysis of high dimensional data such as a model selection by regularization and ensemble learning. The course also covers the theory of supervised, semi-supervised, unsupervised, transduction and reinforcement learning, as well as applications of these learning methods.

**CS 735. High Performance Analytics Dat. 3 credits, 3 contact hours.**
Prerequisites: Knowledge of material from at least four courses in the following list: CS 631 (Data Management Systems Design), CS 634 (Data Mining), CS 643 (Cloud Computing), CS 644 (Introduction to Big Data), CS 675 (Machine Learning). Targeting the latest computing infrastructures and software systems for data analytics, this course introduces students to the design and analysis of scalable data science algorithms, as well as skills to implement high performance data science applications. Specific topics include in-memory data processing, column-oriented data storage and retrieval, cloud-based data intensive systems, as well as classic data analytics algorithms such as causal discovery and network inference and their scalable implementation.

**CS 744. Data Mining and Management in Bioinformatics. 3 credits, 3 contact hours.**
Prerequisites: CS 610 or permission of the instructor. Concepts and principles of bioinformatic data mining and management with focus on efficiency and scalability. Methods for indexing and querying biological databases, biological data mining, and algorithmic development for bimolecular and phlyogenetic data analysis. Trends and advances in areas such as functional genomics and proteomics, genetic engineering, and large-scale gene expression data analysis.

**CS 750. High Performance Computing. 3 credits, 3 contact hours.**
Prerequisite: CS 650. An in-depth study of the state of the art in high performance computing. Topics parallel computer architectures, programming paradigms, and their applications. Parallel architectures include PC clusters, shared-memory multiprocessors, distributed-memory multiprocessors, and multithreaded architectures. Parallel programming paradigms include message passing interface (MPI), its second-generation MPI-2, and multithreaded programming. Applications include computational science and high performance Web and database servers for Internet-based electronic commerce. Students program a parallel machine in class projects. First-hand experience in stable, scalable, high performance computing for Internet-based electronic commerce.

**CS 755. Security and Privacy in Wireless Networks. 3 credits, 3 contact hours.**
This course covers selected topics on security and privacy in wireless networks and is intended for graduate students who are interested in network security. This course can help the students learn the state of the art and open challenges in wireless network security and privacy, thus enhancing their potential to perform research or pursue a career in this emerging area.

**CS 756. Mobile Computing and Sensor Networks. 3 credits, 3 contact hours.**
This course provides an in-depth study of mobile computing and sensor networks, which are becoming major components of the transition from today's world of desktop computers to a world where computing is ubiquitous. The main topics include: techniques to handle mobility in the Internet and ad hoc networks; operating systems, programming languages, and protocols for sensor networks; applications, middleware, programming models, and security ubiquitous computing environments.

**CS 759. Advanced Image Processing and Analysis. 3 credits, 3 contact hours.**
Prerequisite: CS 659. Advanced study of recent research in image processing, analysis, and understanding. Topics include all image processing techniques, high-level recognition approaches, and automated expert vision systems.

**CS 775. Seminar in Software Engineering. 3 credits, 3 contact hours.**
Prerequisite: CS 673. A seminar in which students pursue intensive study of specialized topics in the current literature of software engineering. Each topic is supported by an initial reading list on current problems in theory and practice. The results of the studies are discussed in class with students, faculty and invited specialists.

**CS 777. Seminar in Software Management and Production. 3 credits, 3 contact hours.**
Prerequisites: Ph.D. core courses. A seminar in which students pursue intensive study of specialized topics in the current literature of software management and production. Each topic is supported by an initial reading list covering current problems in theory and practice. The results of the studies are discussed in class with students, faculty, and invited specialists participating. Topics include, but are not limited to, theory of algorithm structure, analysis of algorithms and programs, hardware technology assessment, automated tools for software production, software measurements and quality, peripheral device interfaces, data communications, computer networks, distributed processing, software verification, implementation standards, documentation standards, system security, software copyright, and project control and organization.

**CS 782. Pattern Recognition and Applications. 3 credits, 3 contact hours.**
Prerequisite: CS 610. Study of recent advances in development of (statistical and syntactic) pattern algorithm, approximation, and estimation techniques. Topics include statistical estimation theory, classifier design, parameter estimation and unsupervised learning, bias vs. variance, nonparametric techniques, linear discriminant functions, tree classifiers, feature extraction, and clustering. Additional topics include Support Vector machines (SVM), Bayesian Learning, Hidden Markov Models (HMM), evolutionary computation, neural networks, with applications to signal interpretation, time-series prediction, and Biometrics.

**CS 785. Seminar in Computer and Information Science I. 3 credits, 3 contact hours.**
Prerequisite: determined by nature of topic area. Advance notice of the topics to be covered is given. These seminars examine in depth a special interest area of computer and information science. It emphasizes recent work in area selected for the offering of the course. This course is for master's students and cannot apply toward master's degree credit.

**CS 786. Special Topics. 3 credits, 3 contact hours.**
Prerequisite: as determined by nature of topic area. A continuation of CS 785.

**CS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**

**CS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**CS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**CS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**CS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**CS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**CS 790G. DOCT DISSERTATION & RES. 18 credits, 3 contact hours.**

**CS 791. Graduate Seminar. 0 credits, 0 contact hours.**
Corequisite (for doctoral students only): CS 790. A seminar in which faculty, students, and invited speakers will present summaries of advanced topics in computer and information systems management. In the course students and faculty will discuss research procedures, dissertation organization, and content. Students engaged in research will present their own problems and research progress for discussion and criticism.

**CS 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Restriction: permission from department chairperson. For students admitted to the doctoral program in computer and information science who have passed the field exam or the qualifying examination. Research is carried out under the supervision of a designated faculty member. Students identify a research problem and prepare a plan to solve the problem. A maximum of 6 credits of CS 792 may be applied to the CIS 790 requirement.

**CS 792C. Pre-Doctoral Research. 6 credits, 0 contact hours.**

**IS 513. Programming Foundations for IS. 3 credits, 3 contact hours.**
This course is an introduction to the Java programming language teaching the foundations of writing, testing and debugging of programs. The course has three major parts. The first part teaches fundamental programming techniques that use primitive data types, variables, assignments expressions and operators, control statements, arrays and files I/O. The second part covers testing and debugging, and teaches students how to write programs that work reliably. The third part introduces object-oriented programming.

**IS 531. Database Fundamentals. 3 credits, 3 contact hours.**
This course gives students extensive, pragmatic experience in designing, building, querying, updating, maintaining and managing relational databases, using the Structured Query Language (SQL). We will start our journey by analyzing what database is and why it is superior to other data management methods. We will then conduct logical and physical database design. SQL will be extensively covered, and students will design and implement sophisticated SQL queries invoking self-joins, outer joins, correlated subqueries and related concepts. Hands-on experience will be gained by working with actual databases using industry-standard database management systems such as Oracle.

**IS 565. Aspects Of Information Systems. 3 credits, 3 contact hours.**
Methods and models of supporting the management process; ethical issues pertaining to the construction, deployment, and impact of information systems on organizations and society; description, analysis, and design of information systems to assist problem solving and decision-making in a business environment.

**IS 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisite: students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of each semester's work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS.

**IS 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisite: students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS.

**IS 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: graduate standing, and acceptance by the IS department and the Division of Career Development Services. Students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS.

**IS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**IS 601. Web Systems Development. 3 credits, 3 contact hours.**
Prerequisites:NONE Students will gain experience in open source web development through an intensive hands-on project, applying real-world problem-solving skills to meeting information systems requirements. Students will learn Web development principles, as well as professionally relevant skills including industry standards, conventions, and procedures within large-scale programming projects. Also covered are the communication tools, technologies, and practices that individuals use to coordinate and collaborate within the open source software development community.

**IS 612. Emergency Management Informatics. 3 credits, 3 contact hours.**
This course covers core aspects of Emergency Management (EM) as they relate to information systems and usage of associated technologies. EM theory identifies four critical areas: 1) understanding & mitigating risk, 2) planning & preparedness, 3) reaction & response, 4) recovery & normalization. The role of informatics for each critical area will vary and is the basis for discussions and assignments. This course also focuses on innovative information systems approaches to EM in each area. Within the EM domain, business continuity (information processing and sharing during crisis situations), cyberterrorism, and international response are covered.

**IS 613. Design of Emergency Management Information Systems. 3 credits, 0 contact hours.**
This course is concerned with the development of requirements, the design of the human interaction, and the supporting functionality of any Information System related to the complete preparedness lifecycle for emergency, disaster, and crisis situations for government bodies, non-profit, and/or private organizations that are concerned with business continuity. It also focuses on organizational behavior and its effects on the functionality of the system and the design of the human interface.

**IS 614. Command and Control Systems. 3 credits, 3 contact hours.**
This course investigates the relevance and applicability of using of Command and Control (C2) models in organizational responses to both normal emergencies and catastrophic events. C2 refers to how leadership, authority, decision-making and coordination are assured within an organization, including distributed and virtual organizations. The course examines the functionality and properties of C2 systems in terms of matching requirements for these systems to the behavior of individuals, groups, and organizations during emergency conditions. It will address integrating systems and technologies within organizational emergency operations functions and processes to include business continuity and disaster response.

**IS 616. Learning Methodologies and Training Technologies. 3 credits, 3 contact hours.**
This course provides an overview of learning methodologies and training technologies, with an emphasis on emergency management. It reviews theories and develops skills for the planning, evaluation and selection of traditional and new technology-driven learning and training methods. Course participants will review relevant research and learn how to choose the most effective training methodologies, technologies and content resources appropriate to the needs of different audiences.

**IS 631. Enterprise Database Management. 3 credits, 3 contact hours.**
Prerequisites: IS 601 This course provides an understanding of the issues as well as hands-on experience in managing database systems as an essential organizational resource. Students will obtain a conceptual foundation of database design and explore the implications for organizational database usage. Students also will gain experience with enterprise database management systems, such as Oracle. This course introduces the design and management of enterprise-wide database systems. Topics include: (1) data modeling and database design; (2) database implementation with SQL; (3) database access standards for enterprise database systems; (4) multidimensional databases, online analytic processing (OLAP) and data warehousing, customer relationship management (CRM); and (5) web-based enterprise database systems.

**IS 634. Information Retrieval. 3 credits, 3 contact hours.**
Prerequisites: IS 601 Modern information retrieval systems, such as web search engines, empower users to easily access information on the web. The course covers the concepts and principles of information retrieval systems design, including web crawling, automatic indexing, vector space modeling, retrieval algorithms, digital libraries, text mining, information extraction, and document warehousing. These techniques are essential for building web systems, text databases, document processing systems, and other advanced information management systems.

**IS 661. User Experience Design. 3 credits, 3 contact hours.**
This is a foundation course on the design of digital products. User eXperience Design (UXD) isn't just about making interfaces usable. It is about designing and building relevant and successful products. Effective UXD requires a mix of Interaction Design (ID) methods and processes. This course takes you through the process of creating compelling interaction designs for digital products from the idea stage into creating a simple and intuitive user experience blueprint. You will 'learn by doing' in a team environment, enabling you to practice the techniques with coaching from instructors. The course will demystify Lean UX; Agile UX; Human Computer Interaction (HCI); Design Audits and Claims analysis; Persona construction; Storyboarding; ID scenarios; ID Frameworks; Role of user-research in UXD; and Design Patterns.

**IS 663. System Analysis and Design. 3 credits, 3 contact hours.**
Pre or Corequisite: IS 601 This course develops the skills necessary to analyze, design and manage the development of effective enterprise-scale information systems solutions incorporating contemporary methods and effective organizational and global project management practices. It focuses on technical business systems analysis and design techniques, and covers key software engineering principles, methods and frameworks, including process models, agile and lean principles, project and risk management, estimation, requirements elicitation and analysis, modeling, system and software architecture, design patterns, and quality systems. Students will actively participate in discussions, review selected articles, participate in team exercises and collaborate on projects involving analysis and prototyping of applications addressing real-world problems and integrating current and emerging technologies.

**IS 664. Customer Discovery. 3 credits, 3 contact hours.**
'Customer Discovery' is the term used by lean startup companies to describe the process of directly engaging with customers to explore potential new markets. Such evidence-based entrepreneurship guides the potential for new product ideas early in the development process. Similarly, high-tech innovators in new media, web, software apps, social networking, wearable computing, and mobile devices need to determine early on if their proposed solutions address real user needs. They do this by understanding potential user's practice, preferences and mental models. As a result, knowledge of a basic set of qualitative customer discovery methods is essential for both the lean startup entrepreneur and those engaged in interaction design innovation. This course teaches these methods through hands-on team projects. Students will design and run interview and diary studies, thinking out-loud protocols and focus groups, and analyze and report on findings. Students will explore over the course of the semester a problem domain and gain understanding of customer needs that will serve as a foundation for high-tech, innovative product design.

**IS 665. Data Analytics for Info System. 3 credits, 3 contact hours.**
Prerequisites: IS 601 This course gives a graduate level introduction to data analysis, probability and statistics from an information systems perspective, including many of the techniques that are most relevant to the profession of Data Scientist for business, data and web analytics, as well as current data sets. We will learn and conduct Python, matlab and R based manipulation of data. Course topics include the rudiments of probability and random variables, estimation, special distribution and sampling, Markov processes, hypothesis testing, graphics and visualization.

**IS 676. Requirements Engineering. 3 credits, 3 contact hours.**
Corequisites: IS 663 or CS 673 or equivalent project experience in the field. Requirements engineering is one of the all-important beginning stages of the systems development life cycle. Revealing and understanding the system's requirements is a crucial component of success for developing new computing systems or adjusting existing applications. This course covers the theory, principles, and practical application of the methodologies and tools for requirements engineering. The focus is development of large software systems and the integration of multiple systems into a comprehensive, domain dependent solution. All aspects of requirements engineering including the knowledge and skills needed to elicit and analyze requirements, translate these requirements into technical specifications, verify that the requirements accurately capture the system requirements, and manage software requirements through the system development cycle will be covered. Students will actively participate in discussions, labs and exercises, and prepare operational requirements and technical specifications for real-world problems. We will spend a considerable amount of time interacting and learning through discussion of assigned readings and other material.

**IS 677. Information System Principles. 3 credits, 3 contact hours.**
This course introduces the field of Information Systems; the study of how people and organizations should use information technologies effectively. We examine the major areas in the field, analyzing the major issues, trends and problems. We survey the role of information systems in organizations and how these systems support organizational objectives and organizational structure, as well as providing competitive business advantages. We discuss basic concepts such as the systems point of view, the organization of a system, the nature of information and information flows, as well as how people process information and related cognitive concepts. We also examine various types of information system applications such as e-commerce, supply chain, decision support, and enterprise systems. And, finally, we also consider critical ethics issues including privacy, personalization and security.

**IS 678. IT Service Management. 3 credits, 3 contact hours.**
Prerequisites: IS 663 or CS 673 This course introduces the Information Technology Infrastructure Library (ITIL) fundamentals of the service management life cycle-service strategy, service design, service transition, service operation, and continual service improvement. ITIL provides a comprehensive, consistent, and coherent framework of best practices for IT Service Management (ITSM), which promotes a quality approach for achieving business effectiveness and efficiency in the use of information systems. This course presents the basic terminology and an overview of the functions and processes for each of the life cycle phases as they apply to IT Management. Although ITIL is originally presented as an approach for designing IT processes, we can expand this view and apply it to the design of other business services. Possible semester-long contexts are the processes of an educational services provider or health care services provider.

**IS 680. Information Systems Auditing. 3 credits, 3 contact hours.**
Due to the dynamic nature of information technology, the need arises continually to redefine audit, control and security requirements and processes. Topics include the IS audit process, IT infrastructure and operations, information protection, disaster recovery and business continuity, IT service delivery and support, business application systems, and project management. Students gain practical experience with each by working through a series of sample Certified Information Systems Audit (CISA) exam questions.

**IS 681. Computer Security Auditing. 3 credits, 3 contact hours.**
This course reflects the current emphasis on information security and security management in Fortune 500 corporations. Students will delve into information protection concepts, privacy impact analysis, computer crime, legal issues, controls and auditing systems, and firewall configuration. Students will have the opportunity to learn and perform evaluations on security infrastructures in a controlled environment in class labs by completing realistic security auditing projects and using vulnerability assessment tools to assess risks and evaluate security controls on networked infrastructures.

**IS 682. Forensic Auditing for Computing Security. 3 credits, 3 contact hours.**
A computer forensics audit is the proper identification and collection of computer evidence. Computers are involved in security violations through crime or violations of policy, or being targeted by an attack. This course deals with the preservation, identification, extraction, documentation, reporting, acquisition, analysis and interpretation of computer data. Topics covered include evidence handling, chain of custody, collection, preservation, identification and recovery of computer data. In this hands-on course, you will conduct several labs where you will be taught to analyze, review and extract information from computer hard drives, and determine what and how the information could have been compromised. Computer Forensics Audit professionals become experts in e-discovery and preserving sensitive evidential matter.

**IS 683. Web Systems Development. 3 credits, 3 contact hours.**
Students will gain experience in open source web development through an intensive hands-on project, applying real-world problem-solving skills to meeting information systems requirements. Students will learn Web development principles, as well as professionally relevant skills including industry standards, conventions, and procedures within large-scale programming projects. Also covered are the communication tools, technologies, and practices that individuals use to coordinate and collaborate within the open source software development community.

**IS 684. Business Process Innovation. 3 credits, 3 contact hours.**
Prerequisites: IS 663 or CS 673 This course adopts a balanced approach to business process innovation (BPI) that includes both incremental improvement and re-engineering. It specifically examines the concept of a service-oriented architecture (SOA) and the use of web services as a way to enable scalable and adaptive business processes. Students will learn how to develop process maps using the Business Process Modeling Notation (BPMN) and design process improvements to achieve efficiency, effectiveness, compliance and agility objectives. The focus of the course is on ways in which information technology can be used to manage, transform and improve business processes.

**IS 685. Enterprise Architecture and Integration. 3 credits, 3 contact hours.**
Prerequisites: None, but recommend completion of IS 663 or CS 673. The Enterprise Architecture (EA) describes an organization's IT strategy and operational structure. IS and IT professionals utilize the EA to analyze, design and integrate the (often heterogeneous) IT infrastructure and applications to most effectively support the enterprise and respond to risks. Students learn to develop an EA analysis which reflects its business strategies, capabilities, processes, and systems, metrics, information resources, and networking infrastructure. This enables students to determine the impact of IT solutions, by learning to deconstruct, analyze and configure IT systems in alignment with enterprise-wide business strategies. The course covers the industry standard The Open Group Architecture Framework (TOGAF) enterprise architecture framework and focuses on Enterprise Application Integration (EAI).

**IS 686. Pervasive Computing: An HCI Perspective. 3 credits, 3 contact hours.**
This course examines Pervasive/Ubiquitous Computing, the trend toward increasingly ubiquitous connected computing devices in the environment - a trend being brought about by a convergence of advanced electronic, and particularly, wireless technologies and the internet. We do this from a Human Computer Interaction perspective looking at the current and future design of various systems.

**IS 687. Transaction Mining and Fraud Detection. 3 credits, 3 contact hours.**
Prerequisites: IS 665 Increasingly, all of our transactions are electronic. We use debit and credit cards (electronic transactions) instead of checks and cash at banks, restaurants, stores, and many other businesses. Evaluation of transactions to find risk includes detection of terrorists and money launderers. Every financial institution is legally required to monitor transactions to detect organized crime and terrorism. Mining transaction streams to find good or bad customers in a rapidly growing area of employment for IS graduates. This course will present methods that are being used to analyze and mine transactional data and the business applications of these methods.

**IS 688. Web Mining. 3 credits, 3 contact hours.**
Prerequisite: IS 665. Web mining aims to discover useful information and knowledge from the Web hyperlink structure, page contents and usage logs. It has direct applications in e-commerce, Web analytics, information retrieval/filtering, personalization, and recommender systems. Employees knowledgeable about Web mining techniques and their applications are highly sought by major Web companies such as Google, Amazon, Yahoo, MSN and others who need to understand user behavior and utilize discovered patterns from terabytes of user profile data to design more intelligent applications. The primary focus of this course is on Web usage mining and its applications to business intelligence and biomedical domains. We learn techniques from machine learning, data mining, text mining, and databases to extract useful knowledge from the Web and other unstructured/ semistructured, hypertextual, distributed information repositories. This data could be used for site management, automatic personalization, recommendation, and user profiling. Topics covered include crawling, indexing, ranking and filtering algorithms using text and link analysis, applications to search, classification, tracking, monitoring, and Web intelligence. Programming assignments give hands-on experience. A group project highlights class topics.

**IS 690. Web Services and Middleware. 3 credits, 3 contact hours.**
Prerequisite: IS 601 Web services enable integration of web-based applications and feature sets to any other web-based system in a modular way. Middleware is a set of functionality positioned in between and enabling interoperability among different, distributed enterprise and other computing applications. This course provides an introduction to web services and middleware in the context of digital libraries - large scale multimedia information repositories. Students will gain hands on experience in developing their own web services managing a complex distributed computing platform.

**IS 698. Special topics in Information Systems. 3 credits, 3 contact hours.**
Special area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

**IS 700. Master's Project. 0 credits, 0 contact hours.**
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

**IS 700B. Master's Project. 3 credits, 3 contact hours.**
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

**IS 700C. Master's Project. 6 credits, 6 contact hours.**
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

**IS 701. Master's Thesis. 0 credits, 0 contact hours.**
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

**IS 701B. Master's Thesis. 3 credits, 3 contact hours.**
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

**IS 701C. Master's Thesis. 6 credits, 3 contact hours.**
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

**IS 725. Independent Study in Information Systems. 3 credits, 3 contact hours.**
Prerequisites: Graduate standing and department consent.

**IS 726. Independent Research II. 3 credits, 3 contact hours.**

**IS 727. Independent Research III. 3 credits, 1 contact hour.**

**IS 735. Social Media. 3 credits, 3 contact hours.**
Prerequisite: IS 665 or MATH 661, or a graduate course in statistics or course in quantitative research methods. Seminar style course that covers design and impact of computer-based systems for human communication, including email and IM, discussion boards, Computer-Supported Cooperative Work (CSCW), Group Decision Support Systems (GDSS), and Social Networking Systems. Topics include alternative design structures, impacts of primarily text-based group communication, and recent empirical studies of virtual teams, online communities, and systems used for social networking, including 3-D worlds such as Second Life and "micro blogging" systems such as Twitter.

**IS 764. Research Methods for Human-Centered Computing and Design. 3 credits, 0 contact hours.**
Prerequisites: None. This introductory seminar in human centered computing and design provides a survey of the methodological literature on qualitative research methods paired with appropriate article-length exemplars. We cover a variety of different research strategies including design science, action research, case study, qualitative data collection and analysis techniques, and scenario-based design. This course develops skills in designing and evaluating systems using qualitative methods. We also discuss writing and reviewing academic articles and research proposals. The course utilizes information systems as the primary domain but could be extended for students in other disciplines.

**IS 765. Quantitative Methods in Information Systems Research. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or equivalent. This course is a practical and project-oriented introduction to quantitative methods in information systems (IS) research. The focus of the course is on developing researchers' capability to select and implement appropriate statistical procedures for a variety of research questions and to interpret the results of these procedures.

**IS 766. Philosophy of Information Science. 3 credits, 3 contact hours.**
This seminar explores central issues in contemporary philosophy of science. We consider "scientific" progress in the computing sciences with a focus on information systems and human computer interaction theory. We discuss topics such as confirmation and disconfirmation of theories; falsifiability and pseudo-science; introduction; probability; and statistical inference, prediction, explanation and empirical equivalence. We read key works by philosophers such as Popper and Kuhn. We examine the notion of "design science" and contrast it with "natural science", and examine whether social science research should strive to emulate natural science methods. Readings will be tied into research within information systems and the computing sciences in general, looking at how scientific theories are tested or confirmed.

**IS 776. IS Research Proposition. 3 credits, 3 contact hours.**
Prerequisite: Restricted to students in the doctoral program in Information Systems. The IS Research Study serves as the Information Systems PhD qualifying exam and demonstrates research readiness. Each student works with a faculty member to identify the topic of a research study, and then takes the lead in designing and conducting the study, and analyzing the results.

**IS 785. ST:. 3 credits, 3 contact hours.**
These seminars examine a special interest area of Information Systems in depth. Each seminar emphasizes recent work in the area selected.

**IS 786. Special Topics. 3 credits, 3 contact hours.**
These seminars examine a special interest area of Information Systems in depth. Each seminar emphasizes recent work in the area selected.

**IS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 791. Graduate Seminar. 0 credits, 0 contact hours.**
A seminar in which faculty, students, and invited speakers will present summaries of advanced topics in information systems. In the course students and faculty will discuss research procedures, dissertation organization, and content. Students engaged in research will present their own problems and research progress for discussion and criticism.

**IS 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Prerequisite: permission from department chairperson. For students admitted to the doctoral program in IS who have passed the field exam or the qualifying examination. Research is carried out under the supervision of a designated faculty member. Students identify a research problem and prepare a plan to solve the problem. A maximum of 6 credits of IS 792 may be applied to the IS 790 requirement.

**IT 610. System Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course is an introduction to the skills needed for and tasks performed by a System Administrator. The course will cover administration of host and server systems in modern operating system environments. Topics to be covered include: user, configuration, and change management, shell scripting, monitoring and performance analysis, disaster mitigation and recovery, and auditing.

**IT 620. Wireless Networks Security and Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course introduces the fundamentals of wireless network security and administration. Topics include: wireless LAN vulnerabilities, passive and active wireless attacks, enterprise wireless hardware security, secure wireless authentication and communication, wireless intrusion detection and prevention systems, WiFi and cellular network management, location privacy, personal area network administration and security, mobile IP security, GSM, CDPD, 3G and 4G network security. The course provides both a theoretical foundation and hands-on experience in these areas.

**IT 635. Database Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course provides a broad overview of the tasks and techniques necessary to function as a Database Administrator (DBA)in a modern relational database environment. Students will learn the duties typically performed by a DBA, which include: user authorization, disaster planning and recovery, monitoring, performance analysis, database tuning, metadata maintenance as well as data modeling, analysis and database design.

**IT 640. Network Services Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course provides an introduction to the fundamentals of network services administration. It covers how web-based and domain-services operate, integrate and communicate. Topics include: fundamental technologies that underpin the web services paradigm, key standards necessary for their development, and how other critical domain services should be deployed. This course will enable students to gain skills necessary to plan, install, configure, secure and maintain web servers, DNS servers, email & print servers, resource sharing systems, and domain authentication systems.

**IT 725. Independent Study. 3 credits, 3 contact hours.**

# Computer Science

## Computer Science

The Department of Computer Science is distinguished by prominent researchers who are actively investigating new applications in parallel processing and advanced computer architecture, systems integration, real-time computing, neuroscience and robotics, medical imaging, combinatorial computing, bioinformatics, computer vision and image processing, and software engineering.

The department provides an environment that gives students the background and skills necessary for entry into today's workplace. This is achieved through team research in state-of-the-art facilities; a faculty that works steadily in the forefront of many research areas; interaction with industry and experts; and an administration focused on research and student services. As a result, the department attracts the largest student population for computer and information science in the greater New York/New Jersey area.

The computer science department maintains and offers computing facilities for its students, faculty, and staff. The computing facilities include research laboratories housing research in areas of computer science such as: networking, real-time systems, hypermedia, parallel processing, and collaborative systems. Users have access to the state-of-the-art software and hardware including Oracle database, UNIX-based workstations and Microsoft Windows PCs supported by several file and compute servers. Internet access, departmental intranets, and conferencing systems provide an integrated infrastructure for supporting teaching and research.

## Master of Science in Computer Science

The Master of Science (MS) in Computer Science (CS) is intended for students who are interested in pursuing advanced studies in computer science.

### Admission Requirements

- GPA
  - 3.0 out of 4.0 required for students with a computer science background.
  - 3.0 out of 4.0 required for students without a computer science background who may be required to enroll in bridge courses.
- International students TOEFL score: the Institute requires a minimum score of 213 **paper based or 79 online.**
- International students: GRE required.
- Students with a US or Canadian degree in computer science or engineering: GRE recommended but not required.
- Students with a US or Canadian degree not in computer science or engineering: GRE required.

Students who lack a comprehensive computer science background may be required to take appropriate bridge courses and attain a minimum cumulative GPA of 3.0 in the bridge courses.

Students are expected to have good programming skills, and a grasp of the fundamentals of computer science (students should have acquired this knowledge in the undergraduate degree Bachelor of Science in Computer Science or equivalent degree). To ensure that students have the background to do well and succeed in doing the MS in Computer Science at NJIT, they will be required to take a short answer exam to demonstrate that they have good programming skills (in C++ or Java) and that they know the basic concepts of operating systems, networking, and databases. Students who do not do well in the exam are offered the opportunity to improve their skills via bridge courses.

Note that credits earned in the bridge program cannot count towards the MS program. However, grades of 500-level bridge courses contribute towards the graduate GPA. Students must maintain a cumulative graduate GPA of 3.0 or better.

If a student satisfies a bridge requirement before matriculation, the student can request a bridge course waiver which must be filed no later than the end of the first semester of studies and accompanied by all relevant documentation as required by University regulations. See Academic Policies and Procedures in the NJIT Graduate Catalog at http://catalog.njit.edu/graduate/academic-policies-procedures/.

PASS/FAIL courses, professional development courses, work experience, or a course with a grade less than B (or equivalent) cannot be used to satisfy a bridge course requirement. Grades in the bridge program (500-level courses or higher) contribute to the cumulative graduate GPA. However, these courses do not count toward the MS program credit requirements. The undergraduate catalog, http://catalog.njit.edu/undergraduate/computing-sciences/computer-science/#coursestext, contains descriptions of undergraduate courses included in the bridge program.

### Application Processing

The Computer Science Department reviews only completed applications submitted to the Office of Graduate Admissions. Applicants are advised to request status information on their application directly from the Graduate Admissions Office, not the Computer Science Department. Graduate Admissions can be reached at admissions@njit.edu or www.njit.edu/gadmission (http://www.njit.edu/gadmission) or by mail at NJIT, Graduate Admissions Office, University Heights, Newark NJ 07102.

### Bridge Courses

Students who intend to pursue an MS degree in Computer Science are expected to have a certain background in Computer Science and Mathematics. A student who does not have this background may need to enroll bridge courses before taking graduate level Computer Science courses. This will help ensure success in the MS program. These students will be notified in their acceptance letter that bridge courses are a condition of their acceptance into the Master's Program. If a student's acceptance letter indicates bridge courses are required, they must contact the Graduate Advisor. If the acceptance letter does not indicate bridge courses, none are required and the student may immediately begin taking graduate courses. A student must maintain a cumulative GPA of 3.0 in bridge courses. Bridge courses do not count towards MS degree requirements; however, they count toward the cumulative graduate GPA.

## Bioinformatics

### Admission Requirements

- BS or BA Degree is Computing, Biology, or related discipline. TOEFL and GRE required for international students..
- Computer courses in programming & data structures equivalent to CS 113 Introduction to Computer Science & CS 114 Introduction to Computer Science II.
- One or more courses in genetics or molecular biology, equivalent to R120 352 Genetics or R120 356 Molecular Biology.
- Mathematics courses in calculus equivalent to MATH 111 Calculus I & MATH 112 Calculus II.

If the prerequisites are not fulfilled, completion of specific bridge courses will be required as a condition of admission.

## Computing and Business

Technology and Science are dramatically changing our economy and our society. This is creating new business opportunities and needs, with an increasing push for computing employees to be more involved in business aspects of a company. Computing employees must have a solid understanding of business fundamentals to succeed. Specifically designed to address theses issues, the Master of Science (MS) in Computing and Business degree is primarily for people who want to develop, use, and manage software applications and systems in a business environment.

Offered by the College of Computing Sciences, the MS in Computing and Business contains a mix of courses in computer science and business. With one of the most computing intensive campuses in the world, NJIT has pioneered in the applications of new technologies as learning tools. The College of Computing Sciences educates one of the largest groups of information technology students in the nation.

## Cyber Security and Privacy

### Admission Requirements

To be eligible for admission, a student must have completed an undergraduate degree, preferably in Computer Science, Computer Engineering, Information Systems, Information Technology, or a related field, with a minimum GPA of 3.0 on a 4.0 scale.  Students not satisfying these criteria will be considered for conditional admission on a case-by-case basis.  This includes students whose bachelor's degree is in a non-computing field but have professional experience in computing or systems administration. Any such student who is admitted will be required to complete the following bridge courses with a GPA of 3.0 or higher: CS 505 Programming, Data Structures, and Algorithms, CS 506 Foundations of Computer Science. The bridge courses will not be counted toward the MS degree.

### Application Processing

The Computer Science Department reviews only completed applications submitted to the Office of Graduate Admissions. Applicants are advised to request status information on their application directly from the Graduate Admissions Office, not the Computer Science Department. Graduate Admissions can be reached at admissions@njit.edu or www.njit.edu/gadmission (http://www.njit.edu/gadmission) or by mail at NJIT, Graduate Admissions Office, University Heights, Newark NJ 07102.

## Software Engineering

Software engineering is the disciplined application of computer science knowledge to the analysis, design, development, evaluation and evolution of software products.  Because software pervades economic and personal activity worldwide and because it is increasingly being used in critical applications, the software industry is under intense pressure to deliver quality software.  Because software production remains a labor intensive activity, the demand for large volumes of high quality software translates into high demand for qualified software engineers. *MS in Software Engineering* consists of a judicious balance of theoretical computer science foundations that afford graduates the means to remain abreast of developments in software engineering in the long term and practical applications that afford graduates the means to be operational in the short term.

## Admission Requirements

Applicants are expected to have completed an undergraduate degree in computer science, information systems, information technology, or another computing related field. Students lacking the appropriate background will be considered for conditional admission on a case-by-case basis and may be required to take bridge courses (bridge courses do not count for credit towards the degree).

# NJIT Faculty

## B

Baltrush, Michael A., Associate Professor

Blank, George, University Lecturer

Borcea, Cristian M., Professor

## C

Calvin, James M., Professor

Cohen, Barry, Associate Dean, College of Computing Sciences

Curtmola, Reza, Associate Professor

## D

Ding, Xiaoning, Assistant Professor

## E

Eljabiri, Osama, Senior University Lecturer

## G

Gehani, Narain, Professor

Geller, James, Professor

Gerbessiotis, Alexandros, Associate Professor

## H

Hung, Daochuan, Associate Professor

## K

Kapleau, Jonathan, J., University Lecturer

Karvelas, Dionissios, Senior University Lecturer

Kwestel, Morty D., Senior University Lecturer

## L

Leung, Joseph Y., Distinguished Professor

Liu, Chengjun, Professor

## M

McHugh, James, Professor

Mili, Ali, Professor

## N

Nakayama, Marvin K., Professor

Nassimi, David, Associate Professor

Neamtiu, Iulian, Associate Professor

Nicholson, Theodore L., Senior University Lecturer

### O

Oria, Vincent, Professor

### P

Perl, Yehoshua, Professor

### R

Rohloff, Kurt, Associate Professor

Roshan, Usman W., Associate Professor

Rusinkiewicz, Marek E., Professor

Rutkowski, Wallace, Senior University Lecturer

Ryan, Gerard W., Senior University Lecturer

### S

Shih, Frank Y., Professor

Sohn, Andrew, Associate Professor

Spirollari, Junilda, Senior University Lecturer

### T

Theodoratos, Dimitrios, Associate Professor

### V

Vaks, Leon, University Lecturer

### W

Wang, Guiling (Grace), Professor

Wang, Jason, T., Professor

Wei, Zhi, Associate Professor

Wu, Chase Q., Associate Professor

## Programs

- Bioinformatics - M.S. (p. 674)
- Computer Science - M.S. (p. 675)
- Computing & Business - M.S. (p. 679)
- Cyber Security & Privacy - M.S. (p. 680)
- Software Engineering - M.S. (p. 683)

- Computing Sciences - Ph.D. (p. 684)

Big Data Essentials - Cert.

# Computer Science Courses

**CS 505. Programming, Data Structures, and Algorithms. 3 credits, 4 contact hours.**
Prerequisite: knowledge of at least one procedure-oriented language such as PASCAL or C. Computer science students cannot use this course for graduate degree credit. Intensive introduction to computer science principles: a procedure-oriented language such as C++; program design techniques; introductory data structures (linked lists, stacks, sets, trees, graphs); and algorithms (sorting, searching, etc.) and their analysis. Programming assignments are included.

**CS 506. Foundations of Computer Science. 3 credits, 3 contact hours.**
Prerequisite: knowledge of C/PASCAL. Corequisite: CS 505. Cannot be used for graduate credit towards the M.S. in Computer Science. Introduction to the concepts of iteration, asymptotic performance analysis of algorithms, recursion, recurrence relations, graphs, automata and logic, and also surveys the main data models used in computer science including trees, lists, sets, and relations. Programming assignments are given.

**CS 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: students must have the approval of the co-op advisor for the CIS department. Provides on-the-job reinforcement and application of concepts presented in the undergraduate computer science curriculum. Work assignments are identified by the co-op office and developed and approved by the CIS department in conjunction with the student and employer. Students must submit, for CIS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of each semester's work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in computer science.

**CS 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: students must have the approval of the co-op advisor for the CIS department. Provides on-the-job reinforcement and application of concepts presented in the undergraduate computer science curriculum. Work assignments are identified by the co-op office and developed and approved by the CIS department in conjunction with the student and employer. Students must submit, for CIS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in computer science.

**CS 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: graduate standing, and acceptance by the CIS department and the Division of Career Development Services. Students must have the approval of the co-op advisor for the CIS department. Provides on-the-job reinforcement and application of concepts presented in the undergraduate or graduate computer science curriculum. Work assignments are identified by the co-op office and developed and approved by the CIS department in conjunction with the student and employer. Students must submit, for CIS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in computer science.

**CS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CS 602. Java Programming. 3 credits, 3 contact hours.**
Prerequisite: advanced Web-based programming with an emphasis on the Java language and platform. No prior knowledge of Java is required but students are expected to have a good understanding of object-oriented programming concepts such as encapsulation, inheritance, and polymorphism, experience with C++. Basic constructs and syntax and then the core advanced features. Topics include: networking and sockets, remote method invocation (RMI), database connectivity (JDBC), Java Beans, multi-threading and lighweight components (Swing). Common gateway interface (CGI) languages and browser scripting (JavaScript and VBScript) are discussed when used as a complement to the functionality of the Java language. Emphasis is on the latest version of Java, both deprecated methods and newly introduced features are discussed.

**CS 608. Cryptography and Security. 3 credits, 3 contact hours.**
This course involves computational methods providing secure Internet communication. Among the topics covered are: Security threats in communication systems; conventional cryptography: substitution and transposition codes; distribution of secret key over the Internet; principles of public-key cryptography; RSA and other public-key cryptographic methods; and digital signature protocol.

**CS 610. Data Structures and Algorithms. 3 credits, 3 contact hours.**
Prerequisite: CS 114 or CS 241 or equivalents (see undergraduate catalog for description). Intensive study of the fundamentals of data structures and algorithms. Presents the definitions, representations, processing algorithms for data structures, general design and analysis techniques for algorithms. Covers a broad variety of data structures, algorithms and their applications including linked lists, various tree organizations, hash tables, strings, storage allocation, algorithms for searching and sorting, and a selected collection of other algorithms. Programs are assigned to give students experience in algorithms, data structure design and implementation.

**CS 611. Introduction to Computability and Complexity. 3 credits, 3 contact hours.**
Prerequisite: CS 610. Introduces the theoretical fundamentals of computing, and provides an understanding of both the inherent capabilities and limitations of computation. The main models of computation are deterministic and non-deterministic Turing machines. Auxiliary models include partial and total recursive functions, first order logic, recursive and recursively enumerable sets, and symbol systems. Covers the essentials of computational theory: first order logic, Russel's Paradox, completeness and consistency, Goedel's Theorem, Church's Thesis, countable and uncountable sets, simulation and computation, diagonalization, dove-tailing, decidable and undecidable problems, reduction, recursion theory, Rice's Theorem, Recursion Theorem, execution time measures, P and NP, polynomial-time reduction, NP-completeness and NP-hardness and formal correctness semantics of programs.

**CS 621. Numerical Analysis I. 3 credits, 3 contact hours.**
Prerequisite: MATH 511 (see undergraduate catalog for description) or an introductory course in numerical methods. An introduction to computational aspects of scientific and engineering problems. Time-dependent phenomena and corresponding quantitative models. Numerical stability and conditioning. Approximation of functions. Interpolation, integration. Solution of nonlinear equations. Ordinary differential equations of the first order. Finite and iterative algorithms for solution of systems of linear equations. Emphasis on computer implementation of algorithms and application to variety of engineering problems.

**CS 630. Operating System Design. 3 credits, 3 contact hours.**
Prerequisites: CS 332, CS 432 (see undergraduate catalog for descriptions) and CS 505. An intensive study of computer operating system design including multiprogramming, time-sharing, real-time processing, job and task control, synchronization of concurrent processes and processors, resource scheduling, protection, and management of hierarchical storage.

**CS 631. Data Management System Design. 3 credits, 3 contact hours.**
Prerequisite: knowledge of C and data structures. Acquaintance with fundamental notions of relational database technology. Mathematical properties and usage of database programming languages. Methods of database design and conceptual modeling. Methods of physical storage for database information. Fundamental notions of concurrency control and recovery in database systems.

**CS 632. Advanced Database System Design. 3 credits, 3 contact hours.**
Prerequisites: CS 631 and good knowledge of a high-level programming language. Covers the rapidly changing concepts and principles of modern database systems and database programming based on SQL. Additional topics may include: advanced data modeling, OODBs, parallel and distributed database systems, XML and NO-SQL databases, Web-database systems, active databases, multimedia and text databases, database security, query optimization, indexing techniques, concurrency control, system performance, and data warehaousing.

**CS 633. Distributed Systems. 3 credits, 3 contact hours.**
Prerequisite: completion of bridge requirements. Fundamental topics concerning the design and implementation of distributed computing systems are covered, including interprocess communication, remote procedure calls, authentication, protection, distributed file systems, distributed transactions, replicated data, reliable broadcast protocols, and specifications for distributed programs. All topics will be illustrated with case studies. Optional topics may include synchronization, deadlocks, virtual time, and load balancing.

**CS 634. Data Mining. 3 credits, 3 contact hours.**
This course covers the principles of data mining system design and implementation. It presents methods for association and dependency analysis as well as classification, prediction, and clustering. Optional topics may include time series and graph mining, current trends in data mining, and data mining for scientific, medical and engineering applications.

**CS 635. Computer Programming Languages. 3 credits, 3 contact hours.**
Prerequisites: CS 505 and CS 510. The theory and design of computer language systems; the formal theory of syntax and language classification; a survey of procedure and problem-oriented computer programming languages, their syntax rules, data structures, and operations; control structures and the appropriate environments and methods of their use; a survey of translator types.

**CS 636. Data Analytics with R Program. 3 credits, 3 contact hours.**
Prerequisites: Entry-level courses in programming, probability and statistics (e.g. MATH333, CS280), or permission of the instructor. This course teaches data analytics with R programming. The student will learn and gain basic analytic skills via this high-level language. The course covers fundamental knowledge in R programming. Popular R packages for data science will be introduced as working examples. The course also includes case studies on data analytics projects. As a core course in data science, it provides skills that are highly desirable for both industry and academic employers.

**CS 639. Elec. Medical Records: Med Terminologies and Comp. Imp.. 3 credits, 3 contact hours.**
This course presents a graduate introduction to Medical Informatics for Computer Science students covering (1) the design, use and auditing of medical terminologies, such as the Unified Medical Language System (UMLS) and the Systematized Nomenclature of Medicine (SNOMED); and (2) principles of Electronic Medical Records (EMR), Electronic Health Records (EHR) and Personal Health Records (PHR), including issues of privacy and security.

**CS 640. Recursive Function Theory. 3 credits, 3 contact hours.**
Prerequisite: CS 540 or equivalent. Review of basic computability theory. Topics include Church's thesis; unsolvability results; creative, productive, and simple sets; computational complexity; P=NP problem; and classification of solvable problems according to their complexity.

**CS 643. Cloud Computing. 3 credits, 3 contact hours.**
Prerequisites: CS 633 or CS 656. This course presents a top-down view of cloud computing, from applications and administration to programming and infrastructure. Its main focus is on parallel programming techniques for cloud computing and large scale distributed systems which form the cloud infrastructure. The topics include: overview of cloud computing, cloud systems, parallel processing in the cloud, distributed storage systems, virtualization, secure distributed computing, and multicore programming.

**CS 644. Introduction to Big Data. 3 credits, 3 contact hours.**
Prerequisites: permission of the instructor. This course provides an in-depth coverage of various topics in big data from data generation, storage, management, transfer, to analytics, with focus on the state-of-the-art technologies, tools, architectures, and systems that constitute big-data computing solutions in high-performance networks. Real-life big-data applications and workflows in various domains (particularly in the sciences) are introduced as use cases to illustrate the development, deployment, and execution of a wide spectrum of emerging big-data solutions.

**CS 645. Security and Privacy in Computer Systems. 3 credits, 3 contact hours.**
Prerequisite: Students are expected to enter this course with a basic knowledge of operating systems, networking, algorithms, and data structures. Also, students should be able to program in Java and C/C++. The course covers fundamental principles of building secure systems and techniques to ensure data security and privacy. Topics include access control mechanisms, operating systems security, malicious code threats and software security, trusted computing, content protection, and database security . The course will also study existing technical approaches to protecting privacy, including Web anonymizers and ant-censorship tools, as well as policy and legal aspects of privacy.

**CS 646. Network Protocols Security. 3 credits, 3 contact hours.**
Prerequisites: CS 656 or ECE 637, and ability to program in Java and C/C++. This course covers the security of network protocols currently used on the internet. It seeks to familiarize students with common threats and network attacks, and provides an in-depth study of methods used to secure network communication. The course includes an applied component, which will help students gain practical experience in attacking and defending networked systems. Topics include authentication systems, and routing security, firewalls, intrusion detection, honeypots, wireless network security, malware, propagation and detection, and web security.

**CS 647. Counter Hacking Techniques. 3 credits, 3 contact hours.**
Prerequisites: CS 645 or CS 646 or CS 696 or ECE 638 or approval of the instructor. This course covers advanced techniques that can be used for offensive or defensive goals in network, computer systems and applications. The course follows a ?learning by doing? teaching approach through extensive use of virtual machines with vulnerable operating systems and applications. Topics covered include system memory organizations, CPU registers, assembly language fundamentals, GNU and Immunity debuggers, fuzzing based security testing development of local and remote Linux and Windows exploits, shellcode development, stealthy attacks, bypassing memory protection techniques, network and wireless hacking techniques, and ethical and legal implications of cyber-attacks.

**CS 650. Computer Architecture. 3 credits, 3 contact hours.**
Prerequisites: CS 251 (see undergraduate catalog for description) and CS 510. Exploiting instruction level parallelism (ILP) is central to designing modern computers. Presents design techniques used for such computers as IBM Power architectures, DEC Alpha, MIPS R4600, Intel P6, etc. Introduction of Instruction SET Architecture (ISA), various functional units, basic principles of pipelined computers. Modern techniques to ILP including superscalar, super-pipelining, software pipelining, loop unrolling, and VLIW. Memory hierarchy, including instruction cache, data cache, second level cache, and memory interleaving. Advanced computer architectures, including vector, array processors, interconnection technology, and ATM network of workstations. Hands-on experience designing a simple pipelined computer on screen and using CAD tools such as Cadence or ViewLogic.

**CS 651. Data Communications. 3 credits, 3 contact hours.**
Prerequisite: MATH 333 (see undergraduate catalog for description). Intensive study of the analytic tools required for the analysis and design of data communication systems. Topics include: birth-death queuing systems, Erlang's distribution, bulk-arrival and bulk-service systems, design and analysis of concentrators and multiplexers, elements of Renewal Theory, M/G/1 system, analysis of Time Division Multiplexing, priority queues, analysis of random access systems, time reversibility, open and closed queuing networks, mean value analysis, flow and congestion, control mechanisms, routing algorithms, flow models, and network topological design.

**CS 652. Computer Networks-Architectures, Protocols and Standards. 3 credits, 3 contact hours.**
Prerequisite: A high level programming language, MATH 333 (see undergraduate catalog for description), or instructor approved equivalents. Intensive study of various network architecture and protocol standards; with emphasis on the Open Systems Interconnetion (OSI) model. Topics include: analog and digital transmission, circuit and packet switching, the Integrated Services Digital Network (ISDN), Frame Relay, Broadband ISDN, Cell Relay, SONET, Local Area Networks (CSMA/CD, Token Bus, Token Ring, switched and isochronous Ethernets), Metropolitan Area Networks (FDDI, FDDI-II, DQDB), wireless and satellite networks, synchronization and error control, routing and congestion control, X.25 standard.

**CS 656. Internet and Higher-Layer Protocols. 3 credits, 3 contact hours.**
The course introduces the protocols and standards of the TCP/IP suite that govern the functioning of the Internet. The material covered in class is a top-down approach on introduction, discussion, and analysis of protocols from the data-link layer to the application layer. Alternative protocols to the TCP/IP suite and new protocols adopted by this suite are discussed. Numerical examples related to network planning and proocol functioning are analyzed.

**CS 657. Principles of Interactive Computer Graphics. 3 credits, 3 contact hours.**
Prerequisites: CS 505 or familiarity with the organization of at least one computer system, and knowledge of a structured programming language such as C. Graduate-level introduction to computer graphics concepts, algorithms, and systems. Includes 2-D raster graphics, algorithms, 2-D and 3-D geometric transformations, 3-D viewing, curves and surfaces. Emphasis on PC-based graphics programming projects. Principles of interactive graphics systems in terms of the hardware, software and mathematics required for interactive image production.

**CS 659. Image Processing and Analysis. 3 credits, 3 contact hours.**
Prerequisite: CS 505. Fundamentals of image processing, analysis and understanding. Topics include image representation, image data compression, image enhancement and restoration, feature extraction and shape analysis, region analysis, image sequence analysis and computer vision.

**CS 660. Digital Watermarking. 3 credits, 3 contact hours.**
Digital watermarking and steganography is important to ensure data security because of widely used digital multimedia and rapid growth of the Internet. Digital watermarking is a suitable tool to identify the source, creator, owner, distributor, or authorized consumer of a document or an image. Digital steganography aims at hiding digital information into covert channels, so one can conceal the information and prevent detection. This course intends to provide students an overview on different aspects of mechanisms and techniques for digital watermarking and steganography.

**CS 661. Systems Simulation. 3 credits, 3 contact hours.**
Prerequisite: an undergraduate or graduate course in probability theory and statistics, and working knowledge of at least one higher-level language. An introduction to the simulation of systems, with emphasis on underlying probabilistic and statistical methodologies for discrete-event simulations. Design of simulation applications, and simulation programming in a high-level language. Algorithms for the generation of pseudorandom numbers. Algorithmic methodologies for the simulation of discrete and continuous probabilistic processes. Use of statistical tools. Simulation of queuing systems. Applications of simulation to a variety of system studies. The special purpose simulation language GPSS is studied in detail.

**CS 665. Algorithmic Graph Theory. 3 credits, 3 contact hours.**
Prerequisite: CS 610. The elements of the theory of graphs and directed graphs with motivating examples from communication networks, data structures, etc; shortest paths, depth first search, matching algorithms, parallel algorithms, minimum spanning trees, basic complexity theory, planarity, and other topics. Programming assignments are included.

**CS 666. Simulation for Finance. 3 credits, 3 contact hours.**
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/MATH 666.

**CS 667. Design Techniques for Algorithms. 3 credits, 3 contact hours.**
Prerequisite: CS 610. An introduction to the principles of major design techniques in algorithms. Examples from a variety of topics and problems in computer science are used to demonstrate these design techniques and their appropriate application.

**CS 668. Parallel Algorithms. 3 credits, 3 contact hours.**
Prerequisites: CS 610 and CS 650. This course examines a variety of parallel algorithms and architectures. Shared memory algorithms and algorithms for special architectures (tree processors, grids, systolic arrays, butterflies) are considered. The basic theory of algorithm/architecture performance will be described.

**CS 670. Artificial Intelligence. 3 credits, 3 contact hours.**
Prerequisite: CS 610. Fundamental concepts and general techniques in artificial intelligence. Main topics include goal tree search, logic and deduction, adduction, uncertainty, fuzzy logic, knowledge representations, machine learning, vision, and action planning. The LISP programming language is used extensively. Students are required to do programming assignments, complete a programming term project, and review case studies.

**CS 673. Software Design and Production Methodology. 3 credits, 3 contact hours.**
Prerequisite: CS 631. Modern techniques and methods employed in the development of large software systems, including a study of each of the major activities occurring during the lifetime of a software system, from conception to obsolescence and replacement. Topics include cost/performance evaluation, documentation requirements, system design and production techniques, system verification techniques, automated aids to system development, and project organization and management.

**CS 675. Machine Learning. 3 credits, 3 contact hours.**
Pre-requisites: Basic probability, linear algebra, computer programming, and graduate or undergraduate senior standing, OR approval of instructor. This course is an introduction to machine learning and contains both theory and applications. Students will get exposure to a broad range of machine learning methods and hands on practice on real data. Topics include Bayesian classification, perceptron, neural networks, logistic regression, support vector machines, decision trees, random forests, boosting, dimensionality reduction, unsupervised learning, regression, and learning new feature spaces. There will be several programming assignments, one course project, one mid-term and one final exam.

**CS 680. Linux Kernel Programming. 3 credits, 3 contact hours.**
An in-depth study of how the Linux operating system is built from scratch. AS a hands-on course, students will perform intensive programming using Linux Kernel. The contents include machine booting, segmentation and paging memory management, creating and destroying processes, process switching and scheduling, handling exceptions and hardware interrupts, software interrupts, creating system calls, creating file systems, networking with TCP/IP, device driver writing and module programming, etc. At the end of the course, students will be able to modify Linux operating system to create their own.

**CS 681. Computer Vision. 3 credits, 3 contact hours.**
This course introduces computational models of computer vision and their implementation on computers, and focuses on material that is fundamental and has a broad scope of application. Topics include comtemporary developments in all mainstream areas of computer vision e.g., Image Formation, Feature Detection/Representation, Classification and Recognition, Motion Analysis, Camera Calibration, 3D/Stero Vision, Shape From X (motion, shading, texture, etc.), and typical applications such as Biometrics.

**CS 683. Software Project Management. 3 credits, 3 contact hours.**
This course gives the student the necessary background to allow her/him to manage software projects; this includes economic, managerial and organizational aspects. The essence of software engineering is not only to introduce a valuable software product, but to do so economically and competitively. Like any engineering discipline, software engineering depends critically on managerial, economic and organizational considerations. Students will learn software management technique, various software costing techniques including COCOMO and ROI, team organization and management, and various methods of software development including Cleanroom and Agile.

**CS 684. Software Testing and Quality Assurance. 3 credits, 3 contact hours.**
This course discusses software faults and techniques to reduce faults and improve software quality. Software systems are some of the most complex human artifacts ever built and also some of the most critical means to ensure our safety, well being, and prosperity. This course teaches techniques to ensure software systems perform their function correctly. Topics include software specifications, goals of testing, techniques of test data selection, test oracle design, test data analysis, test lifecycle and quality impacts of testing.

**CS 685. Software Architecture. 3 credits, 3 contact hours.**
The software architecture defines the structure and interactions of software modules. This course provides a working knowledge of the terms, principles and methods of software architecture and module design. It explains the constraints on the design and the properties of capacity, response time, and consistency. The "4+1" architecture model is taught with architectural styles, interface isolation, decoupling, reuse, agile design with software patterns, data structures, queuing effects, design simplification and refactoring. The non-functional requirements of reliability, performance and power consumption, component based design and good industry practices for documenting and managing the architectural process are taught.

**CS 696. Network Management and Security. 3 credits, 3 contact hours.**
Prerequisites: CS 652 or CS 656 or ECE 637 or ECE 683 Thorough introduction to current network management technology and techniques, and emerging network management standards. In-depth study of the existing network security technology and the various practical techniques that have been implemented for protecting data from disclosure, for guaranteeing authenticity of messages, and for protecting systems from network-based attacks. SNMP family of standards including SNMP, SNMPv2, and RMON (Remote Monitoring), OSI systems management. Various types of security attacks (such as intruders, viruses, and worms). Conventional Encryption and Public Key Cryptology. Various security services and standards (such as Kerberos, Digital Signature Standard, Pretty Good Privacy, SNMPv2 security facility). Same as ECE 638.

**CS 698. ST:. 3 credits, 3 contact hours.**

**CS 700. Master'S Project. 0 credits, 0 contact hours.**

**CS 700B. Master's Project. 3 credits, 3 contact hours.**

**CS 701. Master's Thesis. 0 credits, 0 contact hours.**

**CS 701B. Master's Thesis. 3 credits, 3 contact hours.**

**CS 701C. Master's Thesis. 6 credits, 3 contact hours.**

**CS 704. Sequencing and Scheduling. 3 credits, 3 contact hours.**
Advanced sequencing and scheduling for job shops, flow lines, and other general manufacturing and production systems are discussed in this course. Both deterministic and stochastic scheduling models are covered in detail. Heuristics and worst case analysis for "unsolvable" hard scheduling problems (NP-C problems) are introduced.

**CS 708. Advanced Data Security and Privacy. 3 credits, 3 contact hours.**
Prerequisites: CS 608, CS 645, CS 696, or instructor approval. In-depth study of the security and privacy issues associated with the massive amount of data that is collected, stored, shared and distributed in today's society. New paradigms are needed to address the security/privacy challenges when data is outsourced at untrusted servers (such as in cloud computing), when data is anonymized in order to be shared among untrusted parties, or when copyrighted data needs to be protected from unauthorized use.

**CS 725. Independent Study in Computer Science I, II. 3 credits, 3 contact hours.**
Restriction: graduate standing and department consent.

**CS 726. Independent Research II. 3 credits, 3 contact hours.**

**CS 731. Applications of Database Systems. 3 credits, 3 contact hours.**
Prerequisites: CS 631. Restricted to students who are specializing in computer and information systems management. Comparative study of different models of database management systems and their applications. Emphasis on the functions of the database administrator. Includes a survey of physical and logical organization of data, methods of accessing data, characteristics of different models of generalized database management systems, and case studies using these systems from various applications. Student teams design database systems for class projects.

**CS 732. Advanced Machine Learning. 3 credits, 3 contact hours.**
Prerequisites: CS 634 or CS 670. This course presents advanced topics in the machine learning field, with a focus on recent learning techniques developed for analysis of high dimensional data such as a model selection by regularization and ensemble learning. The course also covers the theory of supervised, semi-supervised, unsupervised, transduction and reinforcement learning, as well as applications of these learning methods.

**CS 735. High Performance Analytics Dat. 3 credits, 3 contact hours.**
Prerequisites: Knowledge of material from at least four courses in the following list: CS 631 (Data Management Systems Design), CS 634 (Data Mining), CS 643 (Cloud Computing), CS 644 (Introduction to Big Data), CS 675 (Machine Learning). Targeting the latest computing infrastructures and software systems for data analytics, this course introduces students to the design and analysis of scalable data science algorithms, as well as skills to implement high performance data science applications. Specific topics include in-memory data processing, column-oriented data storage and retrieval, cloud-based data intensive systems, as well as classic data analytics algorithms such as causal discovery and network inference and their scalable implementation.

**CS 744. Data Mining and Management in Bioinformatics. 3 credits, 3 contact hours.**
Prerequisites: CS 610 or permission of the instructor. Concepts and principles of bioinformatic data mining and management with focus on efficiency and scalability. Methods for indexing and querying biological databases, biological data mining, and algorithmic development for bimolecular and phlyogenetic data analysis. Trends and advances in areas such as functional genomics and proteomics, genetic engineering, and large-scale gene expression data analysis.

**CS 750. High Performance Computing. 3 credits, 3 contact hours.**
Prerequisite: CS 650. An in-depth study of the state of the art in high performance computing. Topics parallel computer architectures, programming paradigms, and their applications. Parallel architectures include PC clusters, shared-memory multiprocessors, distributed-memory multiprocessors, and multithreaded architectures. Parallel programming paradigms include message passing interface (MPI), its second-generation MPI-2, and multithreaded programming. Applications include computational science and high performance Web and database servers for Internet-based electronic commerce. Students program a parallel machine in class projects. First-hand experience in stable, scalable, high performance computing for Internet-based electronic commerce.

**CS 755. Security and Privacy in Wireless Networks. 3 credits, 3 contact hours.**
This course covers selected topics on security and privacy in wireless networks and is intended for graduate students who are interested in network security. This course can help the students learn the state of the art and open challenges in wireless network security and privacy, thus enhancing their potential to perform research or pursue a career in this emerging area.

**CS 756. Mobile Computing and Sensor Networks. 3 credits, 3 contact hours.**
This course provides an in-depth study of mobile computing and sensor networks, which are becoming major components of the transition from today's world of desktop computers to a world where computing is ubiquitous. The main topics include: techniques to handle mobility in the Internet and ad hoc networks; operating systems, programming languages, and protocols for sensor networks; applications, middleware, programming models, and security ubiquitous computing environments.

**CS 759. Advanced Image Processing and Analysis. 3 credits, 3 contact hours.**
Prerequisite: CS 659. Advanced study of recent research in image processing, analysis, and understanding. Topics include all image processing techniques, high-level recognition approaches, and automated expert vision systems.

**CS 775. Seminar in Software Engineering. 3 credits, 3 contact hours.**
Prerequisite: CS 673. A seminar in which students pursue intensive study of specialized topics in the current literature of software engineering. Each topic is supported by an initial reading list on current problems in theory and practice. The results of the studies are discussed in class with students, faculty and invited specialists.

**CS 777. Seminar in Software Management and Production. 3 credits, 3 contact hours.**
Prerequisites: Ph.D. core courses. A seminar in which students pursue intensive study of specialized topics in the current literature of software management and production. Each topic is supported by an initial reading list covering current problems in theory and practice. The results of the studies are discussed in class with students, faculty, and invited specialists participating. Topics include, but are not limited to, theory of algorithm structure, analysis of algorithms and programs, hardware technology assessment, automated tools for software production, software measurements and quality, peripheral device interfaces, data communications, computer networks, distributed processing, software verification, implementation standards, documentation standards, system security, software copyright, and project control and organization.

**CS 782. Pattern Recognition and Applications. 3 credits, 3 contact hours.**
Prerequisite: CS 610. Study of recent advances in development of (statistical and syntactic) pattern algorithm, approximation, and estimation techniques. Topics include statistical estimation theory, classifier design, parameter estimation and unsupervised learning, bias vs. variance, nonparametric techniques, linear discriminant functions, tree classifiers, feature extraction, and clustering. Additional topics include Support Vector machines (SVM), Bayesian Learning, Hidden Markov Models (HMM), evolutionary computation, neural networks, with applications to signal interpretation, time-series prediction, and Biometrics.

**CS 785. Seminar in Computer and Information Science I. 3 credits, 3 contact hours.**
Prerequisite: determined by nature of topic area. Advance notice of the topics to be covered is given. These seminars examine in depth a special interest area of computer and information science. It emphasizes recent work in area selected for the offering of the course. This course is for master's students and cannot apply toward master's degree credit.

**CS 786. Special Topics. 3 credits, 3 contact hours.**
Prerequisite: as determined by nature of topic area. A continuation of CS 785.

**CS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**

**CS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**CS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**CS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**CS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**CS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**CS 790G. DOCT DISSERTATION & RES. 18 credits, 3 contact hours.**

**CS 791. Graduate Seminar. 0 credits, 0 contact hours.**
Corequisite (for doctoral students only): CS 790. A seminar in which faculty, students, and invited speakers will present summaries of advanced topics in computer and information systems management. In the course students and faculty will discuss research procedures, dissertation organization, and content. Students engaged in research will present their own problems and research progress for discussion and criticism.

**CS 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Restriction: permission from department chairperson. For students admitted to the doctoral program in computer and information science who have passed the field exam or the qualifying examination. Research is carried out under the supervision of a designated faculty member. Students identify a research problem and prepare a plan to solve the problem. A maximum of 6 credits of CS 792 may be applied to the CIS 790 requirement.

**CS 792C. Pre-Doctoral Research. 6 credits, 0 contact hours.**

# M.S. in Bioinformatics

## Degree Requirements

A minimum of 30 credits is required for the degree, excluding bridge courses. The graduate curriculum consists of five core courses and additional elective courses, with an optional thesis (six credits) or research project (three credits).

## Curriculum

| | | |
|---|---|---|
| **Core Courses** | | |
| BNFO 601 | Foundations of Bioinformatics I | 3 |
| BNFO 602 | Foundations of Bioinformatics II | 3 |
| BNFO 615 | Data Analysis in Bioinformatics | 3 |
| BNFO 644 | Data Mining and Management in Bioinformatics | 3 |
| MATH 663 | Introduction to Biostatistics | 3 |
| **Electives** | | |
| Select five of the following: | | 15 |
| **NJIT Electives** | | |
| BME 661 | Neural Engineering | |
| BME 671 | Biomechanics of Human Structure and Motion | |
| CHEM 658 | Advanced Physical Chemistry | |
| CHEM 673 | Biochemistry | |
| CS 631 | Data Management System Design | |
| CS 632 | Advanced Database System Design | |
| CS 659 | Image Processing and Analysis | |
| CS 634 | Data Mining | |
| CS 681 | Computer Vision | |
| CS 731 | Applications of Database Systems | |
| CS 782 | Pattern Recognition and Applications | |
| IS 634 | Information Retrieval | |
| ECE 609 | Artificial Neural Networks | |
| ECE 640 | Digital Signal Processing | |
| ECE 673 | Random Signal Analysis I | |
| MATH 635 | Analytical Computational Neuroscience | |
| MATH 636 | Systems Computational Neuroscience | |
| MATH 637 | Foundations of Mathematical Biology | |
| MATH 662 | Probability Distributions | |
| **Rutgers-Newark Electives** | | |
| R120 512 | Cell Biology: Methods & Appl | |
| R120 515 | Molecular Bio Of Eukaryotes | |
| R120 516 | Microbial Ecology | |
| R120 526 | Topics in Cell Biology | |
| R120 548 | Biology Of Cancer | |
| R120 573 | Pharmacology | |
| **RBHS Electives** | | |
| UMD 5002 | | |
| UMD 5030 | | |

| | | |
|---|---|---|
| UMD 5200 | | |
| **Total Credits** | | **30** |

# M.S. in Computer Science

## Degree Requirements

Students will meet with the graduate advisor to assist them in formulating a program of study and selecting a possible specialization.

The 30 credit requirement may be satisfied in one of three ways.

## M.S. in Computer Science (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 252 | Computer Organization and Architecture | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms [1] | 3 |
| CS 506 | Foundations of Computer Science [2] | 3 |
| **Total Credits** | | **12** |

1. CS 505 Programming, Data Structures, and Algorithms requires prior knowledge of higher level programming language. For students with no prior programming experiences, CS 113 Introduction to Computer Science and CS 114 Introduction to Computer Science II are recommended for replacement.
2. The credits earned for CS 506 Foundations of Computer Science count towards the 30 credits required for the degree.

| | | |
|---|---|---|
| **Core Courses** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| or CS 667 | Design Techniques for Algorithms | |
| Select three of the following: | | 9 |
| CS 631 | Data Management System Design | |
| CS 630 | Operating System Design | |
| CS 650 | Computer Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | |
| **Elective Courses** | | |
| Two courses from an approved list of advanced courses | | 6 |
| Course either from the Computer Science graduate catalog or from another department's graduate catalog [1] | | 3 |
| Three courses from the Computer Science graduate catalog | | 9 |
| **Total Credits** | | **30** |

1. Courses from outside the Computer Science Department must be relevant to the Computer Science program and require prior approval.

## M.S. in Computer Science (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 252 | Computer Organization and Architecture | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms [1] | 3 |
| CS 506 | Foundations of Computer Science [2] | 3 |
| **Total Credits** | | **12** |

1. CS 505 Programming, Data Structures, and Algorithms requires prior knowledge of higher level programming language. For students with no prior programming experiences, CS 113 Introduction to Computer Science and CS 114 Introduction to Computer Science II are recommended for replacement.
2. The credits earned for CS 506 Foundations of Computer Science count towards the 30 credits required for the degree.

| | | |
|---|---|---|
| **Core Courses** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| or CS 667 | Design Techniques for Algorithms | |

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| CS 631 | Data Management System Design | |
| CS 630 | Operating System Design | |
| CS 650 | Computer Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | |
| **Project** | | |
| CS 700B | Master's Project | 3 |
| **Elective Courses** | | |
| One course from an approved list of advanced courses | | 6 |
| Course either from the Computer Science graduate catalog or from another department's graduate catalog [1] | | 3 |
| Three courses from the Computer Science graduate catalog | | 6 |
| **Total Credits** | | **30** |

1. Courses from outside the Computer Science Department must be relevant to the Computer Science program and require prior approval.

## M.S. in Computer Science (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 252 | Computer Organization and Architecture | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms [1] | 3 |
| CS 506 | Foundations of Computer Science [2] | 3 |
| **Total Credits** | | **12** |

1. CS 505 Programming, Data Structures, and Algorithms requires prior knowledge of higher level programming language. For students with no prior programming experiences, CS 113 Introduction to Computer Science and CS 114 Introduction to Computer Science II are recommended for replacement.
2. The credits earned for CS 506 Foundations of Computer Science count towards the 30 credits required for the degree.

| | | |
|---|---|---|
| **Core Courses** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| or CS 667 | Design Techniques for Algorithms | |
| Select three of the following: | | 9 |
| CS 631 | Data Management System Design | |
| CS 630 | Operating System Design | |
| CS 650 | Computer Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | |
| **Thesis** | | |
| CS 701 | Master's Thesis (two semesters) [2] | 6 |
| **Elective Courses** | | |
| Course either from the Computer Science graduate catalog or from another department's graduate catalog [1] | | 3 |
| Three courses from the Computer Science graduate catalog | | 9 |
| **Total Credits** | | **30** |

1. Courses from outside the Computer Science Department must be relevant to the Computer Science program and require prior approval.
2. A student must select a specialization, and the thesis must match the selected specialization.

## Specializations

Students can optionally specialize in a specific area (see below) by taking a minimum of three (3) courses listed in the specialization in accordance with requirements (b) and (c). Note that some specialization courses have prerequisites that must be fulfilled before enrolling in these courses.

### Computer Networking and Security

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| CS 608 | Cryptography and Security | |
| CS 633 | Distributed Systems | |

| | | |
|---|---|---|
| CS 652 | Computer Networks-Architectures, Protocols and Standards | |
| CS 696 | Network Management and Security | |
| IS 681 | Computer Security Auditing | |
| **Total Credits** | | **9** |

## Databases and Data Mining

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| CS 632 | Advanced Database System Design | |
| CS 731 | Applications of Database Systems | |
| CS 634 | Data Mining | |
| BNFO 644 | Data Mining and Management in Bioinformatics | |
| CS 744 | Data Mining and Management in Bioinformatics [1] | |
| CS 700B | Master's Project [1] | |
| **Total Credits** | | **9** |

1 Taking CS 700 level courses require permission of the graduate advisor.

## Image Processing and Pattern Recognition

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| CS 659 | Image Processing and Analysis | |
| CS 681 | Computer Vision | |
| CS 759 | Advanced Image Processing and Analysis [1] | |
| CS 700B | Master's Project [1] | |
| **Total Credits** | | **9** |

1 Taking CS 700 level courses require permission of the graduate advisor.

## Computer Algorithms

| | | |
|---|---|---|
| CS 611 | Introduction to Computability and Complexity | 3 |
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 700B | Master's Project | 3 |
| **Total Credits** | | **9** |

## Bioinformatics

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| BNFO 601 | Foundations of Bioinformatics I | |
| BNFO 602 | Foundations of Bioinformatics II | |
| CS 744 | Data Mining and Management in Bioinformatics [1] | |
| MATH 663 | Introduction to Biostatistics | |
| CS 700B | Master's Project [1] | |
| **Total Credits** | | **9** |

1 Taking CS 700 level courses require permission of the graduate advisor.

## Master's Project

Students must

- Enroll in CS 700B Master's Project.

In the semester prior to enrolling in CS 700B Master's Project, the student must prepare and submit a project proposal to the Department no later than the last weekday class day of the 8th week of the

- Fall semester for a spring project, or
- Spring semester for a summer or fall project.

The student must have an advisor in the Computer Science Department who is a tenure- track faculty member or who holds a joint appointment in the department.

## Project Requirements

- Before a student pursues a Master's Project, the following requirements must be fully satisfied:
  - All bridge courses must be completed - In the semester prior to the project, a student prepares and submits a project proposal to the Department no later than the last weekday class day of the 8th week of the Fall semester for a spring project and no later than the last weekday class day of the 8th week of the Spring semester for a summer or fall project. The preparatory work for the proposal may be accomplished within the framework of a required course or an independent study course offered by the prospective advisor. Therefore, such a course must be taken in the semester prior to the project.
- A CS Department tenure-track faculty member or a faculty member who holds a joint appointment in the computer science department can advise an MS project.
- Proposal preparation must adhere to the existing departmental guidelines; the information and templates are available online.

# Thesis Option

(30 credits)

Students must

- select a specialization, and
- enroll in the Thesis CS 701 Master's Thesis course for two (2) semesters (Thesis must match specialization).

A student can enroll in CS 701 Master's Thesis during the second semester of full time study. Normally the student enrolls for two semesters of CS 701 Master's Thesis to prepare the thesis proposal, perform the research, and prepare the thesis. The thesis must be orally defended and follow the style set forth by the Graduate School at NJIT. The thesis committee is composed of a Computer Science tenure-track committee chair and two other tenure-track members of the Computer Science Department or Faculty holding a joint appointment to the department.

## Thesis Requirements

- Before a student pursues a Master's Thesis, the following requirements must be fully satisfied:
  - All bridge courses must be completed.
  - In the semester prior to the thesis, a student prepares and submits a thesis proposal to the department no later than week 8 of the Fall semester for a spring thesis and week 8 of the Spring semester for a summer of fall thesis. The preparatory work for the proposal may be accomplished within the framework of a required course or an independent study course offered by the prospective advisor. Therefore, such a course must be taken in the semester prior to the thesis.
- A CS department tenure-track faculty member or a faculty member who holds a joint appointment in the Computer Science Department can advise an MS thesis.
- A thesis must adhere to the style requirements set forth by the Graduate School: www.njit.edu/v2/Directory/Admin/Graduate_Studies/thesis.php (http://www.njit.edu/v2/Directory/Admin/Graduate_Studies/thesis.php).
- An oral defense is required. The defense must take place between one week prior to the Reading Day of the semester and the last day of the Examination period. A committee of at least three tenure-track faculty members from the CS Department, including the thesis advisor, collectively determines the grade for CS 701 Master's Thesis at the conclusion of the oral defense.

## Other Policies

- **Transfer:** Transfer of computer science courses from other US/Canada institutions is allowed as per university regulations provided that these courses are related to the program. Graduate Advisor and Graduate Studies Office approvals are required.
- **MS/MS Program:** Under the University MS/MS program, up to six credits of courses taken in other departments can be used for graduate credits toward the degree as long as these courses are related to computer science. Graduate advisor and Graduate Studies Office approvals are required.
- **Co-op Program:** Before a student applies for CS 590 Graduate Co-op Work Experience I/CS 591 Graduate Co-op Work Experience II/CS 592 Graduate Co-op Work Experience III registration, the successful completion of the bridge program, all ESL requirements, and at least four graduate courses is required.
- The same course cannot satisfy two or more requirements.

# CS Advanced Courses

| | | |
|---|---|---|
| CS 611 | Introduction to Computability and Complexity | 3 |
| CS 632 | Advanced Database System Design | 3 |
| CS 643 | Cloud Computing | 3 |
| CS 659 | Image Processing and Analysis | 3 |
| CS 661 | Systems Simulation | 3 |

| | | |
|---|---|---|
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 670 | Artificial Intelligence | 3 |
| CS 673 | Software Design and Production Methodology | 3 |
| CS 680 | Linux Kernel Programming | 3 |
| CS 681 | Computer Vision | 3 |
| CS 696 | Network Management and Security | 3 |
| CS 704 | Sequencing and Scheduling | 3 |
| CS 731 | Applications of Database Systems | 3 |
| CS 744 | Data Mining and Management in Bioinformatics | 3 |
| CS 750 | High Performance Computing | 3 |
| CS 759 | Advanced Image Processing and Analysis | 3 |
| CS 782 | Pattern Recognition and Applications | 3 |

# M.S. in Computing and Business

(33 credits)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 252 | Computer Organization and Architecture | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| CS 506 | Foundations of Computer Science | 3 |
| MATH 111 | Calculus I | 4 |
| MATH 112 | Calculus II | 4 |
| MATH 211 | Calculus III A | 3 |
| MATH 333 | Probability and Statistics | 3 |

| | | |
|---|---|---|
| **Business Core** | | |
| ACCT 615 | Management Accounting | 3 |
| FIN 600 | Corporate Finance I | 3 |
| HRM 601 | Organizational Behavior | 3 |
| MRKT 620 | Competing in Global Markets | 3 |
| **Computer Science Core** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| CS 631 | Data Management System Design | 3 |
| CS 634 | Data Mining | 3 |
| CS 696 | Network Management and Security | 3 |
| **Electives** | | |
| Select three of the following: [1] | | 9 |
| CS 632 | Advanced Database System Design | |
| CS 652 | Computer Networks-Architectures, Protocols and Standards | |
| CS 656 | Internet and Higher-Layer Protocols | |
| CS 661 | Systems Simulation | |
| ECE 644 | Wireless Communication | |
| FIN 624 | Corporate Finance II | |
| FIN 626 | Financial Investment Institutions | |
| FIN 634 | Mergers, Acquisitions, and Restructuring | |
| FIN 641 | Derivatives Markets | |
| FIN 650 | Investment Analysis and Portfolio Theory | |
| IS 634 | Information Retrieval | |
| IS 681 | Computer Security Auditing | |
| MGMT 630 | Decision Analysis | |
| MGMT 635 | Data Mining and Analysis | |

| | | |
|---|---|---|
| MGMT 650 | Knowledge Management | |
| MIS 625 | Management Strategies for E-Commerce | |
| **Total Credits** | | **33** |

[1] Only one from SOM

# M.S. in Cyber Security and Privacy

## Degree Requirements

An MSCSP course program must satisfy the following distribution requirement:

- 30 credits are required, which can be satisfied as either one of the following options:
  - Courses (30 credits)
  - Courses (27 credits) + MS Project (3 credits)
  - Courses (24 credits) + MS Thesis (6 credits)
- All Core courses are required.
- At most two courses can be Foundational courses.
- At most two courses can be chosen from outside the Department of Computer Science.

If a student chooses the MS project or MS thesis option, the project or thesis must be related to cyber security.

## M.S. in Cyber Security and Privacy (courses only)

| | | |
|---|---|---|
| **Core Course Requirements** | | |
| CS 608 | Cryptography and Security | 3 |
| CS 645 | Security and Privacy in Computer Systems | 3 |
| CS 646 | Network Protocols Security | 3 |
| CS 647 | Counter Hacking Techniques | 3 |
| CS 656 | Internet and Higher-Layer Protocols [1] | 3 |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 696 | Network Management and Security [1] | 3 |
| or ECE 638 | Network Management and Security | |
| **Electives and Foundation Courses** | | 12 |
| Electives | | |
| CS 633 | Distributed Systems | |
| CS 634 | Data Mining | |
| CS 643 | Cloud Computing | |
| CS 660 | Digital Watermarking | |
| CS 673 | Software Design and Production Methodology | |
| CS 680 | Linux Kernel Programming | |
| CS 708 | Advanced Data Security and Privacy | |
| CS 755 | Security and Privacy in Wireless Networks | |
| or ECE 782 | Advanced Data Security and Privacy | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 682 | Forensic Auditing for Computing Security | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IT 620 | Wireless Networks Security and Administration | |
| IT 640 | Network Services Administration | |
| ECE 636 | Computer Networking Laboratory | |
| MGMT 688 | Information Technology, Business and the Law | |
| MGMT 691 | Legal and Ethical Issues | |
| Foundational Courses | | |
| CS 610 | Data Structures and Algorithms | |

| | | |
|---|---|---|
| CS 630 | Operating System Design | |
| CS 631 | Data Management System Design | |
| **Total Credits** | | **30** |

1 Substitution allowed only for students with ECE background and with the permission of the graduate advisor.

## M.S. in Cyber Security and Privacy (Master's project option)

| | | |
|---|---|---|
| **Core Course Requirements** | | |
| CS 608 | Cryptography and Security | 3 |
| CS 645 | Security and Privacy in Computer Systems | 3 |
| CS 646 | Network Protocols Security | 3 |
| CS 647 | Counter Hacking Techniques | 3 |
| CS 656 | Internet and Higher-Layer Protocols | 3 |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 696 | Network Management and Security | 3 |
| or ECE 638 | Network Management and Security | |
| **Project** | | |
| CS 700B | Master's Project [1] | 3 |
| **Electives and Foundation Courses** | | 9 |
| Electives | | |
| CS 633 | Distributed Systems | |
| CS 634 | Data Mining | |
| CS 643 | Cloud Computing | |
| CS 660 | Digital Watermarking | |
| CS 673 | Software Design and Production Methodology | |
| CS 680 | Linux Kernel Programming | |
| CS 708 | Advanced Data Security and Privacy | |
| CS 755 | Security and Privacy in Wireless Networks | |
| or ECE 782 | Advanced Data Security and Privacy | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 682 | Forensic Auditing for Computing Security | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IT 620 | Wireless Networks Security and Administration | |
| IT 640 | Network Services Administration | |
| ECE 636 | Computer Networking Laboratory | |
| MGMT 688 | Information Technology, Business and the Law | |
| MGMT 691 | Legal and Ethical Issues | |
| Foundational Courses | | |
| CS 610 | Data Structures and Algorithms | |
| CS 630 | Operating System Design | |
| CS 631 | Data Management System Design | |
| **Total Credits** | | **30** |

1 The project must be related to cyber security.

2 Substitution allowed only for students with ECE background and with the permission of the graduate advisor.

## M.S. in Cyber Security and Privacy (Master's thesis option)

| | | |
|---|---|---|
| **Core Course Requirements** | | |
| CS 608 | Cryptography and Security | 3 |
| CS 645 | Security and Privacy in Computer Systems | 3 |
| CS 646 | Network Protocols Security | 3 |
| CS 647 | Counter Hacking Techniques | 3 |

| | | |
|---|---|---|
| CS 656 | Internet and Higher-Layer Protocols [2] | 3 |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 696 | Network Management and Security [2] | 3 |
| or ECE 638 | Network Management and Security | |
| **Thesis** | | |
| CS 701C | Master's Thesis [1] | 6 |
| **Electives and Foundation Courses** | | 6 |
| Electives | | |
| CS 633 | Distributed Systems | |
| CS 634 | Data Mining | |
| CS 643 | Cloud Computing | |
| CS 660 | Digital Watermarking | |
| CS 673 | Software Design and Production Methodology | |
| CS 680 | Linux Kernel Programming | |
| CS 708 | Advanced Data Security and Privacy | |
| CS 755 | Security and Privacy in Wireless Networks | |
| or ECE 782 | Advanced Data Security and Privacy | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 682 | Forensic Auditing for Computing Security | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IT 620 | Wireless Networks Security and Administration | |
| IT 640 | Network Services Administration | |
| ECE 636 | Computer Networking Laboratory | |
| MGMT 688 | Information Technology, Business and the Law | |
| MGMT 691 | Legal and Ethical Issues | |
| Foundational Courses | | |
| CS 610 | Data Structures and Algorithms | |
| CS 630 | Operating System Design | |
| CS 631 | Data Management System Design | |
| **Total Credits** | | **30** |

1 The thesis must be related to cyber security.

2 Substitution allowed only for students with ECE background and with the permission of the graduate advisor.

## Master of Science in Cyber Security and Privacy (CSP) - Cyber Defense Option

The objective of the MS CSP – Cyber Defense option is to create leaders with strong communication and management skills in addition to the strong technical knowledge in security and privacy of computer systems, networks, and web applications. This option is designed for working professionals or students who already have acquired some professional experience.

**Degree Program Requirements and Courses**

- 36 credits are required.
- All Cybersecurity Core courses are required.
- 6 credits are required from the PTC (Professional and Technical Communications) list
- 6 credits are required from the Management list
- 6 credits are from the Cybersecurity Elective list
- An elective course can be replaced with an MS project course

If a student chooses to work on an MS project, the project must be related to cybersecurity. Furthermore, team-oriented MS projects designed in collaboration with employers are encouraged.

Each student, who is not working full-time, is required to either participate in an internship (normally in the summer) or register for an MS project before graduation.

**Core Course Requirements:**

| | | |
|---|---|---|
| CS 608 | Cryptography and Security | 3 |
| CS 645 | Security and Privacy in Computer Systems | 3 |
| CS 646 | Network Protocols Security | 3 |
| CS 647 | Counter Hacking Techniques | 3 |
| CS 656 | Internet and Higher-Layer Protocols | 3 |
| CS 696 | Network Management and Security | 3 |
| **PTC (Professional and Technical Communications) Courses** | | 6 |
| Select two from the following: | | |
| PTC 601 | Advanced Professional and Technical Communication | |
| PTC 620 | Proposal Writing | |
| PTC 622 | Working in Teams: Collaborative and Interpersonal Communications | |
| PTC 624 | Professional and Technical Editing | |
| PTC 628 | Analyzing Social Networks | |
| PTC 629 | Theory and Practice of Social Media | |
| PTC 632 | Content Management and Information Architecture | |
| **Management Courses** | | 6 |
| Select two of the following: | | |
| ACCT 615 | Management Accounting | |
| EM 636 | Project Management | |
| FIN 600 | Corporate Finance I | |
| MGMT 641 | Global Project Management | |
| MGMT 650 | Knowledge Management | |
| MGMT 682 | Business Research Methods I | |
| MGMT 688 | Information Technology, Business and the Law | |
| MGMT 691 | Legal and Ethical Issues | |
| **Cybersecurity Elective Courses** | | 6 |
| Select two from the following: | | |
| CS 610 | Data Structures and Algorithms | |
| CS 630 | Operating System Design | |
| CS 631 | Data Management System Design | |
| CS 632 | Advanced Database System Design | |
| CS 634 | Data Mining | |
| CS 643 | Cloud Computing | |
| CS 660 | Digital Watermarking | |
| CS 673 | Software Design and Production Methodology | |
| CS 700B | Master's Project | |
| CS 708 | Advanced Data Security and Privacy | |
| CS 755 | Security and Privacy in Wireless Networks | |
| or ECE 782 | Advanced Data Security and Privacy | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 682 | Forensic Auditing for Computing Security | |
| IT 620 | Wireless Networks Security and Administration | |
| IT 640 | Network Services Administration | |
| EM 636 | Project Management | |

# M.S. in Software Engineering

(33 credits)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 505 | Programming, Data Structures, and Algorithms [1] | 3 |
| IS 390 | Requirements Analysis and Systems Design | 3 |

| | | |
|---|---|---|
| MATH 111 | Calculus I | 4 |
| MATH 333 | Probability and Statistics | 3 |
| **Total Credits** | | **13** |

[1] Students can take other CS courses with advisor approval

| | | |
|---|---|---|
| **Required Courses** | | |
| CS 684 | Software Testing and Quality Assurance [1] | 3 |
| CS 685 | Software Architecture [1] | 3 |
| CS 683 | Software Project Management [1] | 3 |
| IS 676 | Requirements Engineering | 3 |
| CS 673 | Software Design and Production Methodology [1] | 3 |
| CS 700B | Master's Project | 3 |
| **Elective Courses** | | |
| Select five of the following: | | 15 |
| CS 602 | Java Programming | |
| CS 630 | Operating System Design [1] | |
| CS 631 | Data Management System Design [1] | |
| CS 632 | Advanced Database System Design | |
| CS 633 | Distributed Systems [1] | |
| CS 634 | Data Mining | |
| CS 635 | Computer Programming Languages | |
| CS 634 | Data Mining | |
| CS 652 | Computer Networks-Architectures, Protocols and Standards [1] | |
| CS 656 | Internet and Higher-Layer Protocols [1] | |
| CS 659 | Image Processing and Analysis | |
| CS 670 | Artificial Intelligence | |
| CS 675 | Machine Learning | |
| CS 696 | Network Management and Security [1] | |
| IS 690 | Web Services and Middleware | |
| IS 663 | System Analysis and Design | |
| EM 636 | Project Management | |
| EM 637 | Project Control | |
| MGMT 620 | Management of Technology | |
| **Total Credits** | | **33** |

[1] Students can take other CS courses with advisor approval

# Ph.D. in Computer Science

## Course Requirements

For students entering the program with a Master’s degree in Computer Science or related areas, 24 credits at the 600 and 700 level. At least 12 credits must be at the 700 level, and out of those at most 6 credits can be Independent Study in Computer Science (CS 725 and/or CS 726). If a student takes two Independent Studies, then they should be done with two different professors.

For students entering the program without a Master’s degree in Computer Science or related areas, 30 credits at the 600 and 700 level. At least 12 credits must be at the 700 level, and out of those at most63 credits can be Independent Study in Computer Science (CS 725 and/or CS 726). If a student takes two Independent Studies, then they should be done with two different professors.

## Doctoral Dissertation Credits

For students who were admitted in the program in the Fall 2015 semester or after, the rules are described at: http://www5.njit.edu/graduatestudies/content/new-phd-credit-requirements/

For students who were admitted in the program before the Fall 2015 semester, students must complete 30 credits of CS 790. A maximum of 6 credits of CS 792 Pre-Doctoral Research may be used toward the CS 790 requirement.

## CS 791: Doctoral Seminar

Full-time students are required to enroll in CS 791 every semester. *Full-time PhD students are required to attend 2/3 of the weekly Wednesday departmental seminars.*

## Qualifying Examinations

All PhD students are required to take qualifying examinations in four areas.

| | | |
|---|---|---|
| **Two examinations are in the following two areas:** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| CS 611 | Introduction to Computability and Complexity | 3 |
| **Two examinations are in the following two areas:** | | |
| CS 630 | Operating System Design | 3 |
| CS 631 | Data Management System Design | 3 |
| CS 634 | Data Mining | 3 |
| CS 650 | Computer Architecture | 3 |
| CS 656 | Internet and Higher-Layer Protocols | 3 |
| CS 659 | Image Processing and Analysis | 3 |
| CS 661 | Systems Simulation | 3 |
| CS 670 | Artificial Intelligence | 3 |
| CS 675 | Machine Learning | 3 |
| BNFO 601 | Foundations of Bioinformatics I | 3 |
| or BNFO 602 | Foundations of Bioinformatics II | |

## Concentration Areas

A PhD student within the program is required to pick an area of concentration. While the areas of concentrations change according to faculty research interests, here are examples of possible concentrations with possible courses taken within those concentrations.

### Computational Biology and Bioinformatics

| | | |
|---|---|---|
| CS 631 | Data Management System Design | 3 |
| CS 632 | Advanced Database System Design | 3 |
| CS 634 | Data Mining | 3 |
| CS 665 | Algorithmic Graph Theory | 3 |
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 670 | Artificial Intelligence | 3 |
| BIOL 601 | Computational Biology I | 3 |
| CS 744 | Data Mining and Management in Bioinformatics | 3 |

### Computer Algorithms and Theory of Computing

| | | |
|---|---|---|
| CS 610 | Data Structures and Algorithms | 3 |
| CS 611 | Introduction to Computability and Complexity | 3 |
| CS 665 | Algorithmic Graph Theory | 3 |
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 668 | Parallel Algorithms | 3 |
| IE 704 | Sequencing and Scheduling | 3 |

### Computer Systems, and Parallel and Distributed Processing

| | | |
|---|---|---|
| CS 630 | Operating System Design | 3 |
| CS 633 | Distributed Systems | 3 |
| CS 650 | Computer Architecture | 3 |

| | | |
|---|---|---|
| CS 643 | Cloud Computing | 3 |
| CS 668 | Parallel Algorithms | 3 |
| CS 750 | High Performance Computing | 3 |
| ECE 658 | VLSI Design I | 3 |
| ECE 758 | VLSI Design II | 3 |
| ECE 689 | Computer Arithmetic Algorithms | 3 |
| ECE 785 | Parallel Processing Systems | 3 |

## Databases, Data Mining, and Knowledge-Based Engineering

| | | |
|---|---|---|
| CS 630 | Operating System Design | 3 |
| CS 631 | Data Management System Design | 3 |
| CS 632 | Advanced Database System Design | 3 |
| CS 634 | Data Mining | 3 |
| CS 665 | Algorithmic Graph Theory | 3 |
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 670 | Artificial Intelligence | 3 |
| CS 731 | Applications of Database Systems | 3 |
| CS 744 | Data Mining and Management in Bioinformatics | 3 |

## Image Processing and Computer Graphics

| | | |
|---|---|---|
| CS 630 | Operating System Design | 3 |
| CS 632 | Advanced Database System Design | 3 |
| CS 657 | Principles of Interactive Computer Graphics | 3 |
| CS 659 | Image Processing and Analysis | 3 |
| CS 665 | Algorithmic Graph Theory | 3 |
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 759 | Advanced Image Processing and Analysis | 3 |
| CS 782 | Pattern Recognition and Applications | 3 |
| ECE 601 | Linear Systems | 3 |
| ECE 643 | Digital Image Processing I | 3 |
| ME 635 | Computer-Aided Design | 3 |
| Other 600/700-level courses as approved by advisor. | | |

## Networking and Security

| | | |
|---|---|---|
| CS 630 | Operating System Design | 3 |
| CS 651 | Data Communications | 3 |
| CS 652 | Computer Networks-Architectures, Protocols and Standards | 3 |
| CS 656 | Internet and Higher-Layer Protocols | 3 |
| CS 696 | Network Management and Security | 3 |

## Software Engineering

| | | |
|---|---|---|
| CS 610 | Data Structures and Algorithms | 3 |
| CS 611 | Introduction to Computability and Complexity | 3 |
| CS 630 | Operating System Design | 3 |
| CS 635 | Computer Programming Languages | 3 |
| CS 667 | Design Techniques for Algorithms | 3 |
| CS 673 | Software Design and Production Methodology | 3 |
| IS 676 | Requirements Engineering | 3 |
| IS 683 | Web Systems Development | 3 |

## Systems Analysis, Simulation and Modeling

| | | |
|---|---|---|
| CS 621 | Numerical Analysis I | 3 |

| | | |
|---|---|---|
| CS 630 | Operating System Design | 3 |
| CS 631 | Data Management System Design | 3 |
| CS 651 | Data Communications | 3 |
| CS 661 | Systems Simulation | 3 |

# Information Systems

## Information Systems

Information systems are computer systems that support the operations, management, and decision-making in organizations. Information systems are now an integral part of the work environment of every organization and play a critical role in the running of organizations.  They are the heart of our Internet-based economy. Information systems enable people to access the information they need, collaborate, make decisions, and perform their jobs and personal activities effectively.

The field of Information Systems (IS) aims to bridge the fields of computer science and business. It resides at the interaction of these two fields. IS professionals serve as the critical link between the technical areas and other areas of an organization.

NJIT's IS professors are experts in the field and are very student focused. NJIT’s IS graduates place among the highest-paying and most plentiful jobs nationally. NJIT’s very active Career Services Division promotes many co-op and internship opportunities with major local companies. This is fostered by our location within Northern New Jersey’s high concentration of business and industry, and NJIT is just ½ hour from midtown Manhattan by train.  We welcome both part-time and full-time students, and offer relatively low tuition rates for the region.

### Master of Science in Information Systems (MSIS)

The MSIS is a STEM* degree that prepares people to become business and systems analysts, data scientists, systems and application designers, and designers of user interfaces and user experience. The curriculum core focuses on business mining and analytics, systems design that both extracts and utilizes this business data, and the techniques that assure the effectiveness of the user interface for such systems. Four electives provide broad flexibility to develop expertise in related analytics, design, business and computing areas of interest to the student.

### Admission Requirements

(The program is offered both on-campus and online.)

The field of IS is broadly interdisciplinary. Applicants with degrees in any field are therefore welcome to apply for the MSIS program. A series of "bridge courses" are used to develop the required skills of incoming students who may not have been exposed to some parts of the IS curriculum.

### Ph.D. in Information Systems (IS PhD)

The Information Systems (IS) PhD program is a STEM* degree designed to produce scholars with a commanding knowledge of both theory and practice of IS for complex applications and environments. The program encourages an interdisciplinary approach to the exploration of information systems, and the evaluation of its effectiveness and consequences.

IS PhD dissertations must make a substantial scientific contribution to their particular area of research.  PhD students can do research in two research tacks: Information Integration and Informatics (III), i.e., information science and data intensive research, and Human-Centered Computing (HCC).

### Entrance Requirements

- Applicants from varying academic backgrounds may apply.  Applicants without sufficient computing or mathematics/statistics background, however, will be assigned additional foundation coursework.
- Typically applicants are required to have a Master’s degree with a demonstrated record of academic achievement and show promise of being able to excel in the program, but we make exceptions for outstanding students with a Bachelor’s degree.
- GPA should be 3.5 or better on a 4.0 scale.
- To ensure that each student finds a dissertation advisor and committee with proper expertise, after receiving an application, the PhD director will inform those who pass the first round of screening to contact and secure a faculty advocate with the proper expertise to assess and foster their research interests.  Applicants should explore faculty web sites (is.njit.edu (http://is.njit.edu), **look for those listed among our core faculty—assistant professors, associate professors and professors**) and are encouraged to consult with the PhD director regarding research interests and contacting faculty.

### Application Materials

The IS PhD application requires several items in addition those required by NJIT. Therefore applicants must submit both (1) department-specific materials and (2) general NJIT-required materials. For complete details see: is.njit.edu/academics (http://is.njit.edu/academics).

## Financial Support and Application Deadlines

Application deadlines are as follows:

- For Fall semester:
  - For those seeking financial support: December 15
  - For those not seeking financial support: February 15
- For Spring semester:
  - For those seeking financial support: September 1
  - For those not seeking financial support: October 1

## Part-Time Students

The IS PhD program welcomes part-time students, under the following conditions. Part-time students should arrange their work schedules to participate in research group meetings, seminars and other research activities as often as possible. These activities often take place during the day. Part-time students are required to obtain a leave from work obligations for at least one year in order to focus on their research proposition and dissertation research on a full-time basis.

## Distance Students

The IS PhD is an on-campus program; we cannot accommodate distance learning students.

# Business and Information Systems (MS BIS)

The M.S. in Business and Information Systems is a STEM* degree that teaches students concepts in both business and information systems. The focus of the degree is on the application of computing and information systems in business, government, and non-profit organizations. Besides learning about information systems topics such as databases, application development tools, web design, software use and evaluation, management information and decision support systems, students will learn business topics such as accounting, management, marketing, finance, and business operations.

Technology and science are dramatically changing our economy and our society. This is creating new business opportunities and needs, with an increasing push for computing employees to be more involved in designing and evaluating business information systems for both small companies as well as major corporations. Information systems employees must have a solid understanding of business fundamentals to succeed. Specifically designed to address this issue, the M.S. in Business and Information Systems is primarily for students who want to prepare for careers where they will do requirements analysis and application systems design and development, as well as use, analyze and evaluate computing applications and systems in a business environment. The U.S. Bureau of Labor Statistics points to very strong need for managers with technical skills well into the next decade.

## Admission Requirements

(The program is offered both on-campus and online.)

The field of IS is broadly interdisciplinary. Applicants with degrees in any field are therefore welcome to apply for the MSBIS program. A series of "bridge courses" are used to develop the required skills of incoming students who may not have been exposed to some parts of the IS curriculum.

**Science, Technology, Engineering, and Mathematics*

# NJIT Faculty

## B

Bieber, Michael P., Professor

## D

Deek, Fadi P., Distinguished Professor

E

Egan, Richard W., Senior University Lecturer

## H

Hiltz, S. Roxanne, Distinguished Professor Emeritus

## J

Jones, Quentin, Associate Professor

## L

Lee, Michael, Assistant Professor

Lin, Lin, Senior University Lecturer

## S

Scher, Julian M., Associate Professor Emeritus

## T

Tremaine, Marilyn M., Professor Emeritus

Turoff, Murray, Distinguished Professor Emeritus

## W

Williams, Keith A., University Lecturer

Wohn, Donghee Yvette, Assistant Professor

Wu, Yi-Fang, Brook, Associate Professor

## X

Xu, Songhua, Assistant Professor

# Programs

- Business and Information Systems - M.S. (p. 694)
- Information Systems - M.S. (p. 701)
- Information Systems - Ph.D. (p. 704)

Data Mining - Cert.

Web Systems Development - Cert.

Business and Information Systems - Cert.

Software Engineering, Analysis, and Design - Cert.

Information Security - Cert.

Network Security and Information Assurance - Cert.

# Information Systems Courses

**IS 513. Programming Foundations for IS. 3 credits, 3 contact hours.**
This course is an introduction to the Java programming language teaching the foundations of writing, testing and debugging of programs. The course has three major parts. The first part teaches fundamental programming techniques that use primitive data types, variables, assignments expressions and operators, control statements, arrays and files I/O. The second part covers testing and debugging, and teaches students how to write programs that work reliably. The third part introduces object-oriented programming.

**IS 531. Database Fundamentals. 3 credits, 3 contact hours.**
This course gives students extensive, pragmatic experience in designing, building, querying, updating, maintaining and managing relational databases, using the Structured Query Language (SQL). We will start our journey by analyzing what database is and why it is superior to other data management methods. We will then conduct logical and physical database design. SQL will be extensively covered, and students will design and implement sophisticated SQL queries invoking self-joins, outer joins, correlated subqueries and related concepts. Hands-on experience will be gained by working with actual databases using industry-standard database management systems such as Oracle.

**IS 565. Aspects Of Information Systems. 3 credits, 3 contact hours.**
Methods and models of supporting the management process; ethical issues pertaining to the construction, deployment, and impact of information systems on organizations and society; description, analysis, and design of information systems to assist problem solving and decision-making in a business environment.

**IS 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisite: students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of each semester's work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS.

**IS 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisite: students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS.

**IS 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: graduate standing, and acceptance by the IS department and the Division of Career Development Services. Students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS.

**IS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**IS 601. Web Systems Development. 3 credits, 3 contact hours.**
Prerequisites:NONE Students will gain experience in open source web development through an intensive hands-on project, applying real-world problem-solving skills to meeting information systems requirements. Students will learn Web development principles, as well as professionally relevant skills including industry standards, conventions, and procedures within large-scale programming projects. Also covered are the communication tools, technologies, and practices that individuals use to coordinate and collaborate within the open source software development community.

**IS 612. Emergency Management Informatics. 3 credits, 3 contact hours.**
This course covers core aspects of Emergency Management (EM) as they relate to information systems and usage of associated technologies. EM theory identifies four critical areas: 1) understanding & mitigating risk, 2) planning & preparedness, 3) reaction & response, 4) recovery & normalization. The role of informatics for each critical area will vary and is the basis for discussions and assignments. This course also focuses on innovative information systems approaches to EM in each area. Within the EM domain, business continuity (information processing and sharing during crisis situations), cyberterrorism, and international response are covered.

**IS 613. Design of Emergency Management Information Systems. 3 credits, 0 contact hours.**
This course is concerned with the development of requirements, the design of the human interaction, and the supporting functionality of any Information System related to the complete preparedness lifecycle for emergency, disaster, and crisis situations for government bodies, non-profit, and/or private organizations that are concerned with business continuity. It also focuses on organizational behavior and its effects on the functionality of the system and the design of the human interface.

**IS 614. Command and Control Systems. 3 credits, 3 contact hours.**
This course investigates the relevance and applicability of using of Command and Control (C2) models in organizational responses to both normal emergencies and catastrophic events. C2 refers to how leadership, authority, decision-making and coordination are assured within an organization, including distributed and virtual organizations. The course examines the functionality and properties of C2 systems in terms of matching requirements for these systems to the behavior of individuals, groups, and organizations during emergency conditions. It will address integrating systems and technologies within organizational emergency operations functions and processes to include business continuity and disaster response.

**IS 616. Learning Methodologies and Training Technologies. 3 credits, 3 contact hours.**
This course provides an overview of learning methodologies and training technologies, with an emphasis on emergency management. It reviews theories and develops skills for the planning, evaluation and selection of traditional and new technology-driven learning and training methods. Course participants will review relevant research and learn how to choose the most effective training methodologies, technologies and content resources appropriate to the needs of different audiences.

**IS 631. Enterprise Database Management. 3 credits, 3 contact hours.**
Prerequisites: IS 601 This course provides an understanding of the issues as well as hands-on experience in managing database systems as an essential organizational resource. Students will obtain a conceptual foundation of database design and explore the implications for organizational database usage. Students also will gain experience with enterprise database management systems, such as Oracle. This course introduces the design and management of enterprise-wide database systems. Topics include: (1) data modeling and database design; (2) database implementation with SQL; (3) database access standards for enterprise database systems; (4) multidimensional databases, online analytic processing (OLAP) and data warehousing, customer relationship management (CRM); and (5) web-based enterprise database systems.

**IS 634. Information Retrieval. 3 credits, 3 contact hours.**
Prerequisites: IS 601 Modern information retrieval systems, such as web search engines, empower users to easily access information on the web. The course covers the concepts and principles of information retrieval systems design, including web crawling, automatic indexing, vector space modeling, retrieval algorithms, digital libraries, text mining, information extraction, and document warehousing. These techniques are essential for building web systems, text databases, document processing systems, and other advanced information management systems.

**IS 661. User Experience Design. 3 credits, 3 contact hours.**
This is a foundation course on the design of digital products. User eXperience Design (UXD) isn't just about making interfaces usable. It is about designing and building relevant and successful products. Effective UXD requires a mix of Interaction Design (ID) methods and processes. This course takes you through the process of creating compelling interaction designs for digital products from the idea stage into creating a simple and intuitive user experience blueprint. You will 'learn by doing' in a team environment, enabling you to practice the techniques with coaching from instructors. The course will demystify Lean UX; Agile UX; Human Computer Interaction (HCI); Design Audits and Claims analysis; Persona construction; Storyboarding; ID scenarios; ID Frameworks; Role of user-research in UXD; and Design Patterns.

**IS 663. System Analysis and Design. 3 credits, 3 contact hours.**
Pre or Corequisite: IS 601 This course develops the skills necessary to analyze, design and manage the development of effective enterprise-scale information systems solutions incorporating contemporary methods and effective organizational and global project management practices. It focuses on technical business systems analysis and design techniques, and covers key software engineering principles, methods and frameworks, including process models, agile and lean principles, project and risk management, estimation, requirements elicitation and analysis, modeling, system and software architecture, design patterns, and quality systems. Students will actively participate in discussions, review selected articles, participate in team exercises and collaborate on projects involving analysis and prototyping of applications addressing real-world problems and integrating current and emerging technologies.

**IS 664. Customer Discovery. 3 credits, 3 contact hours.**
’Customer Discovery' is the term used by lean startup companies to describe the process of directly engaging with customers to explore potential new markets. Such evidence-based entrepreneurship guides the potential for new product ideas early in the development process. Similarly, high-tech innovators in new media, web, software apps, social networking, wearable computing, and mobile devices need to determine early on if their proposed solutions address real user needs. They do this by understanding potential user's practice, preferences and mental models. As a result, knowledge of a basic set of qualitative customer discovery methods is essential for both the lean startup entrepreneur and those engaged in interaction design innovation. This course teaches these methods through hands-on team projects. Students will design and run interview and diary studies, thinking out-loud protocols and focus groups, and analyze and report on findings. Students will explore over the course of the semester a problem domain and gain understanding of customer needs that will serve as a foundation for high-tech, innovative product design.

**IS 665. Data Analytics for Info System. 3 credits, 3 contact hours.**
Prerequisites: IS 601 This course gives a graduate level introduction to data analysis, probability and statistics from an information systems perspective, including many of the techniques that are most relevant to the profession of Data Scientist for business, data and web analytics, as well as current data sets. We will learn and conduct Python, matlab and R based manipulation of data. Course topics include the rudiments of probability and random variables, estimation, special distribution and sampling, Markov processes, hypothesis testing, graphics and visualization.

**IS 676. Requirements Engineering. 3 credits, 3 contact hours.**
Corequisites: IS 663 or CS 673 or equivalent project experience in the field. Requirements engineering is one of the all-important beginning stages of the systems development life cycle. Revealing and understanding the system's requirements is a crucial component of success for developing new computing systems or adjusting existing applications. This course covers the theory, principles, and practical application of the methodologies and tools for requirements engineering. The focus is development of large software systems and the integration of multiple systems into a comprehensive, domain dependent solution. All aspects of requirements engineering including the knowledge and skills needed to elicit and analyze requirements, translate these requirements into technical specifications, verify that the requirements accurately capture the system requirements, and manage software requirements through the system development cycle will be covered. Students will actively participate in discussions, labs and exercises, and prepare operational requirements and technical specifications for real-world problems. We will spend a considerable amount of time interacting and learning through discussion of assigned readings and other material.

**IS 677. Information System Principles. 3 credits, 3 contact hours.**
This course introduces the field of Information Systems; the study of how people and organizations should use information technologies effectively. We examine the major areas in the field, analyzing the major issues, trends and problems. We survey the role of information systems in organizations and how these systems support organizational objectives and organizational structure, as well as providing competitive business advantages. We discuss basic concepts such as the systems point of view, the organization of a system, the nature of information and information flows, as well as how people process information and related cognitive concepts. We also examine various types of information system applications such as e-commerce, supply chain, decision support, and enterprise systems. And, finally, we also consider critical ethics issues including privacy, personalization and security.

**IS 678. IT Service Management. 3 credits, 3 contact hours.**
Prerequisites: IS 663 or CS 673 This course introduces the Information Technology Infrastructure Library (ITIL) fundamentals of the service management life cycle-service strategy, service design, service transition, service operation, and continual service improvement. ITIL provides a comprehensive, consistent, and coherent framework of best practices for IT Service Management (ITSM), which promotes a quality approach for achieving business effectiveness and efficiency in the use of information systems. This course presents the basic terminology and an overview of the functions and processes for each of the life cycle phases as they apply to IT Management. Although ITIL is originally presented as an approach for designing IT processes, we can expand this view and apply it to the design of other business services. Possible semester-long contexts are the processes of an educational services provider or health care services provider.

**IS 680. Information Systems Auditing. 3 credits, 3 contact hours.**
Due to the dynamic nature of information technology, the need arises continually to redefine audit, control and security requirements and processes. Topics include the IS audit process, IT infrastructure and operations, information protection, disaster recovery and business continuity, IT service delivery and support, business application systems, and project management. Students gain practical experience with each by working through a series of sample Certified Information Systems Audit (CISA) exam questions.

**IS 681. Computer Security Auditing. 3 credits, 3 contact hours.**
This course reflects the current emphasis on information security and security management in Fortune 500 corporations. Students will delve into information protection concepts, privacy impact analysis, computer crime, legal issues, controls and auditing systems, and firewall configuration. Students will have the opportunity to learn and perform evaluations on security infrastructures in a controlled environment in class labs by completing realistic security auditing projects and using vulnerability assessment tools to assess risks and evaluate security controls on networked infrastructures.

**IS 682. Forensic Auditing for Computing Security. 3 credits, 3 contact hours.**
A computer forensics audit is the proper identification and collection of computer evidence. Computers are involved in security violations through crime or violations of policy, or being targeted by an attack. This course deals with the preservation, identification, extraction, documentation, reporting, acquisition, analysis and interpretation of computer data. Topics covered include evidence handling, chain of custody, collection, preservation, identification and recovery of computer data. In this hands-on course, you will conduct several labs where you will be taught to analyze, review and extract information from computer hard drives, and determine what and how the information could have been compromised. Computer Forensics Audit professionals become experts in e-discovery and preserving sensitive evidential matter.

**IS 683. Web Systems Development. 3 credits, 3 contact hours.**
Students will gain experience in open source web development through an intensive hands-on project, applying real-world problem-solving skills to meeting information systems requirements. Students will learn Web development principles, as well as professionally relevant skills including industry standards, conventions, and procedures within large-scale programming projects. Also covered are the communication tools, technologies, and practices that individuals use to coordinate and collaborate within the open source software development community.

**IS 684. Business Process Innovation. 3 credits, 3 contact hours.**
Prerequisites: IS 663 or CS 673 This course adopts a balanced approach to business process innovation (BPI) that includes both incremental improvement and re-engineering. It specifically examines the concept of a service-oriented architecture (SOA) and the use of web services as a way to enable scalable and adaptive business processes. Students will learn how to develop process maps using the Business Process Modeling Notation (BPMN) and design process improvements to achieve efficiency, effectiveness, compliance and agility objectives. The focus of the course is on ways in which information technology can be used to manage, transform and improve business processes.

**IS 685. Enterprise Architecture and Integration. 3 credits, 3 contact hours.**
Prerequisites: None, but recommend completion of IS 663 or CS 673. The Enterprise Architecture (EA) describes an organization's IT strategy and operational structure. IS and IT professionals utilize the EA to analyze, design and integrate the (often heterogeneous) IT infrastructure and applications to most effectively support the enterprise and respond to risks. Students learn to develop an EA analysis which reflects its business strategies, capabilities, processes, and systems, metrics, information resources, and networking infrastructure. This enables students to determine the impact of IT solutions, by learning to deconstruct, analyze and configure IT systems in alignment with enterprise-wide business strategies. The course covers the industry standard The Open Group Architecture Framework (TOGAF) enterprise architecture framework and focuses on Enterprise Application Integration (EAI).

**IS 686. Pervasive Computing: An HCI Perspective. 3 credits, 3 contact hours.**
This course examines Pervasive/Ubiquitous Computing, the trend toward increasingly ubiquitous connected computing devices in the environment - a trend being brought about by a convergence of advanced electronic, and particularly, wireless technologies and the internet. We do this from a Human Computer Interaction perspective looking at the current and future design of various systems.

**IS 687. Transaction Mining and Fraud Detection. 3 credits, 3 contact hours.**
Prerequisites: IS 665 Increasingly, all of our transactions are electronic. We use debit and credit cards (electronic transactions) instead of checks and cash at banks, restaurants, stores, and many other businesses. Evaluation of transactions to find risk includes detection of terrorists and money launderers. Every financial institution is legally required to monitor transactions to detect organized crime and terrorism. Mining transaction streams to find good or bad customers in a rapidly growing area of employment for IS graduates. This course will present methods that are being used to analyze and mine transactional data and the business applications of these methods.

**IS 688. Web Mining. 3 credits, 3 contact hours.**
Prerequisite: IS 665. Web mining aims to discover useful information and knowledge from the Web hyperlink structure, page contents and usage logs. It has direct applications in e-commerce, Web analytics, information retrieval/filtering, personalization, and recommender systems. Employees knowledgeable about Web mining techniques and their applications are highly sought by major Web companies such as Google, Amazon, Yahoo, MSN and others who need to understand user behavior and utilize discovered patterns from terabytes of user profile data to design more intelligent applications. The primary focus of this course is on Web usage mining and its applications to business intelligence and biomedical domains. We learn techniques from machine learning, data mining, text mining, and databases to extract useful knowledge from the Web and other unstructured/semistructured, hypertextual, distributed information repositories. This data could be used for site management, automatic personalization, recommendation, and user profiling. Topics covered include crawling, indexing, ranking and filtering algorithms using text and link analysis, applications to search, classification, tracking, monitoring, and Web intelligence. Programming assignments give hands-on experience. A group project highlights class topics.

**IS 690. Web Services and Middleware. 3 credits, 3 contact hours.**
Prerequisite: IS 601 Web services enable integration of web-based applications and feature sets to any other web-based system in a modular way. Middleware is a set of functionality positioned in between and enabling interoperability among different, distributed enterprise and other computing applications. This course provides an introduction to web services and middleware in the context of digital libraries - large scale multimedia information repositories. Students will gain hands on experience in developing their own web services managing a complex distributed computing platform.

**IS 698. Special topics in Information Systems. 3 credits, 3 contact hours.**
Special area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

**IS 700. Master's Project. 0 credits, 0 contact hours.**
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

**IS 700B. Master's Project. 3 credits, 3 contact hours.**
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

**IS 700C. Master's Project. 6 credits, 6 contact hours.**
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

**IS 701. Master's Thesis. 0 credits, 0 contact hours.**
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

**IS 701B. Master's Thesis. 3 credits, 3 contact hours.**
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

**IS 701C. Master's Thesis. 6 credits, 3 contact hours.**
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

**IS 725. Independent Study in Information Systems. 3 credits, 3 contact hours.**
Prerequisites: Graduate standing and department consent.

**IS 726. Independent Research II. 3 credits, 3 contact hours.**

**IS 727. Independent Research III. 3 credits, 1 contact hour.**

**IS 735. Social Media. 3 credits, 3 contact hours.**
Prerequisite: IS 665 or MATH 661, or a graduate course in statistics or course in quantitative research methods. Seminar style course that covers design and impact of computer-based systems for human communication, including email and IM, discussion boards, Computer-Supported Cooperative Work (CSCW), Group Decision Support Systems (GDSS), and Social Networking Systems. Topics include alternative design structures, impacts of primarily text-based group communication, and recent empirical studies of virtual teams, online communities, and systems used for social networking, including 3-D worlds such as Second Life and "micro blogging" systems such as Twitter.

**IS 764. Research Methods for Human-Centered Computing and Design. 3 credits, 0 contact hours.**
Prerequisites: None. This introductory seminar in human centered computing and design provides a survey of the methodological literature on qualitative research methods paired with appropriate article-length exemplars. We cover a variety of different research strategies including design science, action research, case study, qualitative data collection and analysis techniques, and scenario-based design. This course develops skills in designing and evaluating systems using qualitative methods. We also discuss writing and reviewing academic articles and research proposals. The course utilizes information systems as the primary domain but could be extended for students in other disciplines.

**IS 765. Quantitative Methods in Information Systems Research. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or equivalent. This course is a practical and project-oriented introduction to quantitative methods in information systems (IS) research. The focus of the course is on developing researchers' capability to select and implement appropriate statistical procedures for a variety of research questions and to interpret the results of these procedures.

**IS 766. Philosophy of Information Science. 3 credits, 3 contact hours.**
This seminar explores central issues in contemporary philosophy of science. We consider "scientific" progress in the computing sciences with a focus on information systems and human computer interaction theory. We discuss topics such as confirmation and disconfirmation of theories; falsifiability and pseudo-science; introduction; probability; and statistical inference, prediction, explanation and empirical equivalence. We read key works by philosophers such as Popper and Kuhn. We examine the notion of "design science" and contrast it with "natural science", and examine whether social science research should strive to emulate natural science methods. Readings will be tied into research within information systems and the computing sciences in general, looking at how scientific theories are tested or confirmed.

**IS 776. IS Research Proposition. 3 credits, 3 contact hours.**
Prerequisite: Restricted to students in the doctoral program in Information Systems. The IS Research Study serves as the Information Systems PhD qualifying exam and demonstrates research readiness. Each student works with a faculty member to identify the topic of a research study, and then takes the lead in designing and conducting the study, and analyzing the results.

**IS 785. ST:. 3 credits, 3 contact hours.**
These seminars examine a special interest area of Information Systems in depth. Each seminar emphasizes recent work in the area selected.

**IS 786. Special Topics. 3 credits, 3 contact hours.**
These seminars examine a special interest area of Information Systems in depth. Each seminar emphasizes recent work in the area selected.

**IS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.**
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal.

**IS 791. Graduate Seminar. 0 credits, 0 contact hours.**
A seminar in which faculty, students, and invited speakers will present summaries of advanced topics in information systems. In the course students and faculty will discuss research procedures, dissertation organization, and content. Students engaged in research will present their own problems and research progress for discussion and criticism.

**IS 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Prerequisite: permission from department chairperson. For students admitted to the doctoral program in IS who have passed the field exam or the qualifying examination. Research is carried out under the supervision of a designated faculty member. Students identify a research problem and prepare a plan to solve the problem. A maximum of 6 credits of IS 792 may be applied to the IS 790 requirement.

# M.S. in Business and Information Systems

(30 Credits)

# M.S. in Business and Information Systems

| | | |
|---|---|---|
| **Business Core (2 courses)** | | |
| IS 677 | Information System Principles | 3 |
| or MIS 645 | Information Systems Principles | |
| Select one of the following: | | 3 |
| ACCT 615 | Management Accounting [2] | |
| FIN 600 | Corporate Finance I [1] | |
| HRM 601 | Organizational Behavior [1] | |
| **Information Systems Core (6 courses)** | | |
| IS 601 | Web Systems Development | 3 |
| IS 631 | Enterprise Database Management | 3 |
| IS 663 | System Analysis and Design | 3 |
| IS 665 | Data Analytics for Info System [3] | 3 |
| IS 684 | Business Process Innovation | 3 |
| Select one of the following: | | 3 |
| IS 685 | Enterprise Architecture and Integration | |
| IS 678 | IT Service Management | |
| **Total Credits** | | **24** |

## Electives and Specialization Areas

We strongly encourage students to design and conduct a Masters Project Thesis with an Information Systems professor. If you are considering a Project or Thesis, please consult the professor early to determine the best electives to support your work. IS 700 Master's Project can substitute for one elective and IS 701 Master's Thesis for two electives, and be considered part of a specialization with the MS Advisor's permission.

| | | |
|---|---|---|
| Select two of the following electives or [2] | | 6 |
| Select IS 700B and two of the following electives or | | |
| Select IS 701 to substitute for both of your electives: | | |

| | | |
|---|---|---|
| **Data Analytics** | | |
| Recommended Electives: | | |
| IS 634 | Information Retrieval | 3 |
| IS 687 | Transaction Mining and Fraud Detection | 3 |
| IS 688 | Web Mining | 3 |
| Additional Electives: | | |
| CS 602 | Java Programming | 3 |
| CS 632 | Advanced Database System Design | 3 |
| CS 634 | Data Mining | 3 |
| CS 675 | Machine Learning | 3 |
| CS 731 | Applications of Database Systems | 3 |
| CS 732 | Advanced Machine Learning | 3 |
| CE 602 | Geographic Information System | 3 |
| MGMT 635 | Data Mining and Analysis | 3 |
| PTC 628 | Analyzing Social Networks | 3 |
| **Business Decision Making** | | |
| IS 678 | IT Service Management | 3 |
| ACCT 615 | Management Accounting | 3 |
| FIN 600 | Corporate Finance I | 3 |
| HRM 601 | Organizational Behavior | 3 |
| MIS 648 | Decision Support Systems for Managers | 3 |
| MIS 680 | Management Science | 3 |
| MGMT 620 | Management of Technology | 3 |
| MGMT 630 | Decision Analysis | 3 |
| MGMT 650 | Knowledge Management | 3 |

| | | |
|---|---|---|
| MGMT 685 | Operations Research and Decision Making | 3 |
| MGMT 688 | Information Technology, Business and the Law | 3 |
| MRKT 620 | Competing in Global Markets | 3 |
| MRKT 645 | Internet Marketing Strategy | 3 |
| **Healthcare Informatics** | | |
| CS 639 | Elec. Medical Records: Med Terminologies and Comp. Imp. | 3 |
| IE 686 | Intro to Healthcare Systems | 3 |
| IE 687 | Healthcare Enterprise Systems | 3 |
| IE 688 | Healthcare Sys Perfor Modeling | 3 |
| R834 581 | Health Systems and Policy | 3 |
| R834 582 | Health Care Management | 3 |
| R834 659 | Healthcare Finance | 3 |
| **User Experience Design** | | |
| Recommended Elective: | | |
| IS 661 | User Experience Design [4] | 3 |
| Additional Electives: | | |
| IS 664 | Customer Discovery [4] | 3 |
| IS 686 | Pervasive Computing: An HCI Perspective | 3 |
| IS 735 | Social Media | 3 |
| IE 661 | Man-Machine Systems | 3 |
| IE 662 | Cognitive Engineering | 3 |
| IE 664 | Advanced Ergonomics | 3 |
| PTC 605 | Elements of Visual Design | 3 |
| PTC 606 | Advanced Information Design | 3 |
| PTC 629 | Theory and Practice of Social Media | 3 |
| PTC 650 | ELearning Design for Mobile | 3 |
| **Security and Network Management** | | |
| IS 680 | Information Systems Auditing | 3 |
| IS 681 | Computer Security Auditing | 3 |
| IS 682 | Forensic Auditing for Computing Security | 3 |
| CS 608 | Cryptography and Security | 3 |
| CS 645 | Security and Privacy in Computer Systems | 3 |
| CS 646 | Network Protocols Security | 3 |
| CS 647 | Counter Hacking Techniques | 3 |
| CS 652 | Computer Networks-Architectures, Protocols and Standards | 3 |
| CS 656 | Internet and Higher-Layer Protocols | 3 |
| CS 696 | Network Management and Security | 3 |
| IT 620 | Wireless Networks Security and Administration | 3 |
| IT 640 | Network Services Administration | 3 |
| **Systems Analysis and Design** | | |
| IS 676 | Requirements Engineering | 3 |
| IS 685 | Enterprise Architecture and Integration | 3 |
| IS 661 | User Experience Design | 3 |
| IS 664 | Customer Discovery | 3 |
| CS 673 | Software Design and Production Methodology | 3 |
| CS 683 | Software Project Management | 3 |
| CS 684 | Software Testing and Quality Assurance | 3 |
| CS 685 | Software Architecture | 3 |
| EM 636 | Project Management | 3 |
| EM 637 | Project Control | 3 |
| **Web Systems** | | |
| IS 634 | Information Retrieval | 3 |

| | | |
|---|---|---|
| IS 661 | User Experience Design | 3 |
| IS 664 | Customer Discovery | 3 |
| IS 688 | Web Mining | 3 |
| IS 690 | Web Services and Middleware | 3 |
| PTC 605 | Elements of Visual Design | 3 |
| PTC 628 | Analyzing Social Networks | 3 |
| PTC 632 | Content Management and Information Architecture | 3 |
| **Build Your Own Specialization** | | |
| Students may propose a coherent set of courses that have a common thread related to an area that you are interested in. The MS BIS advisor approves the proposed specialization. | | |

[1] Students who have taken an undergraduate equivalent of one of these courses may substitute up to one business core course with an additional elective.

[2] Students may optionally choose 2 or more courses from a single area, which will constitute a specialization.

[3] Students considering a Master's Project or Thesis with this specialization are encouraged to take IS 665 Data Analytics for Info System as an elective.

[4] Students considering a Master's Project or Thesis with the User Experience specialization are encouraged to take both IS 661 User Experience Design and IS 664 Customer Discovery as electives.

# M.S. in Emergency Management and Business Continuity

For further details, see http://is.njit.edu/academics/

## Summary

| | |
|---|---|
| Fundamental Courses | 12 |
| Elective Courses | 6 |
| Specialty Area Courses | 12 |
| **Total Credits** | **30** |

## M.S. in Emergency Management and Business Continuity (courses only)

| | | |
|---|---|---|
| **Fundamental/Core Courses** [1] | | |
| IS 613 | Design of Emergency Management Information Systems | 3 |
| IS 614 | Command and Control Systems | 3 |
| IS 612 | Emergency Management Informatics | 3 |
| IS 616 | Learning Methodologies and Training Technologies | 3 |
| **Electives** [2] | | |
| Select two of the following: | | 6 |
| HRM 601 | Organizational Behavior | |
| CE 602 | Geographic Information System | |
| EVSC 625 | Social Dimensions of Risk | |
| **Specialty/Application Area** | | |
| Select four courses from the following areas: [3] | | 12 |
| **Critical Infrastructure** | | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| CE 672 | Security Management of Critical Infrastructure | |
| EM 602 | Management Science | |
| ARCH 675 | Elements of Infrastructure Planning | |
| **Computer Engineering** | | |
| ECE 644 | Wireless Communication | |
| ECE 645 | Wireless Networks | |
| ECE 683 | Computer Network Design and Analysis | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 639 | Principles of Broadband Networks | |

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|---|---|---|
| ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| **Environmental Science** | | |
| EVSC 603 | Hazardous Waste Operations and Emergency Response | |
| EVSC 610 | Environmental Chemical Science | |
| EVSC 611 | Hazardous Waste Management | |
| EVSC 612 | Environmental Analysis | |
| EVSC 613 | Environmental Problem Solving | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| **Information Systems** | | |
| IS 631 | Enterprise Database Management | |
| IS 634 | Information Retrieval | |
| IS 677 | Information System Principles | |
| IS 679 | | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 764 | Research Methods for Human-Centered Computing and Design | |
| **Management** | | |
| ACCT 615 | Management Accounting | |
| EM 636 | Project Management | |
| FIN 600 | Corporate Finance I | |
| HRM 630 | Managing Technological and Organizational Change | |
| MIS 645 | Information Systems Principles | |
| or IS 677 | Information System Principles | |
| MIS 648 | Decision Support Systems for Managers | |
| MGMT 630 | Decision Analysis | |
| MGMT 650 | Knowledge Management | |
| MGMT 635 | Data Mining and Analysis | |
| **Total Credits** | | **30** |

[1] Students may choose core courses in any order but we recommend students take IS 612 Emergency Management Informatics in the first semester.

[2] Students who have not worked in this area are advised to consider doing a project or thesis.

[3] Students may take a coherent set of four additional courses in another field that is related to Emergency Management. Usually this would be in their current professional area as specified by their undergraduate or other graduate degrees. Such courses may be applied to a second masters or a Ph.D. program in accordance with NJIT policies and program structure. Students can take all four courses in one specialty area or across several specialties as appropriate to their interests.

# M.S. in Emergency Management and Business Continuity (Master's project)

| | | |
|---|---|---|
| **Fundamental/Core Courses** [1] | | |
| IS 613 | Design of Emergency Management Information Systems | 3 |
| IS 614 | Command and Control Systems | 3 |
| IS 612 | Emergency Management Informatics | 3 |
| IS 616 | Learning Methodologies and Training Technologies | 3 |
| **Electives** | | |
| IS 700B | Master's Project | 3 |
| Select one of the following: | | 3 |
| HRM 601 | Organizational Behavior | |
| CE 602 | Geographic Information System | |
| EVSC 625 | Social Dimensions of Risk | |
| **Specialty/Application Area** | | |

| | | |
|---|---|---|
| Select four courses from the following areas: [2] | | 12 |
| **Critical Infrastructure** | | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| CE 672 | Security Management of Critical Infrastructure | |
| EM 602 | Management Science | |
| ARCH 675 | Elements of Infrastructure Planning | |
| **Computer Engineering** | | |
| ECE 644 | Wireless Communication | |
| ECE 645 | Wireless Networks | |
| ECE 683 | Computer Network Design and Analysis | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| **Environmental Science** | | |
| EVSC 603 | Hazardous Waste Operations and Emergency Response | |
| EVSC 610 | Environmental Chemical Science | |
| EVSC 611 | Hazardous Waste Management | |
| EVSC 612 | Environmental Analysis | |
| EVSC 613 | Environmental Problem Solving | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| **Information Systems** | | |
| IS 631 | Enterprise Database Management | |
| IS 634 | Information Retrieval | |
| IS 677 | Information System Principles | |
| IS 679 | | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 764 | Research Methods for Human-Centered Computing and Design | |
| **Management** | | |
| ACCT 615 | Management Accounting | |
| EM 636 | Project Management | |
| FIN 600 | Corporate Finance I | |
| HRM 630 | Managing Technological and Organizational Change | |
| MIS 645 | Information Systems Principles | |
| or IS 677 | Information System Principles | |
| MIS 648 | Decision Support Systems for Managers | |
| MGMT 630 | Decision Analysis | |
| MGMT 650 | Knowledge Management | |
| MGMT 635 | Data Mining and Analysis | |
| **Total Credits** | | **30** |

1. Students may choose core courses in any order but we recommend students take IS 612 Emergency Management Informatics in the first semester.
2. Students may take a coherent set of four additional courses in another field that is related to Emergency Management. Usually this would be in their current professional area as specified by their undergraduate or other graduate degrees. Such courses may be applied to a second masters or a Ph.D. program in accordance with NJIT policies and program structure. Students can take all four courses in one specialty area or across several specialties as appropriate to their interests.

# M.S. in Emergency Management and Business Continuity (Master's thesis)

**Fundamental/Core Courses** [1]

| | | |
|---|---|---|
| IS 613 | Design of Emergency Management Information Systems | 3 |
| IS 614 | Command and Control Systems | 3 |
| IS 612 | Emergency Management Informatics | 3 |
| IS 616 | Learning Methodologies and Training Technologies | 3 |
| **Thesis** | | |
| IS 701C | Master's Thesis | 6 |
| **Specialty/Application Area** | | |
| Select four courses from the following areas: [2] | | 12 |
| **Critical Infrastructure** | | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| CE 672 | Security Management of Critical Infrastructure | |
| EM 602 | Management Science | |
| ARCH 675 | Elements of Infrastructure Planning | |
| **Computer Engineering** | | |
| ECE 644 | Wireless Communication | |
| ECE 645 | Wireless Networks | |
| ECE 683 | Computer Network Design and Analysis | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| **Environmental Science** | | |
| EVSC 603 | Hazardous Waste Operations and Emergency Response | |
| EVSC 610 | Environmental Chemical Science | |
| EVSC 611 | Hazardous Waste Management | |
| EVSC 612 | Environmental Analysis | |
| EVSC 613 | Environmental Problem Solving | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| **Information Systems** | | |
| IS 631 | Enterprise Database Management | |
| IS 634 | Information Retrieval | |
| IS 677 | Information System Principles | |
| IS 679 | | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 764 | Research Methods for Human-Centered Computing and Design | |
| **Management** | | |
| ACCT 615 | Management Accounting | |
| EM 636 | Project Management | |
| FIN 600 | Corporate Finance I | |
| HRM 630 | Managing Technological and Organizational Change | |
| MIS 645 | Information Systems Principles | |
| or IS 677 | Information System Principles | |
| MIS 648 | Decision Support Systems for Managers | |
| MGMT 630 | Decision Analysis | |
| MGMT 650 | Knowledge Management | |
| MGMT 635 | Data Mining and Analysis | |
| **Total Credits** | | **30** |

[1] Students may choose core courses in any order but we recommend students take IS 612 Emergency Management Informatics in the first semester.

2 Students may take a coherent set of four additional courses in another field that is related to Emergency Management. Usually this would be in their current professional area as specified by their undergraduate or other graduate degrees. Such courses may be applied to a second masters or a Ph.D. program in accordance with NJIT policies and program structure. Students can take all four courses in one specialty area or across several specialties as appropriate to their interests.

## Specialty/Application Area

There is an advisor for each specialty area that may be contacted for questions on that specialty area and for advice on choosing courses. The specialty areas currently include:

### Critical Infrastructure

Critical Infrastructure focuses on planning issues, maintainability and safety engineering, vulnerability analysis, hazard/crisis impact analysis and mitigation, infrastructure inter-dependencies, rehabilitation technologies, condition assessment, problem detection, diagnosis and process propagation, and program management. Students with an undergraduate degree in civil engineering and related engineering disciplines would be encouraged to consider this specialty area.

### Computer Engineering

The design and assurance of communication infrastructure is critical to all aspects of emergency management. Being able to evaluate and insure the mitigation of vulnerabilities for such systems is an important contribution to the infrastructure survivability of such systems. Students with an undergraduate degree in Computer Engineering are encouraged to consider this specialty area.

### Environmental Science

With the increasing complexity of our society comes severe risk of the accidental and deliberate release of a wide range of hazardous materials, both chemical and biological. Those trained to be able to make a meaningful contribution to the understanding of the associated risks, how to detect and track the implications of their occurrence, and how to respond meaningfully to their mitigation represent an important professional talent that needs to be available in the Emergency Management and Business Continuity Area. All organizations dealing with hazardous materials should have this sort of talent in their Emergency Management team.

### Information Systems

The application of computing information and communication in the Emergency Management and Business Continuity field represents the potential use of technology to integrate all the functions that must take place before, during, and after the disaster, as well as among the different organizations and units of organizations that must be involved in the preparedness, response, and recovery. Information systems are the glue that puts together planning, mitigation, detection, training, command and control, response, and recovery into one unified process that provides the necessary infrastructure for the overall responsibilities. As such, they must be designed and developed with the evolving needs of the users and the organizations integrated into the development process.

### Management

The professionals in Emergency Management must be able to integrate the development of plans for response processes (within their organization and across necessary external organizations). They must also ensure that everyone will receive adequate training and that in times of disaster those involved can work as well motivated and coordinated teams, no matter what degree of heterogeneity of expertise and level of experience exists among respondents. The emergency manager or business continuity professional must be able to be an entrepreneur or champion of emergency preparedness, and to prove and present people the best possible justifications for investing in an organizational function that may not be viewed as absolutely necessary by all those concerned, especially in times of restricted budgets. He or she must be able to stimulate planning, communication, and coordination among all parts of the organization or organizational units necessary to bring about effective crisis planning and response.

# M.S. in Information Systems

(30 Credits)

## M.S. in Information Systems

| | | |
|---|---|---|
| **IS Core Courses** | | |
| IS 601 | Web Systems Development | 3 |
| IS 663 | System Analysis and Design | 3 |
| IS 631 | Enterprise Database Management | 3 |
| IS 661 | User Experience Design | 3 |
| IS 665 | Data Analytics for Info System | 3 |
| IS 684 | Business Process Innovation | 3 |
| Select one of the following Analytics courses: | | 3 |
| IS 634 | Information Retrieval | |

| | | |
|---|---|---|
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 688 | Web Mining | |
| **Electives and Specialization Areas** [1] | | |
| Select three of the following electives or [2] | | 9 |
| Select IS 700B and two of the following electives or | | |
| Select IS 701 and one of the following electives: | | |
| **Data Analytics** | | |
| IS 634 | Information Retrieval | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 688 | Web Mining | |
| CS 602 | Java Programming | |
| CS 632 | Advanced Database System Design | |
| CS 634 | Data Mining | |
| CS 675 | Machine Learning | |
| CS 731 | Applications of Database Systems | |
| CS 732 | Advanced Machine Learning | |
| CE 602 | Geographic Information System | |
| MGMT 635 | Data Mining and Analysis | |
| PTC 628 | Analyzing Social Networks | |
| **Business Decision Making** | | |
| IS 677 | Information System Principles | |
| IS 678 | IT Service Management | |
| ACCT 615 | Management Accounting | |
| FIN 600 | Corporate Finance I | |
| HRM 601 | Organizational Behavior | |
| MIS 648 | Decision Support Systems for Managers | |
| MIS 680 | Management Science | |
| MGMT 620 | Management of Technology | |
| MGMT 630 | Decision Analysis | |
| MGMT 650 | Knowledge Management | |
| MGMT 685 | Operations Research and Decision Making | |
| MGMT 688 | Information Technology, Business and the Law | |
| MGMT 710 | Forecasting Methods for Business Decisions | |
| MRKT 620 | Competing in Global Markets | |
| MRKT 645 | Internet Marketing Strategy | |
| **Healthcare Informatics** | | |
| CS 639 | Elec. Medical Records: Med Terminologies and Comp. Imp. | |
| IE 686 | Intro to Healthcare Systems | |
| IE 687 | Healthcare Enterprise Systems | |
| IE 688 | Healthcare Sys Perfor Modeling | |
| R834 581 | Health Systems and Policy | |
| R834 582 | Health Care Management | |
| R834 659 | Healthcare Finance | |
| **User Experience Design** | | |
| IS 664 | Customer Discovery [3] | |
| IS 686 | Pervasive Computing: An HCI Perspective | |
| IS 735 | Social Media | |
| IE 661 | Man-Machine Systems | |
| IE 662 | Cognitive Engineering | |
| IE 664 | Advanced Ergonomics | |
| PTC 605 | Elements of Visual Design | |
| PTC 606 | Advanced Information Design | |

| | |
|---|---|
| PTC 629 | Theory and Practice of Social Media |
| PTC 650 | ELearning Design for Mobile |
| **Security and Network Management** | |
| IS 680 | Information Systems Auditing |
| IS 681 | Computer Security Auditing |
| IS 682 | Forensic Auditing for Computing Security |
| IS 687 | Transaction Mining and Fraud Detection |
| CS 608 | Cryptography and Security |
| CS 645 | Security and Privacy in Computer Systems |
| CS 646 | Network Protocols Security |
| CS 647 | Counter Hacking Techniques |
| CS 651 | Data Communications |
| CS 652 | Computer Networks-Architectures, Protocols and Standards |
| CS 656 | Internet and Higher-Layer Protocols |
| CS 696 | Network Management and Security |
| IT 620 | Wireless Networks Security and Administration |
| IT 640 | Network Services Administration |
| **Systems Analysis and Design** | |
| IS 664 | Customer Discovery |
| IS 676 | Requirements Engineering |
| IS 685 | Enterprise Architecture and Integration |
| CS 673 | Software Design and Production Methodology |
| CS 683 | Software Project Management |
| CS 684 | Software Testing and Quality Assurance |
| CS 685 | Software Architecture |
| EM 636 | Project Management |
| EM 637 | Project Control |
| **Web Systems** | |
| IS 634 | Information Retrieval |
| IS 664 | Customer Discovery |
| IS 688 | Web Mining |
| IS 690 | Web Services and Middleware |
| PTC 605 | Elements of Visual Design |
| PTC 628 | Analyzing Social Networks |
| PTC 632 | Content Management and Information Architecture |
| **Build Your Own Specialization** | |
| Students may propose a coherent set of courses that have a common thread related to an area that you are interested in. The MS IS advisor approves the proposed specialization. | |
| **Total Credits** | **30** |

[1] Please consult the professor or academic advisor early to determine the best electives to support your work.

[2] Students may optionally choose 2 or more courses from a single area, which will constitute a specialization. Students will choose 3 electives if course only option, 2 electives if taking IS 700B Master's Project, or 1 electives if taking IS 701B Master's Thesis. We strongly encourage students to design and conduct a Master Project or Master Thesis with an Information Systems professor. If you are considering a Project or Thesis, please consult the professor early to determine the best electives to support your work. A Master Project or Master Thesis can be considered part of a specialization with the MS Advisor's permission.

[3] Students considering a Master's Project or Thesis with the User Experience specialization are encouraged to take IS 664 Customer Discovery as an elective.

# Ph.D. in Information Systems

## Overall Course Requirements

Students must maintain a grade average of 3.5 (B+) or better in core courses. No course with a grade less than B will count. Up to 2 courses may be independent study. At least 4 courses must be at the 700 level.

## Ph.D. Program Goals

Students in the PhD program will be able to demonstrate the ability to:

1. understand the state of the art of IS practice
2. understand fundamental knowledge of and apply research methods within student's chosen focus of Human-Centered Computing (HCC) or data intensive research
3. critically examine research in the student’s chosen research area
4. develop a fundable research proposal
5. develop research questions, design research methodologies, implement systems, interpret results, and discuss implications for a research project in the student’s chosen research area, and
6. teach effectively in one IS course

## Ph.D. Program Overview and Credits

The PhD program has 4 stages. Full-time students entering with an IS Master’s degree are expected to complete within 4 years. Those entering with only a Bachelors or a non-IS background are expected to complete within 5 years. Per NJIT policy, the maximum duration for the entire doctoral study is 7 years for both full-time and part-time students. The following table shows the expected and maximum time allowed for each stage.

## Ph.D Program Stage Details

### Stage 1: Foundation

Students will consult with the PhD Director to develop an appropriate set of foundation courses which must include the following if not previously studied.

| | | |
|---|---|---|
| **IS Foundation** | | |
| IS 677 | Information System Principles (Required) | 3 |
| **Programming** | | |
| IS 601 | Web Systems Development | 3 |

### Stage 2: Core Knowledge Acquisition

In this stage, students will focus on core courses, article reviews and the qualifying exam. Students may be required to take a different set of core courses or in a different sequence, depending on their educational background. Student additionally should participate in research activities. Students must take four 700 level courses to graduate.

| | | |
|---|---|---|
| **First Year** | | |
| **1st Semester** | | **Term Credits** |
| IS 631 | Enterprise Database Management | 3 |
| IS 661<br>or IS 664 | User Experience Design<br>or Customer Discovery | 3 |
| IS 665 | Data Analytics for Info System | 3 |
| ENG 503 | Advanced English for International Teaching Assistants(international students only) | 3 |
| | **Term Credits** | **12** |
| **2nd Semester** | | |
| IS 663 | System Analysis and Design | 3 |
| IS 765 | Quantitative Methods in Information Systems Research | 3 |
| Select one of the following: | | 3 |
| IS 634 | Information Retrieval (Select one of the following:) | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 688 | Web Mining | |
| | **Term Credits** | **9** |
| **Second Year** | | |

| | | |
|---|---|---|
| **1st Semester** | | |
| IS 684 | Business Process Innovation | 3 |
| IS 776 | IS Research Proposition | 3 |
| 1 specialty course (as recommended by the advisor) | | 3 |
| | **Term Credits** | **9** |
| **2nd Semester** | | |
| IS 725 | Independent Study in Information Systems | 3 |
| or a 700-level specialty course | | |
| 2 specialty courses (if recommended by the advisor) | | 0-6 |
| | **Term Credits** | **3-9** |
| **Third Year** | | |
| **1st Semester** | | |
| IS 726 | Independent Research II | 0-3 |
| if needed to fulfill 700-level course requirements) | | |
| More specialty courses (if recommended by the advisor) | | 0-6 |
| | **Term Credits** | **0-9** |
| | **Total Credits** | **33-48** |

## Participation in Research Activities

IS research group meetings present an important opportunity for faculty and PhD students to immerse themselves in IS research paradigms, learn about research interests, present ideas, and find collaborators.

Full-time funded students must register for IS 791 Graduate Seminar and attend research group meetings, research talks, and serve on research proposition panels every semester. Part-time students also must register for the seminar and actively participate for at least 2 semesters, and are strongly encouraged to attend additional sessions as often as they can remotely via video conferencing. Exit requirements for IS 791 Graduate Seminar include presentations in research group meetings and satisfactory reviewing performance on research proposition panels.

Stage 3: Research & Teaching Apprenticeship

This stage includes:

- finding a dissertation advisor
- completing coursework
- completing a qualifying exam (research study)
- publishing
- apprenticing teaching

## Dissertation Advisor

Students must select a dissertation advisor by the end of the first year of entering Stage 3. This presumably was the student's faculty advocate during the admissions process, though this is a period for students to explore one or more areas of research as part of finding an exciting dissertation topic. Students may switch advisors as their research interests evolve. Starting this stage, including when switching advisors, no student may be without an approved advisor for more than 4 months.

## Coursework

Students must complete their coursework by the end of this stage. Courses fall into three categories:

1. *Core Courses:* Completing the courses listed in Stage 2.
2. *Specific Knowledge for Research and Dissertation:* Students and their advisors are responsible for choosing courses that will provide appropriate knowledge to complete the student's dissertation, and to be considered knowledgeable in the student's chosen field. The advisor can recommend courses in excess of the official number of credits required for graduation if the additional knowledge is critical.
3. *General Knowledge for Teaching:* If necessary, students and their advisors are responsible for choosing additional courses providing enough knowledge to teach general undergraduate courses in Information Systems and/or in the students chosen specialty.

## Qualifying Exam: Research Study

The research study serves as the PhD qualifying exam and demonstrates research readiness. Each student works with a faculty member to identify the topic of a research study, and then takes the lead in designing and conducting the study, and analyzing the results. The study should be submitted by the end of the first semester of this stage. At the start of the second semester the student will present the study and results in a department seminar, and prepare a quality publication as lead author. Recommended revisions to the study and publication must be completed by the end of the second semester. Because the study topic may be part of the faculty member's existing research efforts, the student must petition the department PhD committee to be allowed to utilize it as a dissertation topic. The student will register for IS 776 under the faculty member to conduct this Research Study. (IS 725 and IS 726 cannot be used for this Research Study.)

The faculty advisor (the faculty member working with the student) will propose a Qualifying Exam Committee (QEC) of 3 faculty members with sufficient familiarity of the topic or the study methodology. The QEC must be approved by the Department PhD Committee. The faculty advisor will not be a member of the QEC. Each QEC member will vote (pass-fail) on the Research Study as a whole (considering the design, execution, analysis, and written report to be submitted for publication). The student must receive a unanimous pass vote from the QEC to pass the Qualifying Exam.

## Publishing

Students must have one paper accepted for publication in a quality conference or journal as lead author by the end of their third year. Students are strongly encouraged to start on this requirement during this stage and over time submit multiple papers to ensure that it is met. Students also are encouraged to co-author papers with faculty and other doctoral students.

## Teaching Apprenticeship

Students apprentice with a faculty member for a semester in preparation for a teaching practicum. During the apprenticeship, students typically will serve as a teaching assistant or grader.

# Stage 4: Dissertation Process and Teaching Practicum

This stage includes:

- writing and defending a dissertation proposal
- conducting the main study
- writing and defending the full dissertation thesis
- submitting a publication based both on the thesis and
- independent teaching practicum

## Dissertation Proposal

The dissertation proposal is a binding contract between the dissertation committee and the student. If a student successfully defends a proposal, the research plan in the dissertation proposal is to be followed.

A dissertation proposal must show motivation, appropriate coverage of literature, a sound research framework, a prototype system (where appropriate), a pilot study (where appropriate), data analysis, and the detailed steps for completing the full dissertation.

## Dissertation

The dissertation completes the research proposed, including a formal study, and descriptions of contributions and limitations.

## Publishing Dissertation Research

Before defending the final dissertation, a student must submit a quality paper approved by his or her advisor based upon a substantial aspect of the thesis work to a recognized conference or journal in the field.

Independent Teaching Practicum

During the practicum a degree candidate will teach at least one previously apprenticed course under the course coordinator's direct supervision. Students must receive a satisfactory evaluation to pass this requirement.

Further Ongoing Activities

As future researchers, throughout their studies phd students are encouraged to work with faculty and fellow students to:

- Publish regularly in quality conferences and journals, including co-authoring,
- Attend conferences relevant to the student's research area,
- Regularly review conference and journal submissions, and
- Participate in authoring grant submissions and working on grant-funded projects.

# Information Technology

## Degree

The *MS in IT Administration and Security* degree teaches students how to administer IT systems and networks while ensuring their security. Students gain extensive hands-on experience administering an IT environment. MS ITAS graduates are well prepared for jobs as database, network, security and web services administrators. They are also prepared for successful leadership roles in various IT functions, such as enterprise application administrator, IT administration manager, computer security specialist, and IT department manager.

## Admission Requirements

Applicants are expected to have completed an undergraduate degree, preferably in information technology, computer science, computer engineering, information systems, or a related field. Students not satisfying these criteria will be considered for conditional admission on a case-by-case basis and may be required to complete a bridge program outlined in their acceptance letter. Bridge courses are a condition for admission; they do not count towards the 30 credits needed for degree completion.

## NJIT Faculty

### D

Deek, Maura A., Senior University Lecturer

### H

Halper, Michael H., Professor

### K

Kettering, Joan M., Senior University Lecturer

### S

Senesy, Stanley J., Senior University Lecturer

Sequeira, Marc T., University Lecturer

Statica, Robert, Senior University Lecturer

### W

Watrous-deVersterre, Lori L., Senior University Lecturer

- Information Technology and Administration Security - M.S. (p. 708)

IT Administration - Cert.

## Information Technology Courses

**IT 610. System Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course is an introduction to the skills needed for and tasks performed by a System Administrator. The course will cover administration of host and server systems in modern operating system environments. Topics to be covered include: user, configuration, and change management, shell scripting, monitoring and performance analysis, disaster mitigation and recovery, and auditing.

**IT 620. Wireless Networks Security and Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course introduces the fundamentals of wireless network security and administration. Topics include: wireless LAN vulnerabilities, passive and active wireless attacks, enterprise wireless hardware security, secure wireless authentication and communication, wireless intrusion detection and prevention systems, WiFi and cellular network management, location privacy, personal area network administration and security, mobile IP security, GSM, CDPD, 3G and 4G network security. The course provides both a theoretical foundation and hands-on experience in these areas.

**IT 635. Database Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course provides a broad overview of the tasks and techniques necessary to function as a Database Administrator (DBA)in a modern relational database environment. Students will learn the duties typically performed by a DBA, which include: user authorization, disaster planning and recovery, monitoring, performance analysis, database tuning, metadata maintenance as well as data modeling, analysis and database design.

**IT 640. Network Services Administration. 3 credits, 3 contact hours.**
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course provides an introduction to the fundamentals of network services administration. It covers how web-based and domain-services operate, integrate and communicate. Topics include: fundamental technologies that underpin the web services paradigm, key standards necessary for their development, and how other critical domain services should be deployed. This course will enable students to gain skills necessary to plan, install, configure, secure and maintain web servers, DNS servers, email & print servers, resource sharing systems, and domain authentication systems.

**IT 725. Independent Study. 3 credits, 3 contact hours.**

# M.S. in Information Technology Administration and Security

(30 credits)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| IT 120 | Introduction to Network Technology | 3 |
| IT 220 | Wireless Networks | 3 |
| IT 230 | Computer and Network Security | 3 |
| IT 340 | Introduction to System Administration | 3 |
| IT 420 | Computer Systems and Networks | 3 |
| IS 331 | Database Design Management and Applications | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| or IT 114 | Advanced Programming for Information Technology | |
| **Total Credits** | | **21** |

| | | |
|---|---|---|
| **Required Courses** | | |
| IT 610 | System Administration | 3 |
| IT 620 | Wireless Networks Security and Administration | 3 |
| IT 635 | Database Administration | 3 |
| IT 640 | Network Services Administration | 3 |
| CS 656 | Internet and Higher-Layer Protocols [1] | 3 |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 696 | Network Management and Security | 3 |
| **Elective Courses** | | |
| Select four of the following: | | 12 |
| CS 631 | Data Management System Design | |
| or IS 631 | Enterprise Database Management | |
| CS 632 | Advanced Database System Design | |
| CS 652 | Computer Networks-Architectures, Protocols and Standards [1] | |
| or ECE 683 | Computer Network Design and Analysis | |
| IS 677 | Information System Principles | |
| IS 680 | Information Systems Auditing | |
| IS 681 | Computer Security Auditing | |
| IS 682 | Forensic Auditing for Computing Security | |
| ECE 645 | Wireless Networks | |
| ECE 639 | Principles of Broadband Networks | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

[1] ECE course substitution for CS 652 Computer Networks-Architectures, Protocols and Standards and CS 656 Internet and Higher-Layer Protocols is only for students with ECE background and upon approval of the graduate advisor.

# College of Science and Liberal Arts

The College of Science and Liberal Arts (CSLA) is the home of discovery and scholarship with strong programs in the traditional disciplines of biology, chemistry, physics, mathematics and history. CSLA also is the home of interdisciplinary programs that include communication and media; law, technology and culture; science, technology and society; environmental science; and theatre arts and technology. The sciences and liberal arts have long been the foundation of a university education and they allow us to address the complexities of modern life at the intersection of science, technology, and human values.

With over 150 full-time teachers and researchers, the CSLA community represents a wide range of interests, but also shares the value of academic excellence. CSLA faculty and students are at the forefront of many national research activities, including solar astronomy, mathematical modeling, and the history of medicine and technology.

CSLA provides students with the intellectual foundations necessary to understand and analyze the technological world in which we live. The college's courses and degrees prepare students to ask questions about the world, to collect data and provide evidence, and to express ideas and conclusions with clarity and precision. These skills transcend specific professional competence and distinguish CSLA students as individuals who can blaze a trail for others and lead society into a rapidly evolving future.

## Programs

- Applied Mathematics - M.S. (p. 784)
- Applied Physics - M.S. (p. 800)
- Applied Statistics - M.S. (p. 786)
- Biology - M.S. (p. 737)
- BioStatistics - M.S. (p. 788)
- Chemistry - M.S. (p. 753)
- Computational Biology - M.S. (p. 788)
- Environmental Science - M.S. (p. 754)
- Environmental and Sustainability Policy - M.S. (p. 756)
- History - M.A. (p. 768)
- Mathematical and Computational Finance - M.S. (p. 790)
- Pharmaceutical Chemistry - M.S. (p. 757)
- Professional and Technical Communication - M.S. (p. 773)

## Programs

- Applied Physics - Ph.D. (p. 809)
- Biology - Ph.D. (p. 738)
- Chemistry - Ph.D. (p. 758)
- Environmental Science - Ph.D. (p. 760)
- Materials Science & Engineering - Ph.D. (p. 810)
- Mathematical Sciences - Ph.D. (p. 791)

Digital Marketing Design Essentials - Cert.

Technical Communication Essentials - Cert.

Instructional Design, Evaluation, and Assessment - Cert.

Social Medial Essentials - Cert.

Financial Mathematics - Cert.

Quantitative Tools in Finance - Cert.

Biostatistics Essentials - Cert.

Applied Statistics Methods - Cert.

# College of Science and Liberal Arts Courses

**BIOL 590. Grad Coop Work Experience I. 3 credits, 3 contact hours.**

**BIOL 591. Graduate Coop Work Exper II. 3 credits, 3 contact hours.**

**BIOL 593. Graduate Co-Op Work Exp IV. 0 credits, 0 contact hours.**

**BIOL 601. Computational Biology I. 3 credits, 3 contact hours.**
This course will describe mathematical and simulation techniques used in modeling a variety of biological systems. Students will learn stability analysis, phase space analysis, basic bifurication theory and numerical simulation techniques with examples from neuroscience, cell and molecular biology as well as ecology and evolution. Students enrolling in this course are expected to have basic knowledge of calculus, linear algebra and some programming abilities.

**BIOL 612. Comparative Animal Physiology. 3 credits, 3 contact hours.**
This course will explore how animals, from invertebrates to vertebrates, function from the cellular to the organism level. The study of the structure and function of the various organs provides insight into how animals survive extreme environments and how they respond to changes in their environment. The comparative approach shows that the underlying physiological principles that govern life are common to all animals and yet animals have evolved unique and sometimes startling physiological solutions to problems posed by their particular environments.

**BIOL 622. Evolution. 3 credits, 3 contact hours.**
This course will provide a comprehensive overview of research in the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic bases of variation and heredity, natural selection, evolution and development, and speciation. The format will be brief lectures to review topics covered in text, followed by class discussions of relevant primary literature. Students will write two papers on the topic of their choice and will be required to lead a minimum of one class discussion.

**BIOL 628. Cell Biology of Disease: Cells Gone Bad. 3 credits, 3 contact hours.**
This course will briefly review normal physiological function of humans and will then extensively explore the basis of many human diseases at cellular lever. The goal is to understand how alterations in normal cell functions affect human physiology by reviewing current research in the field of cell biology.

**BIOL 630. Critical Thinking for the Life Sciences. 3 credits, 3 contact hours.**
Researchers in the biological sciences must understand and be able to effectively apply the scientific method, and they must also be able to clearly communicate their ideas and results. This course will involve heavy student participation and discuss the scientific method, analyze and discuss data gathering and organizing, and will analyze existing grant proposals with the goal of enabling graduate students to write a clear and convincing grant proposal.

**BIOL 638. Computational Ecology. 3 credits, 3 contact hours.**
An overview of computational approaches to the study of mathematical models in ecology. Topics include one-, two-, and multi-species models, life history analysis, spatial dynamics, epidemiology. The course is taught as a hands-on computer lab in which students explore models, perform simulations and solve problems.

**BIOL 640. Cellular Neurophysiology. 3 credits, 3 contact hours.**
Prerequisites: Graduate student status or permission of the instructor. This course will examine the nervous system from a functional perspective. The goal is to understand how ion channels and other components of nerve cells give rise to electrical excitability and synaptic function, and how those properties are then used for coding information and higher order function in the nervous system.

**BIOL 641. Systems Neuroscience. 3 credits, 3 contact hours.**
This course will examine neurophysical phenomena from a systems perspective. The course will review basic concepts of cellular neuroscience, such as excitability, impulse conduction, and integration of activity at the cellular, before focusing on network level physiology of the nervous system and its role in the generation of behavior. The goal is to provide students with the basic knowledge to understand neurobiological processes at all levels of complexity.

**BIOL 645. Biological Imaging Techniques. 3 credits, 3 contact hours.**
Prerequisites: Graduate student status or permission of the instructor. This combined lecture and lab course will introduce the students to a variety of approaches to examine biological structures at different microscopic scales: conventional light microscopy, fluorescent microscopy, modern high resolution light microscopy, and electron microscopy. In addition, the course will cover optical approaches to study the dynamics of cellular function, including calcium and voltage imaging, and molecular interactions.

**BIOL 660. College Teaching. 3 credits, 3 contact hours.**
College Teaching helps students in STEM fields who teach or plan to teach in colleges or universities develop important professional knowledge, skills, values, and dispositions that can enable them to help undergraduate and graduate students develop societally and personally significant abilities. The course emphasizes research-based methods demonstrated to be effective for enhancing learning in diverse people.

**BIOL 698. Selected topics in Biology. 3 credits, 3 contact hours.**
Survey of recent research topics in Biology at the Master's level.

**BIOL 699. Selected Topics in Biology. 3 credits, 3 contact hours.**
Survey of recent research topics in Biology at the Masters level.

**BIOL 700. Master's Project. 0 credits, 0 contact hours.**

**BIOL 700B. Master's Project. 3 credits, 3 contact hours.**

**BIOL 701. Master's Thesis. 0 credits, 0 contact hours.**

**BIOL 701B. Master's Thesis. 3 credits, 3 contact hours.**

**BIOL 701C. Master's Thesis. 6 credits, 3 contact hours.**

**BIOL 725. Independent Study. 3 credits, 3 contact hours.**

**BIOL 726. Independent Study. 3 credits, 3 contact hours.**

**BIOL 788. Selected Topics in Biology. 3 credits, 3 contact hours.**
Survey of recent research topics in Biology at the doctoral level.

**BIOL 790. Doct Dissertation & Resrch. 0 credits, 0 contact hours.**

**BIOL 790A. Doct Dissertation & Resrch. 1 credit, 1 contact hour.**

**BIOL 790B. Doct Dissertation & Resrch. 3 credits, 3 contact hours.**

**BIOL 790C. Doctoral Dissertn & Resrch. 6 credits, 6 contact hours.**

**BIOL 790D. Doct Dissertation & Resrch. 9 credits, 0 contact hours.**

**BIOL 790E. Doctoral Dissertation. 12 credits, 12 contact hours.**

**BIOL 791. Biology Seminar. 0 credits, 0 contact hours.**
This seminar includes student and faculty presentations on current papers, student presentations related to their research and occasional outside speakers. It will acquaint students with possible topics for dissertation search, and provide an opportunity to present and receive feedback on current work.

**BIOL 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**BIOL 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.**

**BIOL 794. Computational Biology Colloquium. 1 credit, 1 contact hour.**
Restriction: graduate standing. Students and outside speakers present and discuss current research activities in computational biology and related scientific areas.

**CHEM 590. Graduate Co-Op Work Exper I. 3 credits, 3 contact hours.**

**CHEM 591. Graduate Co-Op Ork Exper II. 3 credits, 3 contact hours.**

**CHEM 592. Graduate Co-Op Work Exper III. 3 credits, 3 contact hours.**

**CHEM 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CHEM 599. Methods for Teaching Assistants and Graduate Assistants. 3 credits, 3 contact hours.**
Restriction: graduate standing. Required for all chemistry teaching assistants and graduate assistants. Covers techniques of teaching, interaction with students, and safety. Does not count as degree credit.

**CHEM 601. Special Topics in Chemistry I. 3 credits, 3 contact hours.**
Restriction: graduate standing and permission of the instructor. Topics of current interest in chemistry.

**CHEM 605. Advanced Organic Chemistry I: Structure. 3 credits, 3 contact hours.**
Prerequisite: undergraduate organic chemistry. Structure of organic molecules. Topics include atomic and molecular structure, stereochemistry, reactive intermediates (cations, anions, radicals, and carbenes), orbital symmetry, and spectroscopy.

**CHEM 606. Physical Organic Chemistry. 3 credits, 3 contact hours.**
Prerequisite: CHEM 502 or equivalent. Emphasis is placed on the physical aspects of the subject. Determination of reaction mechanisms, equilibria, and kinetics using simple molecular orbital theory and absolute reaction rate theory.

**CHEM 610. Advanced Inorganic Chemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate physical chemistry or permission of the instructor. Theories of observed chemical and physical properties of the elements and their compounds; prediction of reactivity and properties of proposed new compounds.

**CHEM 617. Mass Spectrometry and Interpretation of Mass Spectra. 3 credits, 3 contact hours.**
Prerequisite: CHEM 125 and CHEM 126 or equivalent. Historical background, fundamentals and mechanics of operation for components incorporated into modern Mass Spectrometers: vacuum system, ion sources, mass filter, ion detection, plus computer operation and data collection. Explanation and interpretation of mass spectra and fragmentation patterns are a fundamental theme throughout the course. Lecture material includes principles of operation and appropriate applications for modern types of mass spectrometers: magnetic sector, quadrupole, time of flight, ion trap, FT-ICR. Theory and applications of electron impact, chemical, electrospray, and other ionization techniques including atmospheric sampling are covered. High resolution analysis using magnetic sector and FT - ion cyclotron instruments. Analytical applications in environmental, petroleum and biochemical analysis and applications and coupling of mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

**CHEM 658. Advanced Physical Chemistry. 3 credits, 3 contact hours.**
Prerequisite: one year of undergraduate physical chemistry. Principles and applications of quantum chemistry; the wave equation, its properties and mathematics; the Schrodinger equation and wave functions; the harmonic oscillator; variational and perturbational methods; atomic theory, structure, and properties; simple molecules, LCAO and valence bond theories; semi-empirical methods; time dependence, and introduction to electronic and vibration-rotation spectroscopy.

**CHEM 661. Instrumental Analysis Laboratory. 3 credits, 3 contact hours.**
Prerequisite: one year of undergraduate physical chemistry. Instruments for chemical analysis are discussed in class and used in the laboratory; basic theory; sample preparation; use of instruments and interpretation of data are covered for spectroscopy including UV0VIS, FTIR, AA, and NMR; HPLC, GC, ion chromatography, mass spectrometry. Applications to food science, pharmaceuticals, polymers, and other chemical areas.

**CHEM 662. Air Pollution Analysis. 3 credits, 4 contact hours.**
Prerequisite: undergraduate physical chemistry. Chemical and physical principles of gaseous species and trace level measurement techniques for airborne vapors and particulates. Emphasis on analyzing real air samples at the parts-per-billion level, meteorological dispersion and life times of pollutants are covered. Laboratory work in air pollution sampling methods for vapor and particulate species. Determination of primary air pollutants using wet chemical and instrumental techniques.

**CHEM 673. Biochemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate organic and physical chemistry, or suitable background in these subjects. Fundamentals of biochemistry related to physical organic chemistry for students who have an interest in biomedical engineering, chemistry, chemical engineering, or environmental science.

**CHEM 700. Masters Project. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the master's degree. An extensive report involving an experimental, theoretical, or literature investigation is required. The literature investigation should result in a critical review of a specific area. Approval to register for the master's project must be obtained from the project advisor. Students must continue to register for at least 3 credits each semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

**CHEM 700B. Masters Project. 3 credits, 3 contact hours.**
Restriction: matriculation for the master's degree. An extensive report involving an experimental, theoretical, or literature investigation is required. The literature investigation should result in a critical review of a specific area. Approval to register for the master's project must be obtained from the project advisor. Students must continue to register for at least 3 credits each semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

**CHEM 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the master's degree in applied chemistry. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the department, and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum of 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**CHEM 701B. Masters Thesis. 3 credits, 3 contact hours.**

**CHEM 701C. Masters Thesis. 6 credits, 3 contact hours.**

**CHEM 702. Special Topics in Chemistry II. 3 credits, 3 contact hours.**
Restriction: Graduate standing. Topics of current interest in chemistry.

**CHEM 714. Pharmaceutical Analysis. 3 credits, 3 contact hours.**
The objective of this course is to provide an overview of instrumental techniques used in the analysis of different pharmaceutical products. Many different types of analysis are carried out in the pharmaceutical industry pertaining to active ingredients, formulations as well as impurities and dgradants. The focus will be on instrumentation such as chromatography, mass spectroscopy, different types of spectroscopy, quality assurance and GMP.

**CHEM 716. Integrated Drug Dev & Discover. 3 credits, 3 contact hours.**
Prerequisites: Strong background in organic chemistry This course offers an overview of the drug development process combined with hands-on experience in computer-aided drug design. Topics include pharmacokinetics, bioavailability, drug formulation, and structure-based drug design.

**CHEM 717. Mass Spectrometry and Mass Spectral Interpretation. 3 credits, 3 contact hours.**
Prerequisites: CHEM 125 and CHEM126 or equivalent. CHEM 717 and EVSC 617 are comprised of CHWM 717 and EVSC 617 plus a research project: Research projects usually comprise experimental and mass spectrometry interpretation studies. These can be performed at NJIT or in the students corporate mass spectrometry facility. Projects may also include theory, data interpretation or literature reviews pertinent to a current active area in mass spectrometry research. Projects should be approved or in consult with the instructors.

**CHEM 718. Organic Synthesis. 3 credits, 3 contact hours.**
Organic Synthesis is widely used in the production of organic materials and pharmaceutical drugs. The course introduces modern synthetic methods to the graduate students of NJIT. The first part of the course teaches organic reactions categorized by their roles in synthesis. Topics include substitution and addition of carbon nucleophiles, functional group conversion, oxidation, reduction, concerted cycloadditions, aromatic substitutions, and organometallic catalysis. The second part of the course teaches general strategies to develop synthetic plans, special considerations for difficult synthetic targets, and examples of natural product synthesis.

**CHEM 719. Drug Delivery Systems. 3 credits, 3 contact hours.**
Prerequisites: Strong background in organic chemistry This course emphasizes the importance of effective drug delivery to achieve specific therapeutic outcomes. Students learn current trends in research on the design of drug delivery systems to release drug content in a controllable and targeted manner.

**CHEM 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisite: permission from the graduate advisor (not thesis advisor) in chemistry, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHEM 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHEM 727. Independent Study III. 3 credits, 3 contact hours.**
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHEM 734. Thermochemical Kinetics-Detailed Mechanistic Modeling. 3 credits, 3 contact hours.**
Prerequisite: graduate level course in either kinetics or reactor design, or permission of instructor. Quantitative estimation of thermochemical data and chemical reactions in the vapor phase, and to some extent in the liquid phase; theories of transition state, RRKM, and Quantum RRK; and detailed chemical modeling concepts for reactor design. Applied computer project is required.

**CHEM 735. Combustion. 3 credits, 3 contact hours.**
Prerequisite: thermodynamics and kinetics or equivalent, or permission of instructor. Thermodynamic properties of stable molecules and free radical species in combustion and oxidation of aliphatic hydrocarbons; reactions occurring in high temperature combustion systems; and related kinetic principles.

**CHEM 737. Applications of Computational Chemistry and Molecular Modeling. 3 credits, 3 contact hours.**
Students are exposed to hands-on applications and fundamental aspects of computational chemistry and molecular modeling in organic, inorganic, bio- and physical chemistry. The course provides methods to determine the thermochemistry of a reaction, and strength (energy)of interactions by organic drug-like molecules with proteins. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium ratios in chemical environments.

**CHEM 748. Nanomaterials. 3 credits, 3 contact hours.**
New feature of the 700 level course will be hands-on small projects carried out by groups of two students in Professor Iqbal's laboratories during the second half of the semester. The projects will be selected from the topics covered in the course. A second feature will involve a lecture on a specialized nanomaterial topic given by an invited outside lecturer. This 3 credit interdisciplinary course is designed to teach and provide hands-on project experience to M.S. and Ph.D. graduate students in chemistry, physics/materials science, and chemical/biomedical/electrical engineering on the fundamentals, synthesis, characterization and applications of nanomaterials. 75% of the course will comprise of lectures-one or two of which will be given by invited outside lecturers. 25% of the course will involve small projects based on the syllabus and conducted in the research laboratories of the instructor.

**CHEM 764. Advanced Analytical Chemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate General and Analytical Chemistry. The principles of chemical analysis as they apply to chromatography, electrochemistry, and spectroscopy. Sampling considerations, separations, and sample preparation steps. This course is a useful adjunct to CHEM 661, where these analytical techniques are considered in a more practical way.

**CHEM 777. Principles of Medicinal Chemistry. 3 credits, 3 contact hours.**
Teaches about drug design, and the molecular mechanisms by which drugs act in the body. Covers pharmacodynamics, pharmacokinetics, molecular targets used by drugs, the interaction of a drug with a target, and the consequences of this interaction. Covers strategies used in discovering and designing new drugs, and surveys the "tools of the trade" involved, e.g., QSAR, combichem and computer aided design. Covers special topics like chlorinergics, analgesics, opiates, antibacterials, antivirals, and antiulcer agents.

**CHEM 790. Doctoral Dissertation. 0 credits, 0 contact hours.**

**CHEM 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**

**CHEM 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**

**CHEM 790C. Doctoral Dissertation. 6 credits, 3 contact hours.**

**CHEM 790D. Doctoral Dissertation. 9 credits, 3 contact hours.**

**CHEM 790E. Doctoral Dissertation. 12 credits, 3 contact hours.**

**CHEM 790F. Doctoral Dissertation. 15 credits, 15 contact hours.**

**CHEM 790G. Doctoral Dissertation. 18 credits, 18 contact hours.**

**CHEM 791. Graduate Seminar. 0 credits, 0 contact hours.**
Required of all chemistry graduate students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

**CHEM 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**CHEM 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**CHEM 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.**

**ENG 502. English for International Graduate Students. 3 credits, 3 contact hours.**
Practice in writing to improve sentence structure, grammar, vocabulary, and organization. For technical writing, see ENG 541. Level: High Intermediate.

**ENG 503. Advanced English for International Teaching Assistants. 3 credits, 3 contact hours.**
Practice in public speaking for international TAS and other international students who want to improve their oral presentation skills. Also covers teaching techniques and pronunciation. Level: Advanced.

**ENG 505. Advanced Spoken English for International Graduate Students. 3 credits, 3 contact hours.**
Designed to improve English pronunciation; accent reduction. Level: Advanced.

**ENG 507. Advanced Conversation and American Culture. 3 credits, 3 contact hours.**
Practice in conversation in English at an advanced level. The goal is to help students gain the cultural knowledge and speaking skills to increase participation in American life. Level: Advanced.

**ENG 521. Technical Written and Oral Communication. 3 credits, 3 contact hours.**
Develops skill in oral and written technical communication on a professional level. Three areas are emphasized: 1) analyzing professional and technical communication situations; 2) achieving clear, effective oral and written communication; and 3) developing awareness of variations in professional communication across cultures. For some assignments, students will work on projects from courses in their own fields. The approach is practical; course format is that of a workshop. Non-native speakers of English may take this course.

**EPS 601. Research Methods for Environment and Sustainability Policy. 3 credits, 3 contact hours.**
Introduces the research methods necessary to conduct studies in environmental and sustainability policy. Topics covered include literature review, problem identification, hypothesis testing, and quantitative methods of data analysis and problem solving. Students are required to implement and present their independently designed projects.

**EPS 602. Research Analysis for the Social and Policy Sciences. 3 credits, 3 contact hours.**
Prerequisite: EPS 601. Distribution of social, political, economic and health-related data in both samples and populations using a general linear model with residuals. Test hypotheses using both the Fisher and Neyman-Pearson criteria. Use of software such as SPSS, Microsoft Excel and Resampling Stats. to develop and test models using correlation, regression and ANOV techniques.

**EPS 609. Environmental Risk Assessment. 3 credits, 3 contact hours.**
Methodology to assess the social and economic risks to present-day environmental resources of air and water; cost-benefit and trade-off analysis; technical characteristics of materials such as half-life, decomposition rates, and temperature sensitivity; and probabilities of various environmental situations.

**EPS 612. Introduction to Environmental Policy Studies. 3 credits, 3 contact hours.**
Introduction to six areas essential to a comprehensive understanding of environmental policy: concept of environmental policy; tools (law, economics, planning, science, engineering, ethics) for environmental policy; the U.S. perspective (NEPA, clean air and water acts, CERCLA); the international perspective (Club of Rome models, 1972 UNEP, 1992 Rio); industrial perspective (pollution prevention/life cycle engineering, privatization); and the local perspective (New Jersey DEP, NGOs, local industry, shoreline.) Same as MIP 612.

**EPS 613. Environmental History and Policy. 3 credits, 3 contact hours.**
Explores the dialogue between humanity and the environment in the United States, as well as its global implications. Surveys fundamental themes of history and policy from an environmental perspective: colonial development, independence, western expansion, industrialization, urbanization, and the rise of a consumer society. Gives special attention to the emergence of an environmental perspective: wilderness appreciation, the conservation movement, public health, the rise of the environmental movement since the 1960s, environmental science, and the legislative and regulatory process.

**EPS 614. Environmental Economics and Management. 3 credits, 3 contact hours.**
Overviews the complex and dynamic interactions between the economy and the environment from biological, economic, and institutional perspectives and investigates various strategies for resolving conflicts in resource management and pollution control. Topics include the basic principles of risk assessment, cost benefit analysis, and cost-effectiveness analysis in environment management and assessment of contemporary environment politics in air and water pollution control and waste and toxics management.

**EPS 622. Sustainable Politics and Policy. 3 credits, 3 contact hours.**
Identifies the origins of the concept of sustainability development and institutional efforts to implement strategies at various geopolitical scales: international, national, regional, and local. The course introduces tools to measure progress toward sustainability through the use of metrics such as ecological footprint analysis and life-cycle analysis. Other topics include steady-state economics, sustainable systems of production and consumption, and sustainability transitions.

**EPS 638. Physical Geography. 3 credits, 3 contact hours.**
Understanding the interaction between humans and the physical environment is important to the formulation of sound environmental policy. The course examines processes that shape the physical environment, the influence of human activities on these processes and the physical environment, and the application of this information to solving environmental problems.

**EPS 644. The Rhetoric of Environmental Policy. 3 credits, 3 contact hours.**
Introduces students to the major types of rhetorical analysis as well as assures that students can analyze and write technology policy that is informed by core rhetorical principles of that analysis.

**EPS 651. Introduction to Urban and Environmental Health. 3 credits, 3 contact hours.**
Health problems associated with the social and psychological factors found in urban areas and health problems stemming from contamination of air, water, food, the work place and other special environments. Policies required to promote healthful living behavior and those required to regulate negative externalities.

**EPS 660. Ethics and Environmental Policy. 3 credits, 3 contact hours.**
Contemporary environmental problems from the perspective of ethics or moral philosophy. Is there a moral obligation to preserve or protect the natural environment? What are the ethical presumptions and values underlying environmental policy? Are traditional theories of moral philosophy applicable to contemporary environmental problems, or is a new conception of the relationship between humanity and nature needed?.

**EPS 698. ST:. 3 credits, 3 contact hours.**
Course considers advanced topics of special or current interest related to environmental and sustainability policy.

**EPS 699. ST:. 3 credits, 3 contact hours.**
Course considers advanced topics of special or current interest related to environmental and sustainability policy.

**EPS 700. Master'S Project. 0 credits, 0 contact hours.**

**EPS 700B. Master'S Project. 3 credits, 3 contact hours.**

**EPS 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the master's degree, advisor's and departmental approval. Projects involving fieldwork, experimental, or theoretical investigation carried out under the supervision of a designated member of the departmental faculty. The completed thesis should be of a quality as to warrant publication, in whole or in part, in a professional journal. A minimum of 3 credits per semester is required until completion.

**EPS 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Restriction: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**EPS 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Restriction: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**EPS 702. Special Topics. 3 credits, 3 contact hours.**
Restriction: Approval of graduate advisor in Environmental Science. Topics of current interest in the field of environmental policy. Doctoral level course.

**EPS 712. Advanced Studies in Environmental and Sustainability Policy. 3 credits, 3 contact hours.**
Evaluates strategies to reduce energy and material throughput including eco-efficiency relocalization of production and consumption, and green consumerism. Also considered are debates surrounding innovative policies to foster work-time reduction, to develop alternative measures of well-being, and to include societal values shifts.

**EPS 714. Environmental and Natural Resources Economics. 3 credits, 3 contact hours.**
Examines environmental regulation of firms and natural resource use with emphasis on the theoretical foundations required for public policy. Students focus primarily on the application of economic tools to improve environmental quality.

**EPS 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: matriculation for the master's degree, advisor's and departmental approval. Projects not within the scope of existing courses are carried out under the supervision of a designated member of the departmental faculty.

**EPS 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: matriculation for the master's degree, advisor's and departmental approval. Projects not within the scope of existing courses are carried out under the supervision of a designated member of the departmental faculty.

**EVSC 591. Graduate Work Experience. 3 credits, 3 contact hours.**

**EVSC 592. Graduate Work Experience. 3 credits, 3 contact hours.**
Restriction: permission of the associate chairperson for environmental science and the Division of Career Development Services. Provides on-the-job reinforcement of environmental science assignments. Projects are developed by the co-op office in consultation with the associate chairperson for environmental science. Cannot be used for degree credit.

**EVSC 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisite: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**EVSC 600. Environmental Science Seminar. 0 credits, 3 contact hours.**
Restriction: graduate standing. Current environmental topics of interest to the environmental professional are presented. Required every semester for environmental science graduate students receiving departmental or research-based awards and for all doctoral students.

**EVSC 602. Special Topics in Environmental Science I. 3 credits, 3 contact hours.**
Restriction: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

**EVSC 603. Hazardous Waste Operations and Emergency Response. 3 credits, 3 contact hours.**
Explores the safe operation of hazardous waste sites as well as emergency responses to hazardous releases. Overview of OSHA regulations and NIOSH standards concerning toxicological hazards and medical surveillance requirements. Emphasis on recognition and monitoring of site hazards. A written health and safety plan, and participation in a group problem involving a simulated hazardous site entry using actual protective equipment is required. Course satisfies the regulatory compliance mandates to meet 29 CFR 1910.120 for OSHA, with certification valid for one year.

**EVSC 610. Environmental Chemical Science. 3 credits, 3 contact hours.**
Restriction: graduate standing. Principles of physical, inorganic and organic chemistry are applied to understanding the origins of environmental pollutants, their transport, distribution and decomposition pathways.

**EVSC 611. Hazardous Waste Management. 3 credits, 3 contact hours.**
Restriction: graduate standing. An overview of hazardous waste management; case histories; legislation and regulations; treatment, disposal and cleanup technologies; sampling and analysis methodology; persistence and fate in the environment; emergency response procedures.

**EVSC 612. Environmental Analysis. 3 credits, 4 contact hours.**
Restriction: graduate standing. The analysis of environmental samples is studied from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis, and data treatment.

**EVSC 613. Environmental Problem Solving. 3 credits, 3 contact hours.**
Restriction: graduate standing. This course is designed to study solutions for current environmental problems. Students are asked to respond to an imaginary Request for Proposal (RFP) in writing and before a team of technical experts at an oral presentation. Solutions proposed in student RFPs must reflect knowledge of environmental science and technology in current use.

**EVSC 614. Quantitative Environmental Risk Assessment. 3 credits, 3 contact hours.**
Restriction: graduate standing. Applications ofquantitative risk assessment concepts to the management of environmental problems.

**EVSC 615. Global Environmental Problems. 3 credits, 3 contact hours.**
Restriction: graduate standing. With an understanding that environmental problems are not restricted by geographical boundaries, relationships of the earth's temperature balance, global air circulation patterns, global energy needs, and control and remediation technologies are studied.

**EVSC 616. Toxicology for Engineers and Scientists. 3 credits, 3 contact hours.**
Restriction: graduate standing. The general principles of toxicology are presented and applied to the assessment of acute, subacute and chronic effects of hazardous and toxic chemicals. Qualitative and quantitative measures of toxicity and testing protocols are addressed. The role of toxicology in risk assessment and risk management is discussed.

**EVSC 617. Mass Spectrometry and Interpretation of Mass Spectra. 3 credits, 3 contact hours.**
Prerequisite: CHEM 125 and CHEM 126 or equivalent. Historical background, fundamentals and mechanics of operation for components incorporated into modern Mass Spectrometers: vacuum system, ion sources, mass filter, ion detection, plus computer operation and data collection. Explanation and interpretation of mass spectra and fragmentation patterns are a fundamental theme throughout the course. Lecture material includes principles of operation and appropriate applications for modern types of mass spectrometers: magnetic sector, quadrupole, time of flight, ion trap, FT-ICR. Theory and applications of electron impact, chemical, electrospray, and other ionization techniques including atmospheric sampling are covered. High resolution analysis using magnetic sector and FT - ion cyclotron instruments. Analytical applications in environmental, petroleum and biochemical analysis and applications and coupling of mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

**EVSC 621. Ecological Risk Assessment. 3 credits, 3 contact hours.**

**EVSC 622. Bioremediation. 3 credits, 3 contact hours.**

**EVSC 623. Environmental Health. 3 credits, 3 contact hours.**

**EVSC 624. Environmental Analysis Methods and Laboratory. 3 credits, 4 contact hours.**
Basic theory, methods, instruments, and data interpretation for chemical analysis of environmental samples are described in lectures and used in the laboratory; sampling; sample preparation; quality assurance, chain of custody. Instrument methods and uses include: UV-VIS, FTIR, AA, HPLC, GC, Ion Chromatography, and Mass Spectrometry as applied to environmental samples.

**EVSC 625. Social Dimensions of Risk. 3 credits, 3 contact hours.**
Low-probability/high consequence events involving terrorism, food safety, and extreme weather offer ample evidence the prevalent approaches of economics and statistics are not able to deal with the complex ways that risk permeates modern societies. This course treats risk analysis as a broad interdisciplinary activity and draws on the full range of the social sciences to explore the multifaceted way that risk infuses itself into the fabric of contemporary affairs.

**EVSC 626. Hydrogeology. 3 credits, 3 contact hours.**
This course covers the principles of ground water flow, advanced water cycle properties, aquifer flow and aquifer recharge. Contaminant migration and remediation methods are discussed. Basic groundwater chemistry and quality is covered.

**EVSC 627. Environmental Microbiology. 3 credits, 3 contact hours.**
Prerequisite: R120 101, R120 102, (General Biology I and II) or permission of instructor. This course offers an overview of 1) basic microbiology: biochemical principles, cell structure organization, microbial nutrition and growth, 2) the important microbes involved in environmental microbiology and address the environments where they are found, and 3) how they are detected and monitored, and their effects on humans, and the environment. Traditional lectures and exams are supplemented with discussions of current research articles.

**EVSC 700. Masters Project. 0 credits, 0 contact hours.**
Prerequisite: graduate standing and approval of the graduate advisor in environmental science. Written report requiring experimental or theoretical research, or an extensive literature analysis. Registration must be approved by an advisor. Students must continue to register for 3 credits each semester until completion and a written report is accepted. Only a total of 3 credits will count toward the degree.

**EVSC 700B. Masters Project. 3 credits, 3 contact hours.**
Restriction: graduate standing and approval of the graduate advisor in environmental science. Written report requiring experimental or theoretical research, or an extensive literature analysis. Registration must be approved by an advisor. Students must continue to register for 3 credits each semester until completion and a written report is accepted. Only a total of 3 credits will count toward the degree.

**EVSC 701. Masters Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**EVSC 701B. Masters Thesis. 3 credits, 3 contact hours.**
Restriction: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**EVSC 701C. Masters Thesis. 6 credits, 3 contact hours.**
Restriction: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**EVSC 702. Special Topics in Environmental Science II. 3 credits, 3 contact hours.**
Restriction: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

**EVSC 711. Advanced Environmental Analysis. 3 credits, 3 contact hours.**
Prerequisite: EVSC 612 or equivalent. Analysis of complex environmental samples is studied, from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis and data handling. Collection and analysis of samples from air, water, soil, and biological systems will be discussed. Emphasis on the study of current literature.

**EVSC 712. Hazardous Substance Management. 3 credits, 3 contact hours.**
Restriction: Graduate standing. The course material comprises an overview of hazardous materials and hazardous waste management and control in an industrial setting. The course examines the technical approaches utilized in the control, remediation, and prevention of hazardous substances and waste. It also includes the major technical elements of federal regulations that govern operations involving the handling of hazardous materials.

**EVSC 715. Energy and Sustainability. 3 credits, 3 contact hours.**
This course comprises an interdisciplinary review of energy fundamentals including the basic principles necessary to understand energy systems. The technological and engineered systems for processing and using different energy non-renewable and renewable sources. The social and environmental consequences of energy production, distribution, and use, including a comparison of socioeconomic models of global energy applications.

**EVSC 717. Mass Spectrometry and Mass Spectral Interpretation. 3 credits, 3 contact hours.**
Prerequisite: CHEM 125 and CHEM 126 or equivalent. CHEM 717 and EVSC 617 are comprised of CHEM 717 and EVSC 617 plus a research project: Research projects usually comprise experimental and mass spectrometry interpretation studies. These can be performed at NJIT or in the students corporate mass spectrometry facility. Projects may also include theory, data interpretation or literature reviews pertinent to a current active area in mass spectrometry research. Projects should be approved or in consult with the instructors.

**EVSC 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**EVSC 726. Independent Study II. 3 credits, 3 contact hours.**
See description for EVSC 725.

**EVSC 790. Doctoral Dissertation. 0 credits, 0 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790F. Doctoral Dissertation. 15 credits, 15 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 791. Graduate Seminar. 0 credits, 1 contact hour.**
Required of all environmental science graduate students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

**EVSC 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**EVSC 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**HIST 620. City and Disease in History. 3 credits, 3 contact hours.**
Explores the dynamic interaction between the growth of cities and changes in the experience and location of disease. Presumes the intertwining of these two historical developments in the birth of a distinctly urban identity, one predicated on the notion that the modern city is somehow inherently diseased. Focuses on the New York and Newark metropolitan areas in the nineteenth and twentieth centuries. Among the topics considered are epidemic outbreaks, quarantines, the technology and organization of sanitation and hygiene, the professional formation of public, industrial and occupational medicine, and medical and popular responses to immigration.

**HIST 622. Culture and Science in the History of American Medicine. 3 credits, 3 contact hours.**
Provides an overview of American medical history and a familiarity with the theoretical and practical ramifications of different approaches to the complex relationships between medicine, science, and culture. Topics include: the extent to which medicine is or has been scientific; reasons why science has been considered so important to medicine's professional culture; and the degree to which medicine's professional culture has been shaped by science as well as other factors, such as economic and political self-interest, technology, class, race, gender, and other kinds of cultural values.

**HIST 624. Technology, Environment and Medicine in World History, 1500-1900. 3 credits, 3 contact hours.**
Examines the interrelationship between the emerging modern world system and changes in technology, environment, and medicine, with particular emphasis on European overseas expansion and its impact in non-Western regions.

**HIST 626. Social History of American Medicine Since 1800. 3 credits, 3 contact hours.**
Topics include the practices of 19th-century regular medicine; the relation between medical concepts and mainstream social thought; the treatment of women's health; antebellum alternative healers and alternative politics; the triumphs of late 19th- and early 20th-century medical therapeutics; the emergence of medicine as big business; medicine and racism; the emergence of nursing as a profession; modern medicine in an international perspective; New Age healing; the AIDS crisis and AIDS activism; and contemporary debates on the future of health care in the United States.

**HIST 628. Gender, Science and Technology in the Modern World. 3 credits, 3 contact hours.**
Introduction to a wide range of political and cultural analyses of science and technology, with an emphasis on recent feminist critiques of science. Explores the questions of scientific neutrality; the gendering of scientific knowledge; the relationship between science, technology, and capitalism; the role of science in international politics; and why science has not freed women.

**HIST 630. History of the Body in Modern Western Culture. 3 credits, 3 contact hours.**
Considers medical or scientific history primarily in terms of implications for bodily experience in everyday life. Begins with grand narratives of historical shifts in bodily perceptions and practices, and proceeds to more focused narratives of changing bodily experience, engaging key distinctions between genders, classes, and species as well as perceptions of pain and internal bodily structure. Materials will be drawn from early modern and modern Europe, as well as more recent bodily experience in the United States.

**HIST 632. Technology, Culture and History. 3 credits, 3 contact hours.**
Treats the relationship between technology and cultural values in a variety of historical and geographical settings, from early modern Japan to twentieth-century America. Examines the ways in which cultural ideals, conceptions, and preconceptions serve to influence the rate and manner of technological change, as well as the ways in which technology affects social and cultural life.

**HIST 634. Environmental History of North America. 3 credits, 3 contact hours.**
Explores the dialogue between humankind and the environment in North America over the course of the last four centuries. Examines the latest and most interesting work done in the new field of environmental history to see what such a perspective has to offer.

**HIST 635. History of Technology, Environment and Medicine: Theory and Method. 3 credits, 3 contact hours.**
A team-taught course which surveys the methods employed in the three fields. Explores the interdisciplinary nature of each field, and the value of interdisciplinary scholarship.

**HIST 637. Global Environmental History. 3 credits, 3 contact hours.**
This course takes a global view of human interaction with the natural world, mixing broad themes such as colonialism and industrialization with detailed case studies in an effort ot understand the ways that people and the environment have mutually shaped one another. Because environmental change often transcends national boundaries, this course places important subjects in environmental history such as disease, agriculture, pollution, and environmentalism into a global and transnational context.

**HIST 638. Social History of Communication. 3 credits, 3 contact hours.**
Treats selected themes in the history of communication in different social and cultural contexts, from the ancient world to the twentieth century. Topics include: orality, proto-literacy, and literacy in ancient and medieval cultures; printing and the development of print culture in the early modern world; the ?communication revolution? of the late 19th and early 20th centuries; and historiographical debates over the role of communication technologies in society.

**HIST 640. The Urban Environment. 3 credits, 0 contact hours.**
Examines the role of the economy, culture, and technology in shaping the urban environment. Makes extensive use of Newark and the New York metropolitan area, including field observations and local research. In addition to other topics, explores in detail spatial relationships, the role of transportation, and the development of suburbia.

**HIST 642. The History of Health and International Development. 3 credits, 3 contact hours.**
This course examines the history of western efforts to promote health and nutrition in the 'developing world" from the beginnings of tropical medicine. We will trace this history through its many permutations from the establishment of colonial health services to the development of the Global Programme on AIDS. In doing so, we will explore the various economic and political interests and underlying cultural assumptions that have shaped the development of ideas and practices associated with international health and development.

**HIST 644. War, Technology and Society, 1500-1914. 3 credits, 3 contact hours.**
Examines key themes in the interrelationship between warfare, technology and society from the beginnings of modern warfare until World War I. Primary emphasis placed on the historical connections between violent conflict, the technical means by which it is carried out, and the socio-political environment within which wars take place. The effect of technology upon war and considerations of the effect of war on technological change and development. Samples the rich tradition of thought and ideas produced by philosophers and theorists on these themes.

**HIST 645. American Legal History to 1860. 3 credits, 3 contact hours.**
Readings and discussion on the legacy of common law after the Revolution; the emergence of legal instrumentalism; and the evolution of tort, contract, and damages in the context of industrialism and economic growth.

**HIST 650. History of American Conservatism. 3 credits, 3 contact hours.**
This course examines postwar American conservatism through classic works and contemporary studies. Topics include the rise of conservatism, groups under the conservative umbrella, and the rise of the right as related to key events in postwar history (Cold War, McCarthysim, the '60s, the suburbs and urban change). Course interrogates postwar conservatism with respect to American political and intellectual history and in relation to histories of gender, race, class, sexuality, place and religion.

**HIST 652. Topics in the History of Technology. 3 credits, 3 contact hours.**
Selected topics in the history of technology.

**HIST 653. Topics in European Intellectual and Cultural History. 3 credits, 3 contact hours.**
Examination of issues and methods in European intellectual and cultural history, with a consideration of some leading problems in the field.

**HIST 654. Topics in American Intellectual and Cultural History. 3 credits, 3 contact hours.**
Examination of issues and methods in American intellectual and cultural history, with a consideration of some leading problems in the field.

**HIST 655. Topics in American Urban and Ethnic History. 3 credits, 3 contact hours.**
Examination of issues and methods in American urban and ethnic history, with a consideration of some leading problems in the field.

**HIST 656. Topics in the History of Health. 3 credits, 3 contact hours.**
Selected topics in the history of Health.

**HIST 657. Topics in Environmental History. 3 credits, 3 contact hours.**
Selected topics in environmental history.

**HIST 658. Topics in American Legal History. 3 credits, 3 contact hours.**
Readings and discussion on the growth of legal formalism, the evolution of substantive due process, changes in legal education and the legal profession, and the evolution of private law.

**HIST 660. The Enlightenment in Britain. 3 credits, 3 contact hours.**
The 18th century was the age of the Enlightenment. Great Britain became a unified polity and the most powerful imperial force in the world. We examine the Enlightenment in Britain against the backdrop of war and empire, imperial consumer culture, the growth and significance of sociability and politeness, representations of gender, the writing of cultural history, social uses of science/technology, print culture, and competition among varying notions of ethnic identity.

**HIST 661. Problems and Readings in European History since 1850. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in European history since 1850.

**HIST 662. Prob. and Read: Hist/US Foreighn Policy and Diplomacy. 3 credits, 3 contact hours.**
Examination of issues and methods in American diplomatic history, with a consideration of some leading problems in the field.

**HIST 663. Problems and Readings in American History, 1492-1789. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history rom 1492 to 1789.

**HIST 664. Problems and Readings in American History, 1789-1865. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history from 1789 to 1865.

**HIST 665. Problems and Readings in American History, 1865-1914. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history from 1865 to 1914.

**HIST 666. Problems and Readings in American History, 1890-1945. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literatue in American history from 1890 to 1945.

**HIST 667. Problems and Readings in American History, 1945-Present. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history since 1945.

**HIST 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

**HIST 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Restriction: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

**HIST 701C. Master'S Thesis. 6 credits, 6 contact hours.**
Restriction: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

**HIST 702. Master's Essay. 3 credits, 3 contact hours.**
For those who don't write a 6 credit thesis, the 3 credit Master's Essay caps the M.A./M.A.T. A substantial work done with an advisor, may be: 1. Interpretive historical essay based on primary source research. 2. Narrative history based on primary source research. Prereq: R510:504, R510:505, or R510:506. 3. Historiographical essay. 4. Content-focused curriculum design, either a course or significant portion thereof. 5. Design for an historical museum exhibition/other work in public history. Prereq: R510:565.

**HIST 725. Independent Study. 3 credits, 1 contact hour.**
Restriction: permission of graduate history advisor and course instructor.

**HIST 726. Independent Study. 3 credits, 1 contact hour.**
Restriction: permission of graduate history advisor and course instructor.

**HIST 727. Independent Study. 3 credits, 3 contact hours.**
Restriction: permission of graduate history advisor and course instructor.

**HIST 791. Seminar in History of Technology, Environment and Medicine. 0 credits, 0 contact hours.**
Faculty, students and invited speakers present and discuss current topics of research in history, technology and medicine.

**MATH 545. Introductory Mathematical Analysis. 3 credits, 3 contact hours.**
Prerequisite: MATH 211 or MATH 213, and departmental approval. Rigorous treatment of the calculus of real-valued functions of one real variable: the real number system, epsilon-delta theory of limit, continuity, derivative, and the Riemann integral. The fundamental theory of calculus. Series and sequences including Taylor series and uniform convergence. The inverse and implicit function theorems.

**MATH 546. Advanced Calculus. 3 credits, 3 contact hours.**
Prerequisite: MATH 545 or MATH 480. Rigorous treatment of the calculus of real-valued functions of several real variables: the geometry and algebra of n-dimensional Euclidean space, limit, continuity, derivative, and the Riemann integral of functions of several variables, the inverse and implicit function theorems, series, including Taylor series, optimization problems, integration on curves and surfaces, the divergence and related theorems.

**MATH 573. Intermediate Differential Equations. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 337, or departmental approval. Methods and applications for systems of ordinary differential equations: existence and uniqueness for solutions of ODEs, linear systems, stability analysis, phase plane and geometrical methods, Sturm-Liouville eigenvalue problems.

**MATH 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services. Cooperative education/internship providing on-the-job complement to academic programs in mathematics. Work assignments and projects are developed by the Co-op Office in consultation with the Department of Mathematical Sciences.

**MATH 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

**MATH 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

**MATH 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**MATH 599. Teaching in Mathematics. 3 credits, 3 contact hours.**
Required of all master's and doctoral students in Mathematical Sciences who are receiving departmental or research-based awards. Provides students with the skills needed to communicate effectively and to perform their teaching and related duties. Students are exposed to strategies and methods for communicating and for teaching undergraduate mathematics, and they are required to practice and demonstrate these techniques. Not counted for degree credit.

**MATH 604. Mathematical Finance. 3 credits, 3 contact hours.**
Prerequisites: FIN 641 Derivatives, MATH 605 Stochastic Calculus, or permission of the instructor. This course will explore the structure, analysis, and use of financial derivative instruments deployed in investment strategies and portfolio risk management. Topics include continuous time dynamics, arbitrage pricing, martingale methods, and valuation of European, American, and path dependent derivatives.

**MATH 605. Stochastic Calculus. 3 credits, 3 contact hours.**
This course provides an introduction to stochastic calculus. Topics include conditioning, Poisson processes, martingales, Brownian motion, Ito integrals, Ito's formula, stochastic differential equations, Feynman-Kac formula, Girsanov's theorem, and the martingale representation theorem. Financial applications include pricing, hedging, and interest rate models.

**MATH 606. Term Structure Models. 3 credits, 3 contact hours.**
Prerequisites: MATH 605, or permission of the instructor. Corequisite: MATH 608. This course will develop the mathematical structure of interest rate models and explore the considerable hurdles involved in practical implementation. Short rate models, single and multifactor; the Heath-Jarrow-Morton framework; and modern Libor market models will be examined.

**MATH 607. Credit Risk Models. 3 credits, 3 contact hours.**
Prerequisites: MATH 604, MATH 605, MATH 606 or permission of the instructor. This course explores mathematical models and methods for credit risk measurement and rating. The nature of credit risk is reviewed through examination of credit instruments, including credit default swaps, collateralized debt obligations, and basket credit derivatives. These instruments, through which risk exposure opportunities and hedging possibilities are created and managed, are explored with respect to dynamics and valuation techniques, applying PDE methods and stochastic processes.

**MATH 608. Partial Differential Equations for Finance. 3 credits, 3 contact hours.**
This course presents the subject of partial differential equations (PDE's) with a strong emphasis on the PDE's arising in the study of stochastic processes and finance. The focus is on analytical and numerical methods for obtaining solutions in a form useful for solving problems in financial engineering. Topics include modeling with PDE's, classification of PDE's, analytical and numerical methods for PDE's and application to finance.

**MATH 609. Projects in Mathematical and Computational Finance. 3 credits, 3 contact hours.**
Prerequisites: MATH 604 Mathematical Finance, MATH 605 Stochastic Calculus, MATH 606 Term Structure Models, or permission of the instructor. This project course requires students to demonstrate attained mastery of the material studies in the prerequisite courses. Projects also extend students? knowledge of specific areas beyond that covered in earlier courses into areas such as particle filtering or optimization techniques for term structure model calibration. The aim is to broaden the students? classroom focus to the more unconstrained, open ended and less well defined contexts that are frequently encountered in practice.

**MATH 610. Graduate Research Methods. 3 credits, 0 contact hours.**
Prerequisite: MATH 614, MATH 671, and MATH 690. Acquaints second-year graduate students with the techniques and vocabulary of a field in applied mathematics. Each student contacts a designated faculty member and is given several basic papers or books on a research topic of current interest. The student prepares two lectures on his/her topic to be given at the end of the semester. A sample list of active fields of research includes acoustics, electromagnetic theory, elasticity, fluid dynamics, combustion, and mathematical biology.

**MATH 611. Numerical Methods for Computation. 3 credits, 3 contact hours.**
This course provides a practical introduction to numerical methods. Numerical solution of linear systems. Interpolation and quadrature. Interative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial and boundary value problems for ODE's. Introduction to numerical solution of PDE's. Applicatons drawn from science, engineering, and finance.

**MATH 613. Advanced Applied Mathematics I: Modeling. 3 credits, 3 contact hours.**
Prerequisites: MATH 331 and MATH 337, or departmental approval. Concepts and strategies of mathematical modeling are developed by investigation of case studies in a selection of areas. Consistency of a model, nondimensionalization and scaling, regular and singular effects are discussed. Possible topics include continuum mechanics (heat and mass transfer, fluid dynamics, elasticity), vibrating strings, population dynamics, traffic flow, and the Sommerfeld problem.

**MATH 614. Numerical Methods I. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 337, MATH 340, and proficiency in a computer language (FORTRAN, C, or C++), or departmental approval. Theory and techniques of scientific computation, with more emphasis on accuracy and rigor than MATH 611. Machine arithmetic. Numerical solution of a linear system and pivoting. Interpolation and quadrature. Iterative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial- and boundary-value problems for systems of ODEs. Applications. The class includes examples requiring student use of a computer.

**MATH 615. Approaches to Quantitative Analysis in the Life Sciences. 3 credits, 3 contact hours.**
A graduate seminar-style course based around case studies of common data analytic methods used in the life sciences. The case studies are designed to help students who are interested in applications of statistical thinking to biological sciences appreciate the scope of quantitative methods, their underlying concepts, assumptions and limitations. While the mathematics of specific methods are not covered, students of the course will get an understanding of the diverse approaches to statistical inference in the life sciences.

**MATH 630. Linear Algebra and Applications. 3 credits, 3 contact hours.**
Prerequisites: (This course is not intended for students in the Master's in Applied Mathematics program or in the doctoral program in Mathematical Sciences.) Math 211 or Math 213, and Math 222. Development of the concepts needed to study applications of linear algebra and matrix theory to science and engineering. Topics include linear systems of equations, matrix algebra, orthogonality, eigenvalues and eigenvectors, diagonalization, and matrix decomposition.

**MATH 631. Linear Algebra. 3 credits, 3 contact hours.**
Prerequisites: MATH 222 and MATH 337, or departmental approval. Similar in aim and content to MATH 630 but with more emphasis on mathematical rigor. Linear systems of equations, matrix algebra, linear spaces, orthogonality, eigenvalues and eigenvectors, diagonalization, and matrix decomposition. Applications.

**MATH 635. Analytical Computational Neuroscience. 3 credits, 0 contact hours.**
Prerequisites: MATH 211 or 213, MATH 337, and CS 113 or MATH 240, or departmental approval. This course will provide an intermediate-level mathematical and computational modeling background for small neuronal systems. Models of biophysical mechanisms of single and small networks of neurons are discussed. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, single- and multi-compartmental modeling, synaptic transmission, mathematical treatment of 2-cell inhibitory or excitatory networks. In this course, the students will be required to build computer models of neurons and networks and analyze these models using geometric singular-perturbation analysis and dynamical systems techniques.

**MATH 636. Systems Computational Neuroscience. 3 credits, 3 contact hours.**
Prerequisites: MATH 635. This course covers mathematical and computational modeling of neuronal networks. Topics covered include central pattern generators, models of visual processes, models of learning and memory, neural coding and mathematics of neural networks, models of oscillations in sensory, thalamic and thalamo-cortical networks, neuronal wave propagation.

**MATH 637. Foundations of Mathematical Biology. 3 credits, 3 contact hours.**
Prerequisites: MATH 222 and MATH 337, or departmental approval. This course provides an introduction to the use of mathematical techniques applied to solve problems in biology. Models discussed fall into 3 categories: discrete, continuous, and spatially distributed. Biological topics discussed range from the subcellular molecular systems and cellular behavior to physiological problems, population biology and developmental biology.

**MATH 639. Mathematical Modeling II. 3 credits, 3 contact hours.**
Continuation of MATH 613 (Advanced Applied Mathematics I, Modeling). Concepts and strategies of Mathematical modeling are developed by case studies in a selection of areas. Topics will be complementary to those presented in MATH 613, and include for example, the mathematical theory of elasticity and electromagnetism.

**MATH 644. Regression Analysis Methods. 3 credits, 3 contact hours.**
Prerequisite: MATH 661. Regression models and the least squares criterion. Simple and multiple linear regression. Regression diagnostics. Confidence intervals and tests of parameters, regression and analysis of variance. Variable selection and model building. Dummy variables and transformations, growth models. Other regression models such as logistic regression. Using statistical software for regression analysis.

**MATH 645. Analysis I. 3 credits, 3 contact hours.**
Prerequisite: MATH 546 or departmental approval. Review and extension of the fundamental concepts of advanced calculus: the real number system, limit, continuity, differentiation, the Riemann integral, sequences and series. Point set topology in metric spaces. Uniform convergence and its applications.

**MATH 646. Time Series Analysis. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or departmental approval. Time series models, smoothing, trend and removal of seasonality. Naive forecasting models, stationarity and ARMA models. Estimation and forecasting for ARMA models. Estimation, model selection, and forecasting of nonseasonal and seasonal ARIMA models.

**MATH 647. Time Series Analysis II. 3 credits, 3 contact hours.**
Prerequisite: MATH 646. Continuation of MATH 646. Covers methods of time series analysis useful in engineering, the sciences, economics, and modern financial analysis. Topics include spectral analysis, transfer functions, multivariate models, state space models and Kalman filtering. Selected applications from topics such as intervention analysis, neural networks, process control, financial volatility analysis.

**MATH 651. Methods of Applied Mathematics I. 3 credits, 3 contact hours.**
Prerequisite: MATH 222 or departmental approval. A survey of mathematical methods for the solution of problems in the applied sciences and engineering. Topics include: ordinary differential equations and elementary partial differential equations. Fourier series, Fourier and Laplace transforms, and eigenfunction expansions.

**MATH 654. Clinical Trials Design and Analysis. 3 credits, 3 contact hours.**
Prerequisites: MATH 665 or equivalent with Departmental approval. Statistical methods and issues in the design of clinical trials and analysis of their data. Topic include clinical trial designs for phases 1-4, randomization principle and procedures, analysis of pharmacokinetic data for bioequivalence, multi-center trials, categorical data analysis, survival analysis, longitudinal data analysis, interim analysis, estimation of sample size and power, adjustment for multiplicity, evaluation of adverse events, and regulatory overview.

**MATH 656. Complex Variables I. 3 credits, 3 contact hours.**
Prerequisite: MATH 545 or MATH 645 or departmental approval. The theory and applications of analytic functions of one complex variable: elementary properties of complex numbers, analytic functions, elementary complex functions, conformal mapping, Cauchy integral formula, maximum modulus principle, Laurent series, classification of isolated singularities, residue theorem, and applications.

**MATH 659. Survival Analysis. 3 credits, 3 contact hours.**
Prerequisites: MATH 665 or equivalent with Departmental approval. Introduction to statistical methods for modeling time-to-event data in the presence of censoring and truncation, with emphasis on applications to the health sciences. Topics include survival and hazard functions, censoring and truncation, parametric and nonparametric models for survival data, competing-risks, regression models including Cox proportional hazards model and time-dependent covariates, one and two sample tests, and use of appropriate statistical software for computations.

**MATH 660. Introduction to statistical Computing with SAS and R. 3 credits, 3 contact hours.**
Prerequisite: Basic knowledge in statistical concepts or instructor approval. This course will study SAS and R programming and emphasize the SAS and R data steps including getting data into the SAS and R environments, working and combining data using control flows, merge and subsets, etc. as well as learning to export data and to generate high resolution graphics. Several SAS and R statistical procedures or functions will also be discussed and illustrated. Finally, interactive statistical software JMP and Minitab are briefly introduced.

**MATH 661. Applied Statistics. 3 credits, 3 contact hours.**
Prerequisite: MATH 112. Role and purpose of applied statistics. Data visualization and use of statistical software used in course. Descriptive statistics, summary measures for quantitative and qualitative data, data displays. Modeling random behavior: elementary probability and some simple probability distribution models. Normal distribution. Computational statistical inference: confidence intervals and tests for means, variances, and proportions. Linear regression analysis and inference. Control charts for statistical quality control. Introduction to design of experiments and ANOVA, simple factorial design and their analysis. MATH 661 and MATH 663 cannot both be used toward degree credits at NJIT.

**MATH 662. Probability Distributions. 3 credits, 3 contact hours.**
Prerequisite: MATH 341 or MATH 333, and departmental approval. Probability, conditional probability, random variables and distributions, independence, expectation, moment generating functions, useful parametric families of distributions, transformation of random variables, order statistics, sampling distributions under normality, the central limit theorem, convergence concepts and illustrative applications.

**MATH 663. Introduction to Biostatistics. 3 credits, 3 contact hours.**
Prerequisites: Undergraduate Calculus. Introduction to statistical techniques with emphasis on applications in health related sciences. This course will be accompanied by examples from biological, medical and clinical applications. Summarizing and displaying data; basic probability and inference; Bayes' theorem and its application in diagonostic testing; estimation, confidence intervals, and hypothesis testing for means and proportions; contingency tables; regression and analysis of variance; logistic regression and survival analysis; basic epidemiologic tools; use of statistical software. Math 661 and Math 663 cannot both be used toward degree credits at NJIT.

**MATH 664. Methods for Statistical Consulting. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or departmental approval. Communicating with scientists in other disciplines. Statistical tools for consulting. Using statistical software such as JMP, SAS, and S-plus. Case studies which illustrate using statistical methodology and tools are presented by the instructor and guest speakers from academia and industry. Assignments based on case studies with use of statistical software is required.

**MATH 665. Statistical Inference. 3 credits, 3 contact hours.**
Prerequisite: MATH 662 or departmental approval. Review of sampling distributions. Data reduction principles: sufficiency and likelihood. Theory and methods of point estimation and hypothesis testing, interval estimation, nonparametric tests, introduction to linear models.

**MATH 666. Simulation for Finance. 3 credits, 3 contact hours.**
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/MATH 666.

**MATH 671. Asymptotic Methods I. 3 credits, 3 contact hours.**
Prerequisite: MATH 645 or MATH 545, and MATH 656, or departmental approval. Asymptotic sequences and series. Use of asymptotic series. Regular and singular perturbation methods. Asymptotic methods for the solution of ODEs, including: boundary layer methods and asymptotic matching, multiple scales, the method of averaging, and simple WKB theory. Asymptotic expansion of integrals, including: Watson's lemma, stationary phase, Laplace's method, and the method of steepest descent.

**MATH 672. Biomathematics I: Biological Waves and Oscillations. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 331, and MATH 337, or departmental approval. Models of wave propagation and oscillatory phenomena in nerve, muscle, and arteries: Hodgkin-Huxley theory of nerve conduction, synchronization of the cardiac pacemaker, conduction and rhythm abnormalities of the heart, excitation-contraction coupling, and calcium induced waves, wave propagation in elastic arteries, models of periodic human locomotion.

**MATH 673. Biomathematics II: Pattern Formation in Biological Systems. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 331, and MATH 337, or departmental approval. Emergence of spatial and temporal order in biological and ecological systems: Hopf and Turing bifurcation in reaction-diffusion systems, how do zebras get their stripes, patterns on snake skins and butterfly wings, spatial organization in the visual cortex, symmetry breaking in hormonal interactions, how do the ovaries count. Basic techniques of mathematics are introduced and applied to significant biological phenomena that cannot be fully understood without their use.

**MATH 675. Partial Differential Equations. 3 credits, 3 contact hours.**
Prerequisite: MATH 690 or departmental approval. A survey of the mathematical theory of partial differential equations: first-order equations, classification of second-order equations, the Cauchy-Kovalevsky theorem, properties of harmonic functions, the Dirichlet principle. Initial- and boundary-value problems for hyperbolic, elliptic, and parabolic equations. Systems of equations.

**MATH 676. Advanced Ordinary Differential Equations. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 337, and MATH 545 or MATH 645. A rigorous treatment of the theory of systems of differential equations: existence and uniqueness of solutions, dependence on initial conditions and parameters. Linear systems, stability, and asymptotic behavior of solutions. Nonlinear systems, perturbation of periodic solutions, and geometric theory of systems of ODEs.

**MATH 677. Calculus of Variations. 3 credits, 3 contact hours.**
Prerequisite: MATH 545 or MATH 645 or departmental approval. Necessary conditions for existence of extrema. Variation of a functional, Euler's equation, constrained extrema, first integrals, Hamilton-Jacobi equation, quadratic functionals. Sufficient conditions for the existence of extrema. Applications to mechanics.

**MATH 678. Intro to Stat Methods in Data. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or MATH 663, or permission by instructor. This course introduces students to concepts in statistical methods used in data science, including data collection, data visualization and data analysis. Emphasis is on model building and statistical concepts related to data analysis methods. The course provides the basic foundational tools on which to pursue statistics, data analysis and data science in greater depth. Topics include sampling and experimental design, understanding the aims of a study, principles of data analysis, linear and logistic regression, resampling methods, and statistical learning methods. Students will use the R statistical software.

**MATH 687. Quantitative Analysis for Environmental Design Research. 3 credits, 3 contact hours.**
Prerequisites: MATH 333 and departmental approval. Fundamental concepts in the theory of probability and statistics including descriptive data analysis, inferential statistics, sampling theory, linear regression and correlation, and analysis of variance. Also includes an introduction to linear programming and nonlinear models concluding with some discussion of optimization theory.

**MATH 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 0 contact hours.**
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science.

**MATH 689. Advanced Applied Mathematics II: Ordinary Differential Equations. 3 credits, 3 contact hours.**
Prerequisites: MATH 545 or MATH 645, MATH 613, and MATH 631. A practical and theoretical treatment of boundary-value problems for ordinary differential equations: generalized functions, Green's functions, spectral theory, variational principles, and allied numerical procedures. Examples will be drawn from applications in science and engineering.

**MATH 690. Advanced Applied Mathematics III: Partial Differential Equations. 3 credits, 3 contact hours.**
Prerequisite: MATH 689. A practical and theoretical treatment of initial- and boundary-value problems for partial differential equations: Green's functions, spectral theory, variational principles, transform methods, and allied numerical procedures. Examples will be drawn from applications in science and engineering.

**MATH 691. Stochastic Processes with Applications. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Renewal theory, renewal reward processes and applications. Homogeneous, non-homogeneous, and compound Poisson processes with illustrative applications. Introduction to Markov chains in discrete and continuous time with selected applications.

**MATH 692. MSMCF Forum. 0 credits, 0 contact hours.**
Forum comprises informal discussions and debates engaging students in the realities of living and working in the world, with a focus on economics and finance. These realities include broad awareness of contemporary events, ethical implications of decisions, proper implementation and use of models, the research process and the critical skills of communication. Forum meetings are designed to promote understanding and build experience in all these areas.

**MATH 698. Sampling Theory. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Role of sample surveys. Sampling from finite populations. Sampling designs, the Horowitz-Thompson estimator of the population mean. Different sampling methods, simple random sampling, stratified sampling, ratio and regression estimates, cluster sampling, systematic sampling.

**MATH 699. Design and Analysis of Experiments. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Statistically designed experiments and their importance in data analysis, industrial experiments. Role of randomization. Fixed and random effect models and ANOVA, block design, latin square design, factorial and fractional factorial designs and their analysis.

**MATH 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisites: Matriculation for the Master of Science in Applied Mathematics or in Applied Statistics and departmental approval. Work must be initiated with the approval of a faculty member, who will be the student's project advisor. Work of sufficient quality may qualify for extension into a master's thesis, see Math 701.

**MATH 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisites: Matriculation for the Master of Science in Applied Mathematics or in Applied Statistics and departmental approval. Work must be initiated with the approval of a faculty member, who will be the student's project advisor. Work of sufficient quality may qualify for extension into a master's thesis, see MATH 701.

**MATH 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: Matriculation for the master's degree and departmental approval. Students must register for a minimum of 3 credits per semester until completion. The work is carried out under the supervision of a designated member of the faculty.

**MATH 707. Advanced Applied Mathematics IV: Special Topics. 3 credits, 3 contact hours.**
Prerequisite: Departmental approval. A current research topic of interest to departmental faculty. Typical topics include: computational fluid dynamics, theoretical fluid dynamics, acoustics, wave propagation, dynamical systems, theoretical and numerical aspects of combustion, mathematical biology, and various topics in statistics.

**MATH 712. Numerical Methods II. 3 credits, 3 contact hours.**
Prerequisites: MATH 614, MATH 331 or departmental approval, and proficiency in a computer programming language (FORTRAN, C, or C++). Numerical methods for the solution of initial- and boundary-value problems for partial differential equations, with emphasis on finite difference methods. Consistency, stability, convergence, and implementation are considered.

**MATH 713. Advanced Scientific Computing: Multi-Dimensional Finite-Difference Schemes and Spectral Methods. 3 credits, 3 contact hours.**
Prerequisite: MATH 712 and proficiency in a computer programming language (FORTRAN, C, or C++). Derivation and analysis of finite difference schemes for systems of partial differential equations in two and three spatial dimensions and time. Issues pertaining to efficient implementation of algorithms and to stability of physical and numerical boundary conditions. Pseudo-spectral and spectral methods to solve partial differential equations. Approximation properties of Fourier and Chebyshev series and techniques based on the Fast Fourier Transform (FFT) and on matrix multiplication to numerically compute partial derivatives. Time-discretization techniques suitable for use with pseudo-spectral and spectral methods. Model systems arising in wave propagation, fluid dynamics, and mathematical biology will be considered.

**MATH 715. Mathematical Fluid Dynamics I. 3 credits, 3 contact hours.**
Introduction to the basic ideas of fluid dynamics, with an emphasis on rigorous treatment of fundamentals and the mathematical developments and issues. The course focuses on the background and motivation for recent mathematical and numerical work on the Euler and Navier-Stokes equations, and presents a mathematically intensive investigation of various model equations of fluid dynamics (e.g., the Korteweg-de-Vries equations).

**MATH 716. Mathematical Fluid Dynamics II. 3 credits, 0 contact hours.**
Continuation of MATH 715. Further development of the ideas of fluid dynamics, with an emphasis on mathematical developments and issues. A selection of topics will be developed in some detail, for example: Stokes flow and low-Reynolds-number hydrodynamics; flow at high Reynolds number and boundary layers; shock waves and hyperbolic systems; dynamics of interfacial flows; hydrodynamic stability; rotating fluids.

**MATH 717. Inverse Problems and Global Optimization. 3 credits, 3 contact hours.**
Introduction to inverse problems and global optimization. Linear, quasi-linear, and nonlinear inverse problems are studied with emphasis on regularization techniques. Bayesian statistical approaches and Monte Carlo methods are introduced and discussed in the context of inverse problems. The mathematical foundations of simulated annealing, genetic algorithms, and TABU are presented.

**MATH 720. Tensor Analysis. 3 credits, 3 contact hours.**
Prerequisite: MATH 613 and MATH 631, or departmental approval. Review of vector analysis in general curvilinear coordinates. Algebra and differential calculus of tensors. Applications to differential geometry, analytical mechanics, and mechanics of continuous media. The choice of applications will be determined by the interests of the class.

**MATH 722. Wave Propagation. 3 credits, 3 contact hours.**
Derivation of linear wave equations describing acoustic, electromagnetic, elastodynamic and hydrodynamic phenomena. Fundamental solutions and their application to initial value problems. Applications and solution of boundary value problems using Green's functions, image and spectral methods. Related time harmonic problems, including radiation, scattering, diffraction and transmission phenomena. Dispersive waves and the method of stationary phase. Linear waves in anisotropic media.

**MATH 725. Independent Study I. 3 credits, 3 contact hours.**

**MATH 745. Analysis II. 3 credits, 3 contact hours.**
Prerequisite: MATH 645. Lebesgue measure and integration, including the Lebesgue dominated convergence theorem and Riesz-Fischer theorem. Elements of Hilbert spaces and Lp-spaces. Fourier series and harmonic analysis. Multivariate calculus.

**MATH 756. Complex Variables II. 3 credits, 3 contact hours.**
Prerequisite: MATH 656. Selected topics from: conformal mapping and applications of the Schwarz-Christoffel transformation, applications of calculus of residues, singularities, principle of the argument, Rouche's theorem, Mittag-Leffler's theorem, Casorati-Weierstrass theorem, analytic continuation, and applications, Schwarz reflection principle, monodromy theorem, Wiener-Hopf technique, asymptotic expansion of integrals; integral transform techniques, special functions.

**MATH 761. Statistical Reliability Theory and Applications. 3 credits, 3 contact hours.**
Prerequisite: MATH 662 or departmental approval. Survival distributions, failure rate and hazard functions, residual life. Common parametric families used in modeling life data. Introduction to nonparametric aging classes. Coherent structures, fault tree analysis, redundancy and standby systems, system availability, repairable systems, selected applications such as software reliability.

**MATH 763. Generalized Linear Models. 3 credits, 3 contact hours.**
Prerequisites: MATH 662 and MATH 665 or departmental approval. Theoretical and applied aspects of generalized linear models. Classical linear models, nonlinear regression models, and generalized estimating equations.

**MATH 767. Fast Numerical Algorithms. 3 credits, 3 contact hours.**
The course covers state-of-the-art, analysis-based, fast numerical algorithms for computing discrete summations/transforms and for solving differential/ integral equations. In particular, this course presents fast multiple methods and their descendants, including fast Fourier transform for nonequispaced data, fast Gauss transform, fast iterative solver and direct solver for elliptic boundary value problems.

**MATH 768. Probability Theory. 3 credits, 3 contact hours.**
Prerequisite: MATH 645 or departmental approval. Measure theoretic introduction to axiomatic probability. Probability measures on abstract spaces and integration. Random variables and distribution functions, independence, 0-1 laws, basic inequalities, modes of convergence and their interrelationships, Laplace-Stieltjes transforms and characteristic functions, weak and strong laws of large numbers, conditional expectation, discrete time martingales.

**MATH 771. Asymptotic Methods II. 3 credits, 3 contact hours.**
Prerequisite: MATH 671. Continuation of MATH 671. Asymptotic methods for the solution of PDEs, including: matched asymptotic expansions, multiple scales, the WKB method or geometrical optics, and near-field far-field expansions. Applications to elliptic, parabolic, and hyperbolic problems. Further topics in the asymptotic expansion of integrals and the WKB method. Emphasis on examples drawn from applications in science and engineering.

**MATH 786. Large Sample Theory and Inference. 3 credits, 3 contact hours.**
Prerequisites: MATH 665 and MATH 768. Limit theorems, central limit theorem, asymptotic expansions and large deviations, limit theorems in martingales and semi-martingales and stochastic differential equations, asymptotic expansions of functions of statistics, linear parametric estimation, asymptotic efficiency, martingale approach to inference: test for homogeneity and goodness of fit, decomposable statistics, inference for counting processes and censored data, inference in nonlinear regression, existence and consistency of least squares estimator (LSE), asymptotic properties of LSE, Von Mises functionals, estimation of parameters of stable laws, empirical characteristics function for inference, generalized least squares for linear models.

**MATH 787. Non-Parametric Statistics. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Wilcoxon signed-ranks test, Mann-Whitney U test, binomial sign test for single sample and two dependent samples, McNemar's test, Cochran Q test, Wilcoxon matched-pairs signed-ranks test, Kruskal-Wallis one-way analysis of variance, Friedman two-way analysis of variance, Siegel-Tukey test for equal variability, chi-squared goodness-of-fit test, test for homogeneity and independence, single-sample runs test and other tests of randomness, correlation tests: Spearman's rank-order correlation, coefficient and Kendall's tau, Kendall's coefficient of concordance, and Goodman and Kruskal's gamma, comparing power efficiency.

**MATH 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790E. Doctoral Dissertation. 12 credits, 12 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 791. Graduate Seminar. 0 credits, 1 contact hour.**
All master's and doctoral students receiving departmental or research-based awards must register for this course each semester.

**MATH 792B. Pre Doctoral Research. 3 credits, 3 contact hours.**

**MATH 792D. Pre Doctoral Research. 9 credits, 9 contact hours.**

**OPSE 601. Advanced Topics in Optical Science and Engineering. 3 credits, 3 contact hours.**
In small groups or as an individual, students conduct three complete research experiments in the available topics of interest, from preliminary background research through data analysis. Use of modern optical research tools under close guidance of faculty and associated research team members in the faculty member's lab.

**OPSE 610. Virtual Instrumentation. 3 credits, 3 contact hours.**
Prerequisites: A college level programming course. Intended for all engineering, computer science, and science majors. Covers virtual instrumentation including use of IEEE, GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform, such as, National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisitions and instrument control, instrument status, and acquisition speed.

**PHYS 590. Graduate Coop Work Exp I. 3 credits, 3 contact hours.**

**PHYS 591. Graduate Coop Work Exp II. 3 credits, 3 contact hours.**

**PHYS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**PHYS 607. Topics in Astronomy and Cosmology. 3 credits, 3 contact hours.**
Prerequisites: college-level physics and mathematics. A survey of recent progress in astronomy, the physical principles involved, and the impact these new discoveries have on our understanding of the universe. Includes results from recent and ongoing planetary probes of our solar system, discovery of planetary systems around other stars, the evolution of stars, exotic objects such as neutron stars and black holes, the formation of galaxies, and current understanding of the birth and final fate of the universe. Observing sessions familiarize students with the sun, moon, and night sky.

**PHYS 611. Adv Classical Mechanics. 3 credits, 3 contact hours.**

**PHYS 621. Classical Electrodynamic. 3 credits, 3 contact hours.**

**PHYS 641. Statistical Mechanics. 3 credits, 3 contact hours.**

**PHYS 661. Solid-State Physics. 3 credits, 3 contact hours.**
Properties of solid state materials are explained based on principles of physics. Electronic, magnetic, thermal, optical, and lattice properties of materials are studied. Various experimental and theoretical approaches are introduced.

**PHYS 681. Solar Phys & Instrumentn. 3 credits, 3 contact hours.**

**PHYS 682. Introduction To Mems. 3 credits, 3 contact hours.**

**PHYS 687. Physics of Materials. 3 credits, 3 contact hours.**
Prerequisite: PHYS 441 or equivalent (see undergraduate catalog for description). Fundamentals of quantum mechanics; energy bands in crystals; electrical conduction in metals and alloys, semiconductors; optical properties of materials; quantum mechanical treatment of optical properties; magnetic properties of materials; thermal properties, heat capacity, and thermal expansion in solids.

**PHYS 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 3 contact hours.**
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science.

**PHYS 690. Directed Study Appl Phys. 3 credits, 3 contact hours.**

**PHYS 698. ST:. 3 credits, 3 contact hours.**

**PHYS 700. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take Phys 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

**PHYS 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take PHYS 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

**PHYS 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

**PHYS 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

**PHYS 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

**PHYS 721. Classical Electrodynamics II. 3 credits, 3 contact hours.**
Prerequisite: PHYS 621 or equivalent; basic knowledge of tensor analysis. Simple radiating systems, scattering and diffraction; special theory of relativity; dynamics of relativistic particles and electromagnetic fields; collisions between charged particles, energy loss, and scattering; radiation from accelerated charge, synchrotron radiation, and bremsstrahlung.

**PHYS 725. Independent Study. 3 credits, 1 contact hour.**
Prerequisites: permission from the graduate advisor (not thesis advisor) in Physics, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**PHYS 726. Independent Study II. 3 credits, 3 contact hours.**

**PHYS 728. Radio Astronomy. 3 credits, 3 contact hours.**
Prerequisites: PHYS 621and PHYS 641 or the equivalent, or approval of the instructor. An introduction to radio emission processes, radiative transfer, radio diagnostics, and radio instrumentation. Topics include radio flux measurements with single antenna, radio imaging with interferometer arrays ( Fourier Transform imaging), and image reconstruction techniques (CLEAN, MEM). Application is to astronomical objects with special emphasis on the Sun.

**PHYS 731. Quantum Mechanics II. 3 credits, 3 contact hours.**
Prerequisite: PHYS 631 or equivalent. Review of quantum mechanics and theory of special relativity; second quantization; relativistic one-particle problem; Klein-Gordon equation and Dirac equation; canonical field theory; relativistic scattering theory; introduction to quantum electrodynamics and quantum field theory; Feynman diagrams and applications.

**PHYS 741. Basic Plasma Phys w Space, Lab. 3 credits, 3 contact hours.**
Prerequisites: Phys 611, 621 or other equivalent, or approval of the instructor. The course will introduce students to basic concepts of plasma physics and its applications to laboratory experiments and space research. The course will cover the following topics: particle motions in magnetic field, adiabatic invariants, magnetic traps, radiation belts, electromagnetic waves in plasma, electrostatic oscillations, waves in magnetized plasma, collisional processes in plasma, kinetic effects on plasma waves, Landau damping, wave instabilities, plasma as fluid, magnetohydrodynamics, magnetic configurations of laboratory and space plasma, MHD instabilities, reconnection, helicity, dynamo theories, the origin of cosmic magnetic fields, stochastic processes, Fermi process, particle acceleration, and cosmic rays.

**PHYS 747. Intro to Helioseismology. 3 credits, 3 contact hours.**
Prerequisites: Phys 611, Phys 621 or other equivalent The course will introduce the physical principles and methods to study wave oscillations, and the interior structure of the Sun. The course covers processes of acoustic and gravity wave excitation and propagation, interaction with turbulence and magnetic fields, oscillation spectrum, sunquakes, inferences of the structure and composition, the differential rotation, large-scale flows and meridional circulation. It includes the theory of normal modes, inversion techniques, wave dispersion analysis, acoustic tomography and holography, applications to the solar dynamo and magnetic activity.

**PHYS 774. Fundamentals of Spectroscopy. 3 credits, 3 contact hours.**
The major objectives of this course are to integrate theory and practice and to bring together different branches of Academic Studies and Industrial Research through the presentation of critical aspects of modern Spectroscopy. The course will provide a valuable theoretical introduction and an overview of modern topics in spectroscopy, which are of current interest and importance in Semiconductor Industry and Biomedicine. A wide range of techniques is considered, including optical Near field spectroscopy, X-ray, Raman, Neutron scattering, and FT-IR spectroscopy.

**PHYS 780. Curr Topics Applied Phys. 3 credits, 3 contact hours.**

**PHYS 787. New Concepts of Semiconductor. 3 credits, 3 contact hours.**
Prerequisite: PHYS 687 and ECE 657. This is an advanced course on semiconductor physics targeted at describing polycrystalline materials, e.g. cadmium telluride or copper indium diselenide, that are currently used in thin-gilm photovoltiac panels. An overview of classical semiconductor and solar cell theory is followed by topics such as non-shallow dopants, multi-level defects, defect transition energy level, and metastability. These concepts are applied to examine minority carrier lifetime and carrier collection in devices, and to extend the theories of admittance and deep level transient spectroscopy.

**PHYS 789. Physics of Advanced Semiconductor Device Processing. 3 credits, 3 contact hours.**
Prerequisites: NJIT: EE 657, R755 687; or equivalent. Intended for doctoral students in applied physics, electrical engineering, and materials science. (Rutgers = R755 789)Silicon and GaAS technologies: crystal growth methods, epitaxy, oxidation, lithography, dry and wet etching techniques, polysilicon, diffusion, ion implantation, metallization (including silicidation), process integration, analytical characterization techniques, assembly and packaging, and yield and reliability.

**PHYS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Prerequisites: passing grade on departmental qualifying examination and approval of doctoral candidacy. Corequisite: PHYS 791. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester. Registration for additional credits, up to 12 per semester, is permitted with the approval of the department graduate advisor. Experimental or theoretical investigation of a topic in applied physics, including microelectronics, materials science, and laser physics. Cooperative projects with industry or government agencies may be acceptable. Research and writing are carried out under the supervision of a designated graduate faculty member. The completed written dissertation should be a substantial contribution to the knowledge of the topic under research, and should be of sufficient merit to warrant publication in a leading scientific or technical journal.

**PHYS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**PHYS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**PHYS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**PHYS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**PHYS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**PHYS 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.**

**PHYS 790G. Doct Dissertation & Res. 18 credits, 3 contact hours.**

**PHYS 791. Doctoral Seminar. 0 credits, 0 contact hours.**

**PHYS 792. Pre-Doctoral Research. 3 credits, 0 contact hours.**

**PTC 601. Advanced Professional and Technical Communication. 3 credits, 3 contact hours.**
Provides the foundation and direction for all Professional and Technical Communication coursework. This course introduces students to the profession and the academic discipline of technical/professional communication. Modules include usability analysis; visual information; ethics; global diversity, global communication; report writing; information literacy; communicating with new technologies; and technical writing style. Students begin development of the MSPTC ePortfolio.

**PTC 603. Identity, Technology, and Communication. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601. Examines the complex ways in which technology constructs and is constructed by society, with emphasis on interrelationships between technology and communication. Discussions focus on how technological change is expressed in social and political movements, literature, art, architecture, and philosophy and how they, in turn, influence the future direction of technology. Design and updating of the MSPTC ePortfolio will be required in this seminar.

**PTC 604. Communication Theory and Research. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601Reviews the major theories of communication and provides strategies for research in the field of Professional and Technical Communication. The course focuses on these research methods: problem statement and hypothesis formulation derived from theory; research design and data generation; existing information sources and their acquisition; and analytic techniques. Students develop analytic methods necessary to create a well-considered thesis proposal. Design and updating of the MSPTC ePortfolio will be required in this seminar.

**PTC 605. Elements of Visual Design. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601. Provides an understanding of and competency in the visual presentation of information. Course integrates theories of design, techniques of composition, and technologies of electronic and print publishing. Modules include both design principles and hands-on practice in visual literacy, layout and design, and graphic tools. Design and updating of the MSPTC ePortfolio will be required in this seminar.

**PTC 606. Advanced Information Design. 3 credits, 3 contact hours.**
Develops online visual communication strategies and community building. The course will cover the design and creation of multimedia objects, usability heuristics, navigation theory, contemporary design practices and online community building. Students will be required to create media-rich multidimensional online projects that encourage and facilitate interaction and team-building in the online environment. Design and updating of the MSPTC ePortfolio will be required for this seminar.

**PTC 610. Research Methods for Information Design. 3 credits, 3 contact hours.**
Introduces user research methods such as contextual inquiry, ethnographic field studies, card sorting, affinity diagramming, and usability testing that provide the foundation for user- centered interaction design.

**PTC 612. Theory and Practice of Text Encoding. 3 credits, 3 contact hours.**
Students will learn to identify considerations and methods for efficient text encoding. Topics covered will include text encoding tools, markup languages, document analysis, and workflow design for text delivery. After taking this class, students should be able to analyze processes and technologyies that support the collection, management, and publishing of content in a variety of forms and media.

**PTC 620. Proposal Writing. 3 credits, 3 contact hours.**
Provides an understanding of and practice in proposal writing for corporations, foundations, and government agencies. Students build skills to create a range of persuasive documents including proposals for research grants, responses to requests for proposal, and government proposals.

**PTC 622. Working in Teams: Collaborative and Interpersonal Communications. 3 credits, 3 contact hours.**
Introduces interpersonal and collaborative communication topics relating to face-to-face and virtual teams. Covers communication and documentation functions in agile project environments. Examines mobile workplace communication strategies.

**PTC 624. Professional and Technical Editing. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601 . Presents the theory and practice of editing professional and technical writing. Topics include correctness and conciseness, hard copy and on-line editing, editing graphics, document management, editor-author relationships, and ethical considerations in editing. Students edit writing samples from a variety of technical fields.

**PTC 626. Communication Media Design Studio. 3 credits, 3 contact hours.**
This course integrates language and media in a studio approach to multimodal communication projects. Students work with instructor to design individual projects using current media applications.

**PTC 628. Analyzing Social Networks. 3 credits, 3 contact hours.**
Prerequisite: PTC 601 for MSPTC students; approval of instructor for non-MSPTC students. This course will provide students with an overview of social networks by introducing them to the unique terminology of social networks (centrality, boundary spanners, directional ties, etc.) Positive and negative characteristics of social networks will be discussed, followed by visualizations and analyses of those characteristics. Students will read selected journal articles explaining how social networks relate to communication and the flow of information within organizations. The culmination of the course will be a project in which students will create and analyze their own social network, most likely drawing their data from the popular social media site Facebook and using ORA, a freeware social network analysis application created by Carnegie Mellon University.

**PTC 629. Theory and Practice of Social Media. 3 credits, 3 contact hours.**
Introduces social media strategies for reading and writing in today's multi-cultural, screen-oriented, networked culture. Students study relationship between mediated communication and human community and gain hands-on experience with chatting, blogging, tagging, wiki writing, tweeting and social media presentation. Students strategize, plan, design and produce social media projects of their own.

**PTC 631. Communication and Environmental Problem Solving. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601. Develops critical thinking on ecological issues for problem solving by integrating technical information, human values, and communication with environmental change. Students combine theory, research and models, case studies, visual thinking, and scientific inquiry for application in individual decision-making course project.

**PTC 632. Content Management and Information Architecture. 3 credits, 3 contact hours.**
Prerequisite or Corequisite: PTC 601. Today's complex systems often produce complex information needs that require new technical communication methods and tools. This course will focus on the use of Information Architecture methodologies (such as, DITA or DocBook) to develop a structure for presenting technical information and on Content Management tools for creating a single source repository for this information. Students will also use theory and practical applications to design and develop a structured online Help module.

**PTC 640. Health Communications. 3 credits, 3 contact hours.**
This course will focus on the use of communication strategies to inform and influence individual and community decisions regarding health. The course will cover: the multidimensional nature of health communication, research in health communication, behavioral theories in health communication, rhetorical theories in health communication, legal and ethical concerns in health communication, the communication of risk and uncertainty, and the design of health campaigns. Students will be required to (a) research and prepare a health communication strategy for use in a specific context and (b) to design an accompanying print or hypertext document to be used in that context.

**PTC 642. Corporate Media and Communication. 3 credits, 3 contact hours.**
Introduces the dymanics of communication within complex organizations. Develops communication skills for contemporary global corporate and business markets. Focuses on the efforts of businesses and organizations to communicate and persuade in target audiences. Covers translation issues in developing corporate media.

**PTC 644. Communication in Technology Transfer and Innovation. 3 credits, 0 contact hours.**
Examine roles of communication in innovation development and technolgy transfer. Students review models of communication in technology transfer in global contexts. Issues such as audience analysis, user experience, participatory design, and knowledge transfer will be investigated.

**PTC 650. ELearning Design for Mobile. 3 credits, 3 contact hours.**
Designing eLearning for mobile platforms is a critical skill for today's technical communicator. Specific skills and tools are required to ensure a successful implementation. Based on proven user centered design concepts, this course provides the student with the skills necessary to create effective mobile training programs.

**PTC 672. Design Instruction Assess Meth. 3 credits, 3 contact hours.**
Prerequisite: Students must have a graduate standing and should be enrolled in MSPTC program or the Instructional Design and Educational Assessment certificate. Student must meet these requirements, approval of instructor is required. Examines planning and implementation of instruction to facilitate learning and analysis of methods of data gathering on learner progress and mastery, lessons and learning objects so appropriate instructional strategies with associated methods of formative and summative assessments that can yield data for learner assessment and course evaluation can be selected or develop to suit the instructional style, learner needs, and instructional situations.

**PTC 681. Tech in Class & Learning Envir. 3 credits, 3 contact hours.**
Prerequisite: Students must have a graduate standing and should be enrolled in MSPTC program or the Instructional Design and Educational Assessment certificate. Student must meet these requirements, approval of instructor is required. This course examines the various types of technology necessary to develop, use, and process the results of assessments as well as facilitate and augment instructional design. This course examines the integration of present and likely future technology into instruction to foster community, collaboration, conceptual development, and exceptional academic performance as well as a more effective and well-understood assessment system.

**PTC 691. ePortfolio Capstone Seminar. 0 credits, 0 contact hours.**
This course is taken in the student's final semester before graduation. Students complete final revisions of the ePortfolio of work completed in MSPTC seminars (may also include professional and service projects). Student ePortfolios must successfully demonstrate MSPTC core competencies and be presented in an oral presentaiton for faculty and other students.

**PTC 698. Selected Topics in Professional and Technical Communication. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601 This is a Special Topics course (does not require CGE approval). It was presented to CGE in an effort to attract more students. Students will learn approaches to understanding and producing the forms of writing central to academic research. They will review literature, peer-review the work of others, prepare conference material, and produce a submission-quality journal or conference paper in their field of study. The current plan is to run the course every Spring.

**PTC 700. Master'S Project. 0 credits, 0 contact hours.**
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation.

**PTC 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation.

**PTC 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**PTC 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**PTC 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**PTC 725. Independent Study in Professional and Technical Communication. 3 credits, 3 contact hours.**
Prerequisite: approval of graduate advisor and supervising faculty.Allows development of areas of specialization for Master's Project or for areas of study in communication in which one or more students may be interested but which are not of sufficiently broad interest to warrant a regular course offering.

**PTC 726. Independent Study II. 3 credits, 3 contact hours.**

**R215 510. Conservation Ecology. 1-12 credits, 1-12 contact hours.**

**R215 520. Landscape Ecology. 3 credits, 3 contact hours.**

**R215 565. Community Dynamics. 4 credits, 4 contact hours.**

**R215 575. Quant Ecol & Evol. 3 credits, 3 contact hours.**

**R215 590. Population Ecology. 4 credits, 4 contact hours.**

**R215 597. Concpt & Meth Evolution. 4 credits, 4 contact hours.**

**R215 599. Special Topics. 3 credits, 3 contact hours.**

**R460 606. Envir. Geophysics. 3 credits, 0 contact hours.**

# Biological Sciences

## Master of Science in Biology

### Master of Science Graduate Program in Biology Course of Study and Program Requirements

#### Advisement

In the first year of study, students are advised on all academic matters by the MS Program Coordinator. During the first year of full-time study (or part-time equivalent), students complete sufficient course work to fulfill most core curricular requirements and to develop a potential research project (library or laboratory) that will serve as the basis of the capstone Thesis requirement. By the start of the second year, students must choose a faculty member to serve as advisor during their laboratory or bibliographic thesis research project.

### Other Source of Information Regarding the Program's Regulations

The Rutgers-Newark Graduate School Catalog (http://catalogs.rutgers.edu/generated/nwk-grad_current/pg127.html) and the NJIT Graduate Catalog http://catalog.njit.edu/graduate/ should be consulted for University regulations. The new department regulations outlined above for the Masters program in Biology apply to all students who enter the Program as of September 2010.

# Doctor of Philosophy in Biology

## Program Procedures and Requirements

### I. Graduate Standards Committee

The Graduate Standard Committee is responsible for monitoring and advising all graduate students through completion of the Thesis Prospectus stage of the program. The Committee meets with students each semester to evaluate coursework and research progress in an effort to provide advisement on course selections, first-semester mentoring, laboratory rotations, and potential thesis advisors. Records of Standards Committee meeting are kept on file via the Standards Committee Report form. Whenever necessary, the Committee will discuss student progress with faculty mentors and advisors to ensure proper and successful progress within the program. The ultimate charge of the Committee is to assist and guide the student toward successful completion of the Qualifying Exam and Thesis Prospectus.

# NJIT Faculty

## B

Bucher, Dirk M., Associate Professor

Bunker, Daniel E., Assistant Professor

## F

Flammang-Lockyer, Brooke E., University Lecturer

Fortune, Eric S., Associate Professor

## G

Garnier, Simon J., Assistant Professor

Golowasch, Jorge P., Professor

## H

Haspel, Gal, Assistant Professor

## N

Nadim, Farzan, Professor

## R

Russell, Gareth J., Associate Professor

## S

Soares, Daphne F., Assistant Professor

Stanko, Maria L., University Lecturer

## T

Trimby, Christopher M., University Lecturer

## W

Wisner, Ellen M., University Lecturer

## Y

Yarotsky, John J., University Lecturer

# Biological Sciences Courses

**BIOL 590. Grad Coop Work Experience I. 3 credits, 3 contact hours.**

**BIOL 591. Graduate Coop Work Exper II. 3 credits, 3 contact hours.**

**BIOL 593. Graduate Co-Op Work Exp IV. 0 credits, 0 contact hours.**

**BIOL 601. Computational Biology I. 3 credits, 3 contact hours.**
This course will describe mathematical and simulation techniques used in modeling a variety of biological systems. Students will learn stability analysis, phase space analysis, basic bifurication theory and numerical simulation techniques with examples from neuroscience, cell and molecular biology as well as ecology and evolution. Students enrolling in this course are expected to have basic knowledge of calculus, linear algebra and some programming abilities.

**BIOL 612. Comparative Animal Physiology. 3 credits, 3 contact hours.**
This course will explore how animals, from invertebrates to vertebrates, function from the cellular to the organism level. The study of the structure and function of the various organs provides insight into how animals survive extreme environments and how they respond to changes in their environment. The comparative approach shows that the underlying physiological principles that govern life are common to all animals and yet animals have evolved unique and sometimes startling physiological solutions to problems posed by their particular environments.

**BIOL 622. Evolution. 3 credits, 3 contact hours.**
This course will provide a comprehensive overview of research in the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic bases of variation and heredity, natural selection, evolution and development, and speciation. The format will be brief lectures to review topics covered in text, followed by class discussions of relevant primary literature. Students will write two papers on the topic of their choice and will be required to lead a minimum of one class discussion.

**BIOL 628. Cell Biology of Disease: Cells Gone Bad. 3 credits, 3 contact hours.**
This course will briefly review normal physiological function of humans and will then extensively explore the basis of many human diseases at cellular lever. The goal is to understand how alterations in normal cell functions affect human physiology by reviewing current research in the field of cell biology.

**BIOL 630. Critical Thinking for the Life Sciences. 3 credits, 3 contact hours.**
Researchers in the biological sciences must understand and be able to effectively apply the scientific method, and they must also be able to clearly communicate their ideas and results. This course will involve heavy student participation and discuss the scientific method, analyze and discuss data gathering and organizing, and will analyze existing grant proposals with the goal of enabling graduate students to write a clear and convincing grant proposal.

**BIOL 638. Computational Ecology. 3 credits, 3 contact hours.**
An overview of computational approaches to the study of mathematical models in ecology. Topics include one-, two-, and multi-species models, life history analysis, spatial dynamics, epidemiology. The course is taught as a hands-on computer lab in which students explore models, perform simulations and solve problems.

**BIOL 640. Cellular Neurophysiology. 3 credits, 3 contact hours.**
Prerequisites: Graduate student status or permission of the instructor. This course will examine the nervous system from a functional perspective. The goal is to understand how ion channels and other components of nerve cells give rise to electrical excitability and synaptic function, and how those properties are then used for coding information and higher order function in the nervous system.

**BIOL 641. Systems Neuroscience. 3 credits, 3 contact hours.**
This course will examine neurophysical phenomena from a systems perspective. The course will review basic concepts of cellular neuroscience, such as excitability, impulse conduction, and integration of activity at the cellular, before focusing on network level physiology of the nervous system and its role in the generation of behavior. The goal is to provide students with the basic knowledge to understand neurobiological processes at all levels of complexity.

**BIOL 645. Biological Imaging Techniques. 3 credits, 3 contact hours.**
Prerequisites: Graduate student status or permission of the instructor. This combined lecture and lab course will introduce the students to a variety of approaches to examine biological structures at different microscopic scales: conventional light microscopy, fluorescent microscopy, modern high resolution light microscopy, and electron microscopy. In addition, the course will cover optical approaches to study the dynamics of cellular function, including calcium and voltage imaging, and molecular interactions.

**BIOL 660. College Teaching. 3 credits, 3 contact hours.**
College Teaching helps students in STEM fields who teach or plan to teach in colleges or universities develop important professional knowledge, skills, values, and dispositions that can enable them to help undergraduate and graduate students develop societally and personally significant abilities. The course emphasizes research-based methods demonstrated to be effective for enhancing learning in diverse people.

**BIOL 698. Selected topics in Biology. 3 credits, 3 contact hours.**
Survey of recent research topics in Biology at the Master's level.

**BIOL 699. Selected Topics in Biology. 3 credits, 3 contact hours.**
Survey of recent research topics in Biology at the Masters level.

**BIOL 700. Master's Project. 0 credits, 0 contact hours.**

**BIOL 700B. Master's Project. 3 credits, 3 contact hours.**

**BIOL 701. Master's Thesis. 0 credits, 0 contact hours.**

**BIOL 701B. Master's Thesis. 3 credits, 3 contact hours.**

**BIOL 701C. Master's Thesis. 6 credits, 3 contact hours.**

**BIOL 725. Independent Study. 3 credits, 3 contact hours.**

**BIOL 726. Independent Study. 3 credits, 3 contact hours.**

**BIOL 788. Selected Topics in Biology. 3 credits, 3 contact hours.**
Survey of recent research topics in Biology at the doctoral level.

**BIOL 790. Doct Dissertation & Resrch. 0 credits, 0 contact hours.**

**BIOL 790A. Doct Dissertation & Resrch. 1 credit, 1 contact hour.**

**BIOL 790B. Doct Dissertation & Resrch. 3 credits, 3 contact hours.**

**BIOL 790C. Doctoral Dissertn & Resrch. 6 credits, 6 contact hours.**

**BIOL 790D. Doct Dissertation & Resrch. 9 credits, 0 contact hours.**

**BIOL 790E. Doctoral Dissertation. 12 credits, 12 contact hours.**

**BIOL 791. Biology Seminar. 0 credits, 0 contact hours.**
This seminar includes student and faculty presentations on current papers, student presentations related to their research and occasional outside speakers. It will acquaint students with possible topics for dissertation search, and provide an opportunity to present and receive feedback on current work.

**BIOL 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**BIOL 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.**

**BIOL 794. Computational Biology Colloquium. 1 credit, 1 contact hour.**
Restriction: graduate standing. Students and outside speakers present and discuss current research activities in computational biology and related scientific areas.

## Rutgers-Newark Courses

**R120 503. Plant Morphology. 3 credits, 3 contact hours.**

**R120 504. Plant Physiology. 3 credits, 3 contact hours.**

**R120 505. Bio Stat And Compt Meth. 3 credits, 3 contact hours.**

**R120 509. Adv Problems In Biology. 3-5 credits, 3-5 contact hours.**

**R120 510. Adv Prob In Biol. 3 credits, 3 contact hours.**

**R120 512. Cell Biology: Methods & Appl. 3 credits, 0 contact hours.**

**R120 515. Molecular Bio Of Eukaryotes. 3 credits, 3 contact hours.**

**R120 516. Microbial Ecology. 3 credits, 3 contact hours.**

**R120 517. Develomental Neurobiology. 3 credits, 3 contact hours.**

**R120 518. Neuroimmunology. 3 credits, 3 contact hours.**

**R120 519. Microbial Metal. 3 credits, 0 contact hours.**

**R120 520. Analyt & Comp Neurosci. 3 credits, 3 contact hours.**

**R120 522. Resource Sustainability. 3 credits, 3 contact hours.**

**R120 523. Scale Of Biodiversity. 3 credits, 3 contact hours.**

**R120 524. Cell Molec Dev. 3 credits, 3 contact hours.**

**R120 526. Topics in Cell Biology. 3 credits, 0 contact hours.**

**R120 530. Cell Surface Recept. 3 credits, 3 contact hours.**

**R120 532. Evolution. 3 credits, 3 contact hours.**

**R120 534. Biological Invasion. 3 credits, 3 contact hours.**

**R120 536. Mulitvariate Biostatistics. 3 credits, 3 contact hours.**

**R120 538. Topics In Molecular Genetics. 3 credits, 3 contact hours.**

**R120 539. Adv Human Physio I. 3 credits, 0 contact hours.**

**R120 540. Adv Human Phsiology & Patho II. 3 credits, 3 contact hours.**

**R120 543. Envr Microbiology. 3 credits, 3 contact hours.**

**R120 545. Plant Molecular Bio. 3 credits, 3 contact hours.**

**R120 547. Pathophysiology. 3 credits, 3 contact hours.**

**R120 548. Biology Of Cancer. 3 credits, 3 contact hours.**

**R120 551. Biology Of Pollution. 3 credits, 3 contact hours.**

**R120 552. Paleobotany. 3 credits, 3 contact hours.**

**R120 560. College Teaching. 3 credits, 3 contact hours.**

**R120 563. Topics in Modern Plant Biology. 3 credits, 3 contact hours.**

**R120 571. Biochemistry I. 3 credits, 3 contact hours.**

**R120 572. Concepts in Pharm Drug Dev. 3 credits, 3 contact hours.**

**R120 573. Pharmacology. 3 credits, 3 contact hours.**

**R120 580. Topic Marine Ecology. 3 credits, 3 contact hours.**

**R120 587. Systems Ecology. 3 credits, 0 contact hours.**

**R120 588. Topics Adv Ecology. 3 credits, 0 contact hours.**

**R120 590. Intro to Env Biophys. 3 credits, 3 contact hours.**

**R120 593. Physiological Ecol. 3 credits, 0 contact hours.**

**R120 594. Systematics. 3 credits, 3 contact hours.**

**R120 601. Human Molecular Genetics. 3 credits, 3 contact hours.**

**R120 604. Microbio: Prin & Appl. 3 credits, 3 contact hours.**

**R120 616. Topics In Biology. 3 credits, 3 contact hours.**

**R120 624. Cell Biol:Signal Transduction. 3 credits, 3 contact hours.**

**R120 640. Topics In Immunology. 3 credits, 3 contact hours.**

**R120 651. Biology Colloquium. 1 credit, 1 contact hour.**

**R120 652. Biology Colloquium. 1 credit, 1 contact hour.**

# M.S. in Biology

## Curriculum-Course and Credit Requirements

The program requires successful completion of a minimum of 30 credits of graduate-level work. These must include at least one 3-credit course in each of four of the following five core areas:

1. cell biology/biochemistry,
2. molecular biology,
3. computational biology,
4. ecology/evolution,
5. plant biology.

A partial list of courses offerings in each of these areas is appended. When nearing completion of, the minimum 30 required credits for the MS, Rutgers students must submit and Application for Admission to Candidacy for the Degree of Master of Science to the Graduate Program Director listing courses complete (totaling 30 credits) and offered toward the degree. NJIT students must complete an application for graduation and submit it to the Graduate Program Director for signature.

## Curriculum-Thesis Requirements

Students can fulfill the written thesis requirement either by conducting laboratory or library research. Important to successful completion of the thesis requirement is early identification of a thesis advisor such that proper planning is in place to complete research requirements in a timely and effective manner. The basic requirement and process for these two thesis pathways is laboratory or field research thesis option; or bibliographic thesis option.

### Laboratory or Field Research Thesis Option

Students selecting the experimentally-based **research thesis option** must successfully complete a minimum of 24 credits of course work and 6 credits in research (R120 701 Research In Biology, R120 702 Research In Biology for RU-N students, BIOL 700 Master's Project, BIOL 701 Master's Thesis for NJIT students) with a graduate faculty of the department. Under the guidance of this faculty member the student will perform original research. The thesis resulting from this research is expected to be presented as an hypothesis-driven scholarly work, with conclusions clearly derived from the experimental research and published background information. Students will write a scholarly thesis demonstrating the ability to write clearly and scientifically and based on experimental laboratory and/or field project research.

Upon completion of the written thesis, the student will defend the thesis publicly on the topic of their research, followed by a Q&A session with the examination committee. The thesis committee must be approved by the Graduate Program Director and will consist of the primary advisor and at least one other faculty reader who are full members of the Graduate Faculty. If a research plan requires the expertise of a non-graduate faculty advisor the committee will consist of three members-two from the graduate faculty and the advisor. Format and style of the final document must be in accordance with the guidelines set by an available at the office of graduate studies of the respective institutions.

### Bibliographic Thesis Option

Students selecting the bibliographic-based **research thesis option** must successfully complete a minimum of 27 credits of coursework and 3 credits of Independent Study (BIOL 725 Independent Study for NJIT students, R120 844 Research Internship for Rutgers students) with a graduate faculty member of the department. Under the guidance of this faculty member, the student will write a scholarly review of the literature on a scientific topic of interest. The thesis resulting from this research is expected to be a scholarly work, with conclusions clearly derived from the published information referred to by the author. This thesis should demonstrate the ability of the student to write scientifically, bringing together facts interpretations relevant to that topic, in a clear, scholarly manner. Upon completion of the written thesis, the student will defend it publicly, followed by a Q&A session with the examination committee. The thesis committee must be approved by the Graduate Program Director and will consist of the primary advisor and at least one other faculty reader who are full members of the Graduate Faculty. If a research plan requires the expertise of a non-graduate faculty advisor the committee will consist of three members-two from the graduate faculty and the advisor. Format and style of the final document must be in accordance with the guidelines set by and available at the office of the graduate studies of the respective institutions.

## Additional Curriculum Options

### RU-N students

- After completing 12 graduate credits in the program, a student may solicit the Graduate Program Director to transfer up to 9 relevant graduate credits from another institution toward the 30 credits need for MS.
- No undergraduate credits are allowed for credit towards the MS degre.

### NJIT students

- *Credits already taken:* Up to nine (9) credits may be transferred for credit toward the 30 credits need for the MS provided that they were taken at an accredited college or university in the United States or Canada, were not used in fulfillment of a previous degree awarded, earned a final grade of 3.0 or above on a scale whose maximum is 4.0, were earned in graduate level course(s) for which full academic credit was awarded, were in units of at least three (3) credits and were not earned more than seven years ago. Credits earned in quarter system will be converted to equivalent semester credits.

- *Credits Not Yet Taken:* Up to nine (9) credits may be transferred for credit provided that they are taken at an accredited college or university in the United States or Canada, earn a final grade of 3.0 or above on a scale whose maximum is 4.0, are in graduate level course(s) for which full academic credit is awarded, and are in units of at least three (3) credits. Credits earned in quarter systems will be converted to equivalent semester credits. Prior approval required.

### Part-Time Students

Part-time students are expected to fulfill exactly the same requirements as full-time students

# Ph.D. in Biology

## Course Requirements

### General Credit/Course Distribution

| | |
|---|---|
| Three Biology Graduate Program Core Courses | 9 |
| Three Track Specific Core Courses | 9 |
| Two Semester Long Laboratory Rotations | 6 |
| Elective Courses (can be taken at Rutgers, RBHS, NJIT) | 12 |
| Total Required Research Credits | 36 |
| **Total Credits** | **72** |

### Ph.D. in Biology (cell biology track)

| | | |
|---|---|---|
| **Required Courses** | | |
| R120 560 | College Teaching | 3 |
| BIOL 630 | Critical Thinking for the Life Sciences | 3 |
| MATH 615 | Approaches to Quantitative Analysis in the Life Sciences [1] | 3 |
| **Cell Biology Core Courses** | | |
| R120 524 | Cell Molec Dev | 3 |
| R120 515 | Molecular Bio Of Eukaryotes | 3 |
| R160 581 | Biochemistry | 3 |
| **Electives** | | |
| Approved electives [2] | | 12 |
| **Laboratory Rotations** | | |
| R120 509<br>& R120 510 | Adv Problems In Biology<br>and Adv Prob In Biol | 6 |
| **Required Research** | | |
| Research | | 36 |
| **Total Credits** | | **72** |

1. Equivalent course may be substituted if approved.
2. Elective course may be taken from offerings in the following graduate programs:
    - Rutgers University, Newark -- Biology, Environmental Sciences, Integrative Neuroscience, and Chemistry
    - NJIT -- Applied Mathematics, Physics, Biomedical Engineering, and Computer Science
    - RBHS -- Program in Biomedical Sciences
    - Rutgers University, New Brunswick and Camden -- various programs

    Prior to enrolling in courses offered by graduate programs outside of the Graduate Program in Biology, students must receive permission from the Graduate Standards Committee if they are pre-qualifiers or from the Program Director if they are post-qualifiers. This is accomplished by completion of the Graduate Transfer Credit Form. Whenever appropriate the student should consult with his/her thesis research advisor. Please check course catalogs and online schedule of classes for specific course offerings on a semester-by-semester basis.

### Ph.D. in Biology (ecology and evolution track)

| | | |
|---|---|---|
| **Required Courses** | | |
| R120 560 | College Teaching | 3 |
| BIOL 630 | Critical Thinking for the Life Sciences | 3 |

| | | |
|---|---|---|
| MATH 615 | Approaches to Quantitative Analysis in the Life Sciences [1] | 3 |
| **Ecology and Evolution Core Courses** | | |
| R120 523 | Scale Of Biodiversity | 3 |
| BIOL 622 | Evolution | 3 |
| R120 593 | Physiological Ecol | 3 |
| **Electives** | | |
| Approved electives [2] | | 12 |
| **Laboratory Rotations** | | |
| R120 509<br>& R120 510 | Adv Problems In Biology<br>and Adv Prob In Biol | 6 |
| **Required Research** | | |
| Research | | 36 |
| **Total Credits** | | **72** |

1. Equivalent course may be substituted if approved.
2. Elective course may be taken from offerings in the following graduate programs:
   - Rutgers University, Newark -- Biology, Environmental Sciences, Integrative Neuroscience, and Chemistry
   - NJIT -- Applied Mathematics, Physics, Biomedical Engineering, and Computer Science
   - RBHS -- Program in Biomedical Sciences
   - Rutgers University, New Brunswick and Camden -- various programs

   Prior to enrolling in courses offered by graduate programs outside of the Graduate Program in Biology, students must receive permission from the Graduate Standards Committee if they are pre-qualifiers or from the Program Director if they are post-qualifiers. This is accomplished by completion of the Graduate Transfer Credit Form. Whenever appropriate the student should consult with his/her thesis research advisor. Please check course catalogs and online schedule of classes for specific course offerings on a semester-by-semester basis.

## Ph.D. in Biology (computational neuroscience track)

| | | |
|---|---|---|
| **Required Courses** | | |
| R120 560 | College Teaching | 3 |
| BIOL 630 | Critical Thinking for the Life Sciences | 3 |
| MATH 615 | Approaches to Quantitative Analysis in the Life Sciences [1] | 3 |
| **Computational Neuroscience Core Courses** | | |
| MATH 637 | Foundations of Mathematical Biology | 3 |
| MATH 635 | Analytical Computational Neuroscience | 3 |
| or MATH 636 | Systems Computational Neuroscience | |
| BIOL 641 | Systems Neuroscience | 3 |
| **Electives** | | |
| Approved electives [2] | | 12 |
| **Laboratory Rotations** | | |
| R120 509<br>& R120 510 | Adv Problems In Biology<br>and Adv Prob In Biol | 6 |
| **Required Research** | | |
| Research | | 36 |
| **Total Credits** | | **72** |

1. Equivalent course may be substituted if approved.
2. Elective course may be taken from offerings in the following graduate programs:
   - Rutgers University, Newark -- Biology, Environmental Sciences, Integrative Neuroscience, and Chemistry
   - NJIT -- Applied Mathematics, Physics, Biomedical Engineering, and Computer Science
   - RBHS -- Program in Biomedical Sciences
   - Rutgers University, New Brunswick and Camden -- various programs

   Prior to enrolling in courses offered by graduate programs outside of the Graduate Program in Biology, students must receive permission from the Graduate Standards Committee if they are pre-qualifiers or from the Program Director if they are post-qualifiers. This is accomplished by completion of the Graduate Transfer Credit Form. Whenever appropriate the student should consult with his/her thesis research advisor. Please check course catalogs and online schedule of classes for specific course offerings on a semester-by-semester basis.

## Notes on Grade Requirements in Coursework

Students are expected to successfully complete all of the core and elective credits taken within the graduate program. Course work provides the formal foundation upon which a successful dissertation project and thesis defense is built.

To remain in good standing, a GPA of 3.0 or better must be maintained for all courses taken as part of the graduate course of study. Courses cannot be repeated in order to improve on poor performance. Furthermore, while in the program a student can receive grades of C or C+ in a maximum of two courses, only one of which may be in the six Program and Track Core courses. Receipt of a grade of F in any course-core or elective - will under normal circumstances result in dismissal from the program at the end of the academic year.

# Mentoring Laboratory

Incoming student will be assigned to a "mentor lab" during their first semester in the program. During this time, students are required to actively participate in lab meetings, journal clubs, and other general lab activities. Additionally, the student must participate in some "minimal form" of research work as determined by the faculty mentor. At the end of the semester, the student must submit a brief three page-maximum report on the research conducted and the mentor submits a Student Rotation/Mentoring Evaluation Form to the Graduate Standards Committee.

# Biology Colloquium

The biolody colloquium is a combined seminar and reading course that provides students exposure to modern day research in areas representing the three tracks of the Ph.D program. Every student is required to attend the weekly colloquium seminars while he/she is matriculated in the Doctoral Program in Biology. Failure to meet this obligation (missing three or more colloquia) can result in loss of financial support and suspension from the Program.

# Laboratory Research Rotations

Laboratory rotations (Advanced Problems in Biology R120 509 Adv Problems In Biology, R120 510 Adv Prob In Biol) provide opportunities for laboratory research and independent study with graduate faculty members. Students are required to complete a minimum of two rotations; it is expected that one of the rotations will be completed in the laboratory where the student plans to complete his/her thesis work. Students start the first of two mandatory semester long laboratory rotations in the spring semester of the first year in the program. Typically rotations are completed in the spring and summer of the student's first year in the program.

Selection of laboratory rotation is done in consultation with the Graduate Standards Committee and the appropriate faculty member. The student must submit a Rotation Prospectus Form to the Graduate Standards Committee prior to the start of the rotation. Completion of the laboratory rotation requires the student to prepare a written report that is to be submitted within one month following the end of the rotation. The rotation advisor decides upon the format, content, and anticipated outcome of the rotation report. Additionally, at the end of the rotation the advisor submits a Student Rotation/Mentoring Evaluation Form to the Graduate Standards Committee.

The anticipated outcomes of the rotation include, but are not limited to, development of laboratory/field/computational research skills, development of analytical and critical thinking skills, appreciation of a specific research field, and identification of a prospective thesis research lab. Under extraordinary circumstances, the Graduate Standards Committee may approve a student's request to conduct a third rotation that must be completed in the fall semester of the second year in the program.

# Selection of Dissertation Lab

Following completion of all laboratory rotations, students must select a graduate faculty member who will serve as his/her primary advisor during the research phase of the doctoral program. This process is typically completed by the beginning of the second year in the program at which time the student will commence developing and accumulating preliminary data for his/her thesis dissertation project.

# Qualifying Examination

The qualifying exam will be administered by the Qualifying Examination Committee, which consists of three faculty members from the student's intended research track within the Graduate Program in Biology. A student's thesis advisor may not be a member of her/his Qualifying Examination Committee. The Qualifying Examination will be administered during the first two weeks of June. Examination dates will be posted on the department's Academic Calendar. Students take the examination at the end of their fourth semester in the program following successful completion of all core course requirements, successful completion of two rotations, and identification of the thesis advisor.

The Qualifying Examination will consist of written and oral components. Before beginning to write the detailed research proposal, the student sends a one-page summary of the specific aims to the Qualifying Exam Committee (this summary is to be submitted by April 1st at the latest). The committee must approve the proposal; the committee may offer general feedback on the scope of the project and suitability of the aims. There is no specific restriction on the subject of the qualifying exam proposal other than it must be original and the work product of the student. The proposal is the detailed description of a feasible research project, including specific aims, background and significance, and research design and methods (10,000 words maximum). A good format to follow is that of a pre- or post-doctoral grant application submitted to the National Science Foundation (specific format information is available in the program office). Preliminary data are NOT required as part of the proposal. The full proposal must be sent to each of the examiners at least 14 days before the date of the exam. Submitting a proposal that is too long or too late is unprofessional and runs the risk of non-acceptance and examination failure.

The Qualifying Exam Committee will review the written proposal for clarity of presentation, scientific soundness, and understanding of the hypothesis being tested. The student prepares an oral introduction and overview of the project that sound last no more than 25 minutes. The examiners will interrupt with questions during the presentation, so the actual presentation component will take longer. The oral presentation generally takes the form of a PowerPoint presentation, but any format that effectively communicates the main ideas is acceptable, including overheads and writing on a board. While the written proposal is the main focus of the exam, students are expected to demonstrate substantial knowledge in the field of the proposal and in related scientific areas. For example, if the proposal was aimed at understanding information transfer along the pathway from retina to visual cortex in the adult rodent, it would be fair the examiners to ask questions concerning the cell and the developmental biology of the pathway, the synaptic connectivity along the pathway, the general principles of synaptic physiology, and how it is studied.

The outcome of the examination must persuade the committee that the student has a solid comprehension of general principles and phenomena in the biological sciences and that he/she can reason through an experimental problem. Results of the examination will be reported on the Qualifying Examination Committee Report form and submitted to the Program Administrator. If a student does not pass the written and/or oral component of the qualifying examination, the student may be offered a second attempt to complete the exam. The reasons and recommendation for a second exam will be made available to the student via the Qualifying Examination Committee Report form. The second attempt at completion of the Qualifying Exam will take place six weeks after the initial exam date. Results of the second examination will be reported by completion submission of the Qualifying Examination Committee Report form. Failure to pass either the written or oral part of the qualifying examination on the second attempt will result in dismissal of the student from the program.

After successful completion of the Qualifying Examination, the student must submit to the Graduate Program Director either the Application for Admission to Candidacy for the Doctoral Degree (Rutgers matriculated students) or the Ph.D Examination Report Form (NJIT matriculated students) that was signed by all members of the Qualifying Examination Committee. After review and completion of the form by the Graduate Program Director, this application must be returned to the appropriate Office of the Graduate School Dean at Rutgers or the Office of Graduate Studies at NJIT.

## Thesis Prospectus and Dissertation Committee

Within six months of passing the Qualifying Examination, the student will prepare and submit a written thesis prospectus to her/his Dissertation Committee. The Dissertation Committee will be composed of the student's thesis advisor (who serves as committee chair), at least two other members of the Biology Graduate Faculty, and one member from outside the Rutgers_NJIT scholarly community; the external member may not be a member of the Graduate Program in Biology, he/she shall have demonstrated research expertise in the general area of prospective dissertation project, and he/she shall have no vested interest in the outcome of the dissertation research. The outside committee member may be appointed at any time but no later than one year prior to the dissertation defense. The Dissertation Committee is the primary advisor group responsible for supervision and guidance of the student during the research phase of the dissertation. The Dissertation Committee serves as the examination committee for the dissertation defense.

To establish Dissertation Committee, the student and advisor must submit the Ph.D Dissertation Committee Appointment Report for for approval from the Graduate Program Director. Students matriculated at NJIT are responsible for also completing the NJIT Ph.D Dissertation Committee Appointment Report and submitting this form to the NJIT Office of Graduate Studies; a copy is kept on file with the student's permanent record.

The written prospectus will follow the format of a NH or NSF postdoctoral fellowship application. The thesis prospectus meeting will determine the student's ability to conceive, design, and conduct the proposed research project. After completion of the Thesis Prospectus meeting, the outcome of the meeting must be recorded on the Dissertation Progress Report form and the completed form submitted to the Graduate Program Administrator for filling with the student's permanent record. Additionally for NJIT matriculated students, a Ph.D Proposal Defense Report must be completed; the signed original is returned to the NJIT Office of Graduate Studies and a copy is submitted to the Graduate Program Administrator.

During the course of the research thesis, the Dissertation Committee should regularly meet with the student (six month intervals is appropriate) to discuss research progress, experimental challengers, and potential changes to the original thesis prospectus. Meeting dates, recommendation, and outcomes will be recorded by the Thesis Advisor on the Dissertation Progress Report form and forwarded to the Program's Administrator for filling with the student's permanent record.

In the event a student does not successfully complete his/her thesis prospectus in a timely manner, the Standards Committee will convene a meeting with the student and his/her mentor to review the student's progress and to prepare a plan of action for completion of the prospectus requirement. A record of this meeting will be detailed on the Dissertation Progress Report form that becomes part of the student's permanent file.

Failure to comply with the above timelines and procedures can result in loss of departmental financial support and dismissal from the program.

## Dissertation Defense

Approximately six months prior to the Dissertation Defense, the Dissertation Committee will convene a meeting with the Ph.D candidate for a final progress report to the committee. The meeting should be attended by all members of the Dissertation Committee (internal and external), at which time the committee will evaluate if sufficient progress has been made to warrant the final preparation of the thesis and to establish an approximate timetable for completion of the thesis. The outcome of this meeting is recorded and reported on the Dissertation Progress Report form.

The completed dissertation must be submitted to all members the final Dissertation Committee at least one month prior to the scheduled Dissertation Defense. The Dean of the Rutgers-Newark and NJIT Graduate Schools, Program Director, and Department Chairs must be invited to attend and the event must be publicized and open to anyone wishing to attend. The public defense of the dissertation is followed by an oral examination by the Dissertation Committee. Following completion of the Dissertation Defense the student's advisor must complete and file a Defence Report form with the Graduate Program Administrator.

Upon successful defense of the dissertation, Rutgers matriculated students must retrieve the Application for Admission to Candidacy for the Doctoral Degree previously submitted to the Office of the Dean of Graduate School-Newark and present this to the Chair of the Dissertation Committee. The Dissertation Committee must sign the retrieved form, and the Program Director must sign Part II of the Application for Admission to Candidacy for the Doctoral Degree. Students matriculated at NJIT are required to file the Ph.D Dissertation Defense Report form, which must be signed by all Dissertation Committee member, the Graduate Program Director and the Department Chairman before returning the original to the NJIT Office of Graduate Studies; a copy is forwarded to the Graduate Program Administrator. The student should consult with the appropriate Office of the Dean well in advance of his or her anticipated completion date regarding submission deadlines for the Diploma Application, submission requirements for the dissertation, payment of the microfilming fee, and other matters.

In the event that the student fails to successfully defend the dissertation, one additional Dissertation Defense may be attempted. Reasons for the failure will be provided on the Ph.D. Dissertation Defense Report form. Failure on the second attempt will result in dismissal from the program. Appeals by the student should be directed to the Academic Standing and Student Review Committee of the Graduate School.

The Rutgers Graduate School has a seven-year limit for full time students for attaining a doctoral degree. The NJIT Office of Graduate Studies allows no more than six years of registration for doctoral dissertation.

## Assistantships and Fellowships

Full-time matriculated students may be offered, on a competitive basis, assistantships or fellowships. These are academic or calendar year awards and are renewable on a yearly basis, usually for not longer than a total of five years. Students are encouraged to apply to national, regional, and state level funding agencies to obtain grant support to their intended research program.

## Teaching Duties

Students awarded teaching assistantships generally will be given teaching assignments each semester. Failure to perform adequately as a teaching assistant will result in revocation of the assistantship by the Program Director.

Students awarded graduate assistantship, research assistantship, or fellowships through the Department or who are supported by research grants or external fellowships will be expected to serve a total of not less than two semesters for a total of six to nine contact hours as teaching assistants, except in instances in which the assistantship or fellowship explicitly requires that the student not engage in any teaching activities. The Department Chair makes teaching assignments. Students awarded assistantships or fellowships are not permitted to hold employment outside the University. Failure to comply with this regulation will result in immediate revocation of the assistantship or fellowship.

## Research Project Location

All thesis research must be performed on site with the student's advisor in University facilities. The term "on site" includes appropriate venues such as, but not limited to, field sites, research stations, museums, aquaria and other such locations.

## Exceptions to Regulations

Exceptions to the foreign regulations may be granted by the Program Director, after consultation with the Admissions Committee and the Graduate Standards Committee, only in extremely unusual circumstances and only after rigorous justifications is presented in writing to the Program Directors.

Applications for performing research off-campus must include a detailed proposal for the research and the special facilities required for the project. A student may not register for "Matriculation Continued" unless he/she has been admitted to candidacy and has completed all coursework requirements (36 credits), rotations, and thesis prospectus,

## General Notes on Curriculum

Although the Program has three tracks and most students are likely to choose one track in which to concentrate, the Ph.D. program recognizes that some students may wish to establish an individualized course of study intermediate between the tracks. The individualized course of study must be developed in consultation with the student's major advisor and the Standards Committee with written approval of the Program Director.

## Academic Integrity and Scholarly Ethics

All students, faculty and staff associated with the Graduate Program in Biology are expected to adhere to the highest standards of academic integrity and scholarly ethics. As a guide to academic integrity and scholarly ethics please refer to the following sites:

http://academicintegrity.rutgers.edu/academic-integrity-at-rutgers
http://integrity.njit.edu

http://uhr.rutgers.edu/ethics/

## Lecture Outline

There will be 4 lecture exams ( a test will follow sections I-IV).

**I. Test #1:** The basis of cell structure and the structure and function of proteins, DNA and chromosomes will be discussed. Emphasis will be placed on the structure of DNA as it relates to replication, repair and recombination. **Chapters 1 & 4-6.**

**II. Test #2:** The regulation of transcription and translation in both prokaryotes and eukaryotes will be discussed with emphasis placed on laboratory techniques such as DNA cloning and manipulation will be discussed. **Chapters 7-8 & 10.**

**III. Test #3:** The structure of the plasma membrane and its use in both intercellular and intracellular transport will be discussed. **Chapters 11-12 & 15.**

**IV. Test #4:** The use of plasma membrane and the cytoskeleton in cell communication and cell division will be discussed. The molecular regulation of cell division and errors in cell division will also be covered. **Chapters 16-18 & 20.**

## Laboratory Outline

1. Laboratories will be completed and handed in the day they are complete in their entirety.
2. Labs are found in your lab manual and should be read in time for the lab.
3. Students may work in groups of 2-3 and should remain lab partners for the semester, as you will be sharing lab equipment.
4. The following labs will be covered during this semester (see calendar)
    a. Protein Purification
    b. Isolation of DNA from your cells and the Polymerase Chain Reaction
    c. Analysis of your PCR reactions
    d. Isolation and analysis of proteins from cells
    e. Western Blotting
    f. Cell Transformation
    g. Analysis of Cell Transportation
    h. Cell structure and communication
    i. Analysis of common mutations in cancer cells
    j. Capstone Lab: Restriction digests

# Chemistry and Environmental Science

## Chemistry

### Master of Science in Chemistry

An undergraduate degree in chemistry or chemical engineering is usually required. Students with baccalaureate degrees in other areas of science and engineering may be considered for admission and required to take an individually designed program that includes undergraduate courses before beginning the graduate program. These courses are not counted toward degree credit.

A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent, is typically required for admission. General GRE scores must be submitted by those seeking financial support and those whose last prior degree was from outside the United States. Subject GRE is not required. International students must achieve a minimum TOEFL score of 550 (paper and pencil) and 213 (computer based).

***Off-Campus Programs:*** At the National Starch and Chemical Corporation, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see **Extension Programs** in this catalog. In addition, a distance-based, 12-credit graduate certificate in Applied Chemistry is available as a step toward this degree for employees of the corporation. For further information about extension programs and **Graduate Certificates**, call the Associate Vice President for Continuing and Distance Education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; e-mail: cpe@njit.edu.

### Doctor of Philosophy in Chemistry

Doctoral candidates are expected to demonstrate creative thinking, self-motivation and a commitment to achieving quality in their research product. Departmental research includes a well-balanced mixture of experimental, computational, and theoretical projects in the areas of analytical, bio-, organic, inorganic, and physical chemistry. Chemistry doctoral students address real problems, have strong interactions with their advisors and are expected to solve pertinent chemical and environmental problems.

Qualified students may be accepted directly into the program with a bachelor's degree or after they have completed a master's degree in chemistry. A GPA in previous work of 3.5 or better is expected, and international students must submit a TOEFL score of at least 550 (214 on the computer based test). General GRE scores are also required for admission. GRE subject scores are not required. Although the program is intended for full-time students, courses many be taken on a part-time basis initially. A minimum of one year in full-time residency required for completion of the dissertation. Teaching assistantships (TAs) and Research Assistantships (RAs) are available on a competitive basis. In addition to tuition remission, assistantships include stipends for Ph.D. students.

# Environmental Science

The environmental science graduate programs are offered through several departments at New Jersey Institute of Technology and at Rutgers Newark, collaborating in an interdisciplinary program of research and teaching. These are the departments of Chemistry and Environmental Science, Environmental Engineering and Environmental Policy at NJIT, the Federated Department of Biological Sciences, and the Rutgers-Newark Department of Earth & Environmental Sciences. The strong research program is supported by major grants from federal and state agencies, and industry. Environmental science plays a major role in several NJIT research centers, including the Otto York center for Environmental Engineering and Science.

## Master of Science in Environmental Science

This is an interdisciplinary program intended for individuals with backgrounds in science or engineering who want advanced education in the identification, management, treatment and effects of hazardous and toxic materials in the environment. It may be taken on a part-time or full-time basis.

### Admission Requirements

Applicants should have undergraduate degrees in chemistry, biology, chemical engineering, environmental engineering, environmental science, or related fields who have taken a minimum of one year of college chemistry and mathematics through calculus. Students who lack an appropriate background may be considered for admission and required to take a program of courses that is designed in consultation with the graduate advisor. These may include undergraduate courses which are not counted toward degree credit.

A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent, is typically required for admission. Those applying for financial support and those whose last prior degree was from outside the United States must submit GRE scores. International students must achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based).

## Doctor of Philosophy in Environmental Science

This is a research-oriented degree intended for full-time students. Although courses may be taken on a part-time basis, a minimum of one year of full-time residency is typically required for completion of the doctoral dissertation.

### Admission Requirements for Students Entering with a Master's Degree

A master's degree in chemistry, biology, chemical engineering, environmental engineering, environmental science, or related fields is usually required. Highly qualified students with bachelor's degrees in these fields may also be accepted directly into the doctoral program.

A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is typically required for admission. GRE scores must be submitted. International students must achieve a minimum TOEFL score of 550.

### Admission Requirements for Students Entering with a Bachelor's Degree

Exceptional students with appropriate undergraduate degrees may apply directly for admission to the doctoral program. Applicants are evaluated on a case-by-case basis. A minimum undergraduate GPA of 3.5 on a 4.0 scale, or equivalent, is typically required for admission. GRE scores must be submitted. International students must achieve a minimum TOEFL score of 550.

# Environmental and Sustainability Policy

The Graduate Program in Environmental and Sustainability Policy focuses on the role of the social sciences in the development, implementation, and evaluation of environmental policy. Building on the strengths of a technological university, students take a series of foundation courses (Tier One) in environmental social science, environmental science, research methods, and economics. Advanced courses (Tier Two) build on this initial framework and provide extensions in specific applications in environmental law, energy policy, and a selection of advanced topics.

The faculty is multidisciplinary with strengths in environmental social science, economics, geography, and law. Graduates of the program have secured employment in both the public and private sectors including with the United States Environmental Protection Agency, the New Jersey Department of Environmental Protection, regional planning commissions, local community development programs, and engineering and planning firms. Graduates have also entered doctoral- level programs in environmental science, policy, and law.

The Ph.D. in Environmental Science (Policy Concentration) is offered by the Department of Chemistry and Environmental Science of which the Graduate Program in Environmental Policy is a constituent part. Successful environmental policies must rest on the development of reliable models for assessing change to the biophysical environment in the presence of human action. The Department offers a research-oriented doctoral degree in Environmental Science with a concentration in Environmental Policy. The program emphasis is on the integration of environmental and social sciences to develop more effective responses to contemporary problems of resource management. For more information about degree requirements, please visit the website of the Department of Chemistry and Environmental Science.

## Master of Science in Environmental and Sustainability Policy

The Master of Science in Environmental and Sustainability Policy is designed to provide students with the opportunity to acquire skills in the methods and tools used in environmental problem solving and policy analysis. The Program may be completed on a part-time or full-time basis. Courses are offered both online and on a face-to-face basis.

## Admission Requirements

The following criteria are applied when considering an applicant for admission to the program:

- An undergraduate degree in earth sciences (e.g. physical geography, geology, meteorology, ecology), social sciences (e.g. human geography, economics, sociology), engineering (e.g. environmental, civil, chemical) or another related discipline.
- An undergraduate GPA of at least 3.0 and at least 3.5 in major field (on a scale of 4.0).
- A minimum of one semester of statistics at the undergraduate level; an advanced statistics course at the undergraduate level is highly desirable.
- A combined GRE score (verbal and quantitative) of at least 1100

The following materials must be submitted to be considered for admission:

- Application for Admission to Graduate Study form
- MS-EPS Supplemental Materials form
- Official transcripts of all prior work and certificate of graduation
- Personal statement (two to three pages)
- Three letters of recommendation
- Graduate Record Examination (GRE) scores
- International students are required to pass the TOEFL at 550 (pencil and paper), 213 (computer based) or above.

# NJIT Faculty

## B

Balasubramanian, Bhavani, University Lecturer

Bonchonsky, Michael P., University Lecturer

Bozzelli, Joseph W., Distinguished Professor

Butherus, Alexander D., University Lecturer

## C

Conley, Robert J., Emeritus

## D

Dauerman, Leonard, Associate Professor

## E

Ellis, Frank B., Senior University Lecturer

## F

Farinas, Edgardo T., Associate Professor

## G

Getzin, Donald, Associate Professor Emeritus

Gilbert, Kathleen M., University Lecturer

Gund, Tamara, Professor

## H

Huang, Haidong, Assistant Professor

### J

Jackson, Nancy L., Professor

### K

Kebbekus, Barbara B., Professor Emeritus

Khalizov, Alexei, Assistant Professor

Krasnoperov, Lev N., Professor

### L

Lambert, Donald G., Associate Professor Emeritus

Lei, George Y., Associate Professor Emeritus

### M

Mitra, Somenath, Distinguished Professor

### P

Petrova, Roumiana S., Senior University Lecturer

### Q

Qiu, Zeyuan, Associate Professor

### S

Skawinski, William, Senior University Lecturer

### V

Venanzi, Carol A., Distinguished Professor Emeritus

## Programs



## Programs



## Chemistry and Environmental Science Courses

**CHEM 590. Graduate Co-Op Work Exper I. 3 credits, 3 contact hours.**

**CHEM 591. Graduate Co-Op Ork Exper II. 3 credits, 3 contact hours.**

**CHEM 592. Graduate Co-Op Work Exper III. 3 credits, 3 contact hours.**

**CHEM 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CHEM 599. Methods for Teaching Assistants and Graduate Assistants. 3 credits, 3 contact hours.**
Restriction: graduate standing. Required for all chemistry teaching assistants and graduate assistants. Covers techniques of teaching, interaction with students, and safety. Does not count as degree credit.

**CHEM 601. Special Topics in Chemistry I. 3 credits, 3 contact hours.**
Restriction: graduate standing and permission of the instructor. Topics of current interest in chemistry.

**CHEM 605. Advanced Organic Chemistry I: Structure. 3 credits, 3 contact hours.**
Prerequisite: undergraduate organic chemistry. Structure of organic molecules. Topics include atomic and molecular structure, stereochemistry, reactive intermediates (cations, anions, radicals, and carbenes), orbital symmetry, and spectroscopy.

**CHEM 606. Physical Organic Chemistry. 3 credits, 3 contact hours.**
Prerequisite: CHEM 502 or equivalent. Emphasis is placed on the physical aspects of the subject. Determination of reaction mechanisms, equilibria, and kinetics using simple molecular orbital theory and absolute reaction rate theory.

**CHEM 610. Advanced Inorganic Chemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate physical chemistry or permission of the instructor. Theories of observed chemical and physical properties of the elements and their compounds; prediction of reactivity and properties of proposed new compounds.

**CHEM 617. Mass Spectrometry and Interpretation of Mass Spectra. 3 credits, 3 contact hours.**
Prerequisite: CHEM 125 and CHEM 126 or equivalent. Historical background, fundamentals and mechanics of operation for components incorporated into modern Mass Spectrometers: vacuum system, ion sources, mass filter, ion detection, plus computer operation and data collection. Explanation and interpretation of mass spectra and fragmentation patterns are a fundamental theme throughout the course. Lecture material includes principles of operation and appropriate applications for modern types of mass spectrometers: magnetic sector, quadrupole, time of flight, ion trap, FT-ICR. Theory and applications of electron impact, chemical, electrospray, and other ionization techniques including atmospheric sampling are covered. High resolution analysis using magnetic sector and FT - ion cyclotron instruments. Analytical applications in environmental, petroleum and biochemical analysis and applications and coupling of mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

**CHEM 658. Advanced Physical Chemistry. 3 credits, 3 contact hours.**
Prerequisite: one year of undergraduate physical chemistry. Principles and applications of quantum chemistry; the wave equation, its properties and mathematics; the Schrodinger equation and wave functions; the harmonic oscillator; variational and perturbational methods; atomic theory, structure, and properties; simple molecules, LCAO and valence bond theories; semi-empirical methods; time dependence, and introduction to electronic and vibration-rotation spectroscopy.

**CHEM 661. Instrumental Analysis Laboratory. 3 credits, 3 contact hours.**
Prerequisite: one year of undergraduate physical chemistry. Instruments for chemical analysis are discussed in class and used in the laboratory; basic theory; sample preparation; use of instruments and interpretation of data are covered for spectroscopy including UV0VIS, FTIR, AA, and NMR; HPLC, GC, ion chromatography, mass spectrometry. Applications to food science, pharmaceuticals, polymers, and other chemical areas.

**CHEM 662. Air Pollution Analysis. 3 credits, 4 contact hours.**
Prerequisite: undergraduate physical chemistry. Chemical and physical principles of gaseous species and trace level measurement techniques for airborne vapors and particulates. Emphasis on analyzing real air samples at the parts-per-billion level, meteorological dispersion and life times of pollutants are covered. Laboratory work in air pollution sampling methods for vapor and particulate species. Determination of primary air pollutants using wet chemical and instrumental techniques.

**CHEM 673. Biochemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate organic and physical chemistry, or suitable background in these subjects. Fundamentals of biochemistry related to physical organic chemistry for students who have an interest in biomedical engineering, chemistry, chemical engineering, or environmental science.

**CHEM 700. Masters Project. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the master's degree. An extensive report involving an experimental, theoretical, or literature investigation is required. The literature investigation should result in a critical review of a specific area. Approval to register for the master's project must be obtained from the project advisor. Students must continue to register for at least 3 credits each semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

**CHEM 700B. Masters Project. 3 credits, 3 contact hours.**
Restriction: matriculation for the master's degree. An extensive report involving an experimental, theoretical, or literature investigation is required. The literature investigation should result in a critical review of a specific area. Approval to register for the master's project must be obtained from the project advisor. Students must continue to register for at least 3 credits each semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

**CHEM 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the master's degree in applied chemistry. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the department, and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum of 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**CHEM 701B. Masters Thesis. 3 credits, 3 contact hours.**

**CHEM 701C. Masters Thesis. 6 credits, 3 contact hours.**

**CHEM 702. Special Topics in Chemistry II. 3 credits, 3 contact hours.**
Restriction: Graduate standing. Topics of current interest in chemistry.

**CHEM 714. Pharmaceutical Analysis. 3 credits, 3 contact hours.**
The objective of this course is to provide an overview of instrumental techniques used in the analysis of different pharmaceutical products. Many different types of analysis are carried out in the pharmaceutical industry pertaining to active ingredients, formulations as well as impurities and dgradants. The focus will be on instrumentation such as chromatography, mass spectroscopy, different types of spectroscopy, quality assurance and GMP.

**CHEM 716. Integrated Drug Dev & Discover. 3 credits, 3 contact hours.**
Prerequisites: Strong background in organic chemistry This course offers an overview of the drug development process combined with hands-on experience in computer-aided drug design. Topics include pharmacokinetics, bioavailability, drug formulation, and structure-based drug design.

**CHEM 717. Mass Spectrometry and Mass Spectral Interpretation. 3 credits, 3 contact hours.**
Prerequisites: CHEM 125 and CHEM126 or equivalent. CHEM 717 and EVSC 617 are comprised of CHWM 717 and EVSC 617 plus a research project: Research projects usually comprise experimental and mass spectrometry interpretation studies. These can be performed at NJIT or in the students corporate mass spectrometry facility. Projects may also include theory, data interpretation or literature reviews pertinent to a current active area in mass spectrometry research. Projects should be approved or in consult with the instructors.

**CHEM 718. Organic Synthesis. 3 credits, 3 contact hours.**
Organic Synthesis is widely used in the production of organic materials and pharmaceutical drugs. The course introduces modern synthetic methods to the graduate students of NJIT. The first part of the course teaches organic reactions categorized by their roles in synthesis. Topics include substitution and addition of carbon nucleophiles, functional group conversion, oxidation, reduction, concerted cycloadditions, aromatic substitutions, and organometallic catalysis. The second part of the course teaches general strategies to develop synthetic plans, special considerations for difficult synthetic targets, and examples of natural product synthesis.

**CHEM 719. Drug Delivery Systems. 3 credits, 3 contact hours.**
Prerequisites: Strong background in organic chemistry This course emphasizes the importance of effective drug delivery to achieve specific therapeutic outcomes. Students learn current trends in research on the design of drug delivery systems to release drug content in a controllable and targeted manner.

**CHEM 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisite: permission from the graduate advisor (not thesis advisor) in chemistry, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHEM 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHEM 727. Independent Study III. 3 credits, 3 contact hours.**
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHEM 734. Thermochemical Kinetics-Detailed Mechanistic Modeling. 3 credits, 3 contact hours.**
Prerequisite: graduate level course in either kinetics or reactor design, or permission of instructor. Quantitative estimation of thermochemical data and chemical reactions in the vapor phase, and to some extent in the liquid phase; theories of transition state, RRKM, and Quantum RRK; and detailed chemical modeling concepts for reactor design. Applied computer project is required.

**CHEM 735. Combustion. 3 credits, 3 contact hours.**
Prerequisite: thermodynamics and kinetics or equivalent, or permission of instructor. Thermodynamic properties of stable molecules and free radical species in combustion and oxidation of aliphatic hydrocarbons; reactions occurring in high temperature combustion systems; and related kinetic principles.

**CHEM 737. Applications of Computational Chemistry and Molecular Modeling. 3 credits, 3 contact hours.**
Students are exposed to hands-on applications and fundamental aspects of computational chemistry and molecular modeling in organic, inorganic, bio- and physical chemistry. The course provides methods to determine the thermochemistry of a reaction, and strength (energy)of interactions by organic drug-like molecules with proteins. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium ratios in chemical environments.

**CHEM 748. Nanomaterials. 3 credits, 3 contact hours.**
New feature of the 700 level course will be hands-on small projects carried out by groups of two students in Professor Iqbal's laboratories during the second half of the semester. The projects will be selected from the topics covered in the course. A second feature will involve a lecture on a specialized nanomaterial topic given by an invited outside lecturer. This 3 credit interdisciplinary course is designed to teach and provide hands-on project experience to M.S. and Ph.D. graduate students in chemistry, physics/materials science, and chemical/biomedical/electrical engineering on the fundamentals, synthesis, characterization and applications of nanomaterials. 75% of the course will comprise of lectures-one or two of which will be given by invited outside lecturers. 25% of the course will involve small projects based on the syllabus and conducted in the research laboratories of the instructor.

**CHEM 764. Advanced Analytical Chemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate General and Analytical Chemistry. The principles of chemical analysis as they apply to chromatography, electrochemistry, and spectroscopy. Sampling considerations, separations, and sample preparation steps. This course is a useful adjunct to CHEM 661, where these analytical techniques are considered in a more practical way.

**CHEM 777. Principles of Medicinal Chemistry. 3 credits, 3 contact hours.**
Teaches about drug design, and the molecular mechanisms by which drugs act in the body. Covers pharmacodynamics, pharmacokinetics, molecular targets used by drugs, the interaction of a drug with a target, and the consequences of this interaction. Covers strategies used in discovering and designing new drugs, and surveys the "tools of the trade" involved, e.g., QSAR, combichem and computer aided design. Covers special topics like chlorinergics, analgesics, opiates, antibacterials, antivirals, and antiulcer agents.

**CHEM 790. Doctoral Dissertation. 0 credits, 0 contact hours.**

**CHEM 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**

**CHEM 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**

**CHEM 790C. Doctoral Dissertation. 6 credits, 3 contact hours.**

**CHEM 790D. Doctoral Dissertation. 9 credits, 3 contact hours.**

**CHEM 790E. Doctoral Dissertation. 12 credits, 3 contact hours.**

**CHEM 790F. Doctoral Dissertation. 15 credits, 15 contact hours.**

**CHEM 790G. Doctoral Dissertation. 18 credits, 18 contact hours.**

**CHEM 791. Graduate Seminar. 0 credits, 0 contact hours.**
Required of all chemistry graduate students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

**CHEM 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**CHEM 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**CHEM 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.**

**EPS 601. Research Methods for Environment and Sustainability Policy. 3 credits, 3 contact hours.**
Introduces the research methods necessary to conduct studies in environmental and sustainability policy. Topics covered include literature review, problem identification, hypothesis testing, and quantitative methods of data analysis and problem solving. Students are required to implement and present their independently designed projects.

**EPS 602. Research Analysis for the Social and Policy Sciences. 3 credits, 3 contact hours.**
Prerequisite: EPS 601. Distribution of social, political, economic and health-related data in both samples and populations using a general linear model with residuals. Test hypotheses using both the Fisher and Neyman-Pearson criteria. Use of software such as SPSS, Microsoft Excel and Resampling Stats. to develop and test models using correlation, regression and ANOV techniques.

**EPS 609. Environmental Risk Assessment. 3 credits, 3 contact hours.**
Methodology to assess the social and economic risks to present-day environmental resources of air and water; cost-benefit and trade-off analysis; technical characteristics of materials such as half-life, decomposition rates, and temperature sensitivity; and probabilities of various environmental situations.

**EPS 612. Introduction to Environmental Policy Studies. 3 credits, 3 contact hours.**
Introduction to six areas essential to a comprehensive understanding of environmental policy: concept of environmental policy; tools (law, economics, planning, science, engineering, ethics) for environmental policy; the U.S. perspective (NEPA, clean air and water acts, CERCLA); the international perspective (Club of Rome models, 1972 UNEP, 1992 Rio); industrial perspective (pollution prevention/life cycle engineering, privatization); and the local perspective (New Jersey DEP, NGOs, local industry, shoreline.) Same as MIP 612.

**EPS 613. Environmental History and Policy. 3 credits, 3 contact hours.**
Explores the dialogue between humanity and the environment in the United States, as well as its global implications. Surveys fundamental themes of history and policy from an environmental perspective: colonial development, independence, western expansion, industrialization, urbanization, and the rise of a consumer society. Gives special attention to the emergence of an environmental perspective: wilderness appreciation, the conservation movement, public health, the rise of the environmental movement since the 1960s, environmental science, and the legislative and regulatory process.

**EPS 614. Environmental Economics and Management. 3 credits, 3 contact hours.**
Overviews the complex and dynamic interactions between the economy and the environment from biological, economic, and institutional perspectives and investigates various strategies for resolving conflicts in resource management and pollution control. Topics include the basic principles of risk assessment, cost benefit analysis, and cost-effectiveness analysis in environment management and assessment of contemporary environment politics in air and water pollution control and waste and toxics management.

**EPS 622. Sustainable Politics and Policy. 3 credits, 3 contact hours.**
Identifies the origins of the concept of sustainability development and institutional efforts to implement strategies at various geopolitical scales: international, national, regional, and local. The course introduces tools to measure progress toward sustainability through the use of metrics such as ecological footprint analysis and life-cycle analysis. Other topics include steady-state economics, sustainable systems of production and consumption, and sustainability transitions.

**EPS 638. Physical Geography. 3 credits, 3 contact hours.**
Understanding the interaction between humans and the physical environment is important to the formulation of sound environmental policy. The course examines processes that shape the physical environment, the influence of human activities on these processes and the physical environment, and the application of this information to solving environmental problems.

**EPS 644. The Rhetoric of Environmental Policy. 3 credits, 3 contact hours.**
Introduces students to the major types of rhetorical analysis as well as assures that students can analyze and write technology policy that is informed by core rhetorical principles of that analysis.

**EPS 651. Introduction to Urban and Environmental Health. 3 credits, 3 contact hours.**
Health problems associated with the social and psychological factors found in urban areas and health problems stemming from contamination of air, water, food, the work place and other special environments. Policies required to promote healthful living behavior and those required to regulate negative externalities.

**EPS 660. Ethics and Environmental Policy. 3 credits, 3 contact hours.**
Contemporary environmental problems from the perspective of ethics or moral philosophy. Is there a moral obligation to preserve or protect the natural environment? What are the ethical presumptions and values underlying environmental policy? Are traditional theories of moral philosophy applicable to contemporary environmental problems, or is a new conception of the relationship between humanity and nature needed?.

**EPS 698. ST:. 3 credits, 3 contact hours.**
Course considers advanced topics of special or current interest related to environmental and sustainability policy.

**EPS 699. ST:. 3 credits, 3 contact hours.**
Course considers advanced topics of special or current interest related to environmental and sustainability policy.

**EPS 700. Master'S Project. 0 credits, 0 contact hours.**

**EPS 700B. Master'S Project. 3 credits, 3 contact hours.**

**EPS 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the master's degree, advisor's and departmental approval. Projects involving fieldwork, experimental, or theoretical investigation carried out under the supervision of a designated member of the departmental faculty. The completed thesis should be of a quality as to warrant publication, in whole or in part, in a professional journal. A minimum of 3 credits per semester is required until completion.

**EPS 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Restriction: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**EPS 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Restriction: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**EPS 702. Special Topics. 3 credits, 3 contact hours.**
Restriction: Approval of graduate advisor in Environmental Science. Topics of current interest in the field of environmental policy. Doctoral level course.

**EPS 712. Advanced Studies in Environmental and Sustainability Policy. 3 credits, 3 contact hours.**
Evaluates strategies to reduce energy and material throughput including eco-efficiency relocalization of production and consumption, and green consumerism. Also considered are debates surrounding innovative policies to foster work-time reduction, to develop alternative measures of well-being, and to include societal values shifts.

**EPS 714. Environmental and Natural Resources Economics. 3 credits, 3 contact hours.**
Examines environmental regulation of firms and natural resource use with emphasis on the theoretical foundations required for public policy. Students focus primarily on the application of economic tools to improve environmental quality.

**EPS 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: matriculation for the master's degree, advisor's and departmental approval. Projects not within the scope of existing courses are carried out under the supervision of a designated member of the departmental faculty.

**EPS 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: matriculation for the master's degree, advisor's and departmental approval. Projects not within the scope of existing courses are carried out under the supervision of a designated member of the departmental faculty.

**EVSC 591. Graduate Work Experience. 3 credits, 3 contact hours.**

**EVSC 592. Graduate Work Experience. 3 credits, 3 contact hours.**
Restriction: permission of the associate chairperson for environmental science and the Division of Career Development Services. Provides on-the-job reinforcement of environmental science assignments. Projects are developed by the co-op office in consultation with the associate chairperson for environmental science. Cannot be used for degree credit.

**EVSC 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisite: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**EVSC 600. Environmental Science Seminar. 0 credits, 3 contact hours.**
Restriction: graduate standing. Current environmental topics of interest to the environmental professional are presented. Required every semester for environmental science graduate students receiving departmental or research-based awards and for all doctoral students.

**EVSC 602. Special Topics in Environmental Science I. 3 credits, 3 contact hours.**
Restriction: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

**EVSC 603. Hazardous Waste Operations and Emergency Response. 3 credits, 3 contact hours.**
Explores the safe operation of hazardous waste sites as well as emergency responses to hazardous releases. Overview of OSHA regulations and NIOSH standards concerning toxicological hazards and medical surveillance requirements. Emphasis on recognition and monitoring of site hazards. A written health and safety plan, and participation in a group problem involving a simulated hazardous site entry using actual protective equipment is required. Course satisfies the regulatory compliance mandates to meet 29 CFR 1910.120 for OSHA, with certification valid for one year.

**EVSC 610. Environmental Chemical Science. 3 credits, 3 contact hours.**
Restriction: graduate standing. Principles of physical, inorganic and organic chemistry are applied to understanding the origins of environmental pollutants, their transport, distribution and decomposition pathways.

**EVSC 611. Hazardous Waste Management. 3 credits, 3 contact hours.**
Restriction: graduate standing. An overview of hazardous waste management; case histories; legislation and regulations; treatment, disposal and cleanup technologies; sampling and analysis methodology; persistence and fate in the environment; emergency response procedures.

**EVSC 612. Environmental Analysis. 3 credits, 4 contact hours.**
Restriction: graduate standing. The analysis of environmental samples is studied from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis, and data treatment.

**EVSC 613. Environmental Problem Solving. 3 credits, 3 contact hours.**
Restriction: graduate standing. This course is designed to study solutions for current environmental problems. Students are asked to respond to an imaginary Request for Proposal (RFP) in writing and before a team of technical experts at an oral presentation. Solutions proposed in student RFPs must reflect knowledge of environmental science and technology in current use.

**EVSC 614. Quantitative Environmental Risk Assessment. 3 credits, 3 contact hours.**
Restriction: graduate standing. Applications ofquantitative risk assessment concepts to the management of environmental problems.

**EVSC 615. Global Environmental Problems. 3 credits, 3 contact hours.**
Restriction: graduate standing. With an understanding that environmental problems are not restricted by geographical boundaries, relationships of the earth's temperature balance, global air circulation patterns, global energy needs, and control and remediation technologies are studied.

**EVSC 616. Toxicology for Engineers and Scientists. 3 credits, 3 contact hours.**
Restriction: graduate standing. The general principles of toxicology are presented and applied to the assessment of acute, subacute and chronic effects of hazardous and toxic chemicals. Qualitative and quantitative measures of toxicity and testing protocols are addressed. The role of toxicology in risk assessment and risk management is discussed.

**EVSC 617. Mass Spectrometry and Interpretation of Mass Spectra. 3 credits, 3 contact hours.**
Prerequisite: CHEM 125 and CHEM 126 or equivalent. Historical background, fundamentals and mechanics of operation for components incorporated into modern Mass Spectrometers: vacuum system, ion sources, mass filter, ion detection, plus computer operation and data collection. Explanation and interpretation of mass spectra and fragmentation patterns are a fundamental theme throughout the course. Lecture material includes principles of operation and appropriate applications for modern types of mass spectrometers: magnetic sector, quadrupole, time of flight, ion trap, FT-ICR. Theory and applications of electron impact, chemical, electrospray, and other ionization techniques including atmospheric sampling are covered. High resolution analysis using magnetic sector and FT - ion cyclotron instruments. Analytical applications in environmental, petroleum and biochemical analysis and applications and coupling of mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

**EVSC 621. Ecological Risk Assessment. 3 credits, 3 contact hours.**

**EVSC 622. Bioremediation. 3 credits, 3 contact hours.**

**EVSC 623. Environmental Health. 3 credits, 3 contact hours.**

**EVSC 624. Environmental Analysis Methods and Laboratory. 3 credits, 4 contact hours.**
Basic theory, methods, instruments, and data interpretation for chemical analysis of environmental samples are described in lectures and used in the laboratory; sampling; sample preparation; quality assurance, chain of custody. Instrument methods and uses include: UV-VIS, FTIR, AA, HPLC, GC, Ion Chromatography, and Mass Spectrometry as applied to environmental samples.

**EVSC 625. Social Dimensions of Risk. 3 credits, 3 contact hours.**
Low-probability/high consequence events involving terrorism, food safety, and extreme weather offer ample evidence the prevalent approaches of economics and statistics are not able to deal with the complex ways that risk permeates modern societies. This course treats risk analysis as a broad interdisciplinary activity and draws on the full range of the social sciences to explore the multifaceted way that risk infuses itself into the fabric of contemporary affairs.

**EVSC 626. Hydrogeology. 3 credits, 3 contact hours.**
This course covers the principles of ground water flow, advanced water cycle properties, aquifer flow and aquifer recharge. Contaminant migration and remediation methods are discussed. Basic groundwater chemistry and quality is covered.

**EVSC 627. Environmental Microbiology. 3 credits, 3 contact hours.**
Prerequisite: R120 101, R120 102, (General Biology I and II) or permission of instructor. This course offers an overview of 1) basic microbiology: biochemical principles, cell structure organization, microbial nutrition and growth, 2) the important microbes involved in environmental microbiology and address the environments where they are found, and 3) how they are detected and monitored, and their effects on humans, and the environment. Traditional lectures and exams are supplemented with discussions of current research articles.

**EVSC 700. Masters Project. 0 credits, 0 contact hours.**
Prerequisite: graduate standing and approval of the graduate advisor in environmental science. Written report requiring experimental or theoretical research, or an extensive literature analysis. Registration must be approved by an advisor. Students must continue to register for 3 credits each semester until completion and a written report is accepted. Only a total of 3 credits will count toward the degree.

**EVSC 700B. Masters Project. 3 credits, 3 contact hours.**
Restriction: graduate standing and approval of the graduate advisor in environmental science. Written report requiring experimental or theoretical research, or an extensive literature analysis. Registration must be approved by an advisor. Students must continue to register for 3 credits each semester until completion and a written report is accepted. Only a total of 3 credits will count toward the degree.

**EVSC 701. Masters Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**EVSC 701B. Masters Thesis. 3 credits, 3 contact hours.**
Restriction: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**EVSC 701C. Masters Thesis. 6 credits, 3 contact hours.**
Restriction: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**EVSC 702. Special Topics in Environmental Science II. 3 credits, 3 contact hours.**
Restriction: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

**EVSC 711. Advanced Environmental Analysis. 3 credits, 3 contact hours.**
Prerequisite: EVSC 612 or equivalent. Analysis of complex environmental samples is studied, from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis and data handling. Collection and analysis of samples from air, water, soil, and biological systems will be discussed. Emphasis on the study of current literature.

**EVSC 712. Hazardous Substance Management. 3 credits, 3 contact hours.**
Restriction: Graduate standing. The course material comprises an overview of hazardous materials and hazardous waste management and control in an industrial setting. The course examines the technical approaches utilized in the control, remediation, and prevention of hazardous substances and waste. It also includes the major technical elements of federal regulations that govern operations involving the handling of hazardous materials.

**EVSC 715. Energy and Sustainability. 3 credits, 3 contact hours.**
This course comprises an interdisciplinary review of energy fundamentals including the basic principles necessary to understand energy systems. The technological and engineered systems for processing and using different energy non-renewable and renewable sources. The social and environmental consequences of energy production, distribution, and use, including a comparison of socioeconomic models of global energy applications.

**EVSC 717. Mass Spectrometry and Mass Spectral Interpretation. 3 credits, 3 contact hours.**
Prerequisite: CHEM 125 and CHEM 126 or equivalent. CHEM 717 and EVSC 617 are comprised of CHEM 717 and EVSC 617 plus a research project: Research projects usually comprise experimental and mass spectrometry interpretation studies. These can be performed at NJIT or in the students corporate mass spectrometry facility. Projects may also include theory, data interpretation or literature reviews pertinent to a current active area in mass spectrometry research. Projects should be approved or in consult with the instructors.

**EVSC 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**EVSC 726. Independent Study II. 3 credits, 3 contact hours.**
See description for EVSC 725.

**EVSC 790. Doctoral Dissertation. 0 credits, 0 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 790F. Doctoral Dissertation. 15 credits, 15 contact hours.**
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

**EVSC 791. Graduate Seminar. 0 credits, 1 contact hour.**
Required of all environmental science graduate students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

**EVSC 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**EVSC 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

# M.S. in Chemistry

## Degree Requirements

A minimum of 30 degree credits is required. Students must attain a cumulative GPA of 3.0 or better in the core courses listed below, and a minimum overall GPA of 3.0.

***Seminar:*** In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in CHEM 791 Graduate Seminar.

## M.S. in Chemistry (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 661<br>or CHEM 664 | Instrumental Analysis Laboratory | 3 |
| CHEM 610<br>or CHEM 673 | Advanced Inorganic Chemistry<br>Biochemistry | 3 |
| CHEM 658 | Advanced Physical Chemistry | 3 |
| **Elective Courses** | | |
| Two 600- or 700-level chemical engineering or chemistry courses | | 6 |
| Four electives [1] | | 12 |
| **Total Credits** | | **30** |

[1] A maximum of 6 elective credits may be taken from outside chemistry or chemical engineering; a maximum of 3 credits may be at the 500 level.

## M.S. in Chemistry (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 661<br>or CHEM 664 | Instrumental Analysis Laboratory | 3 |
| CHEM 610<br>or CHEM 673 | Advanced Inorganic Chemistry<br>Biochemistry | 3 |
| CHEM 658 | Advanced Physical Chemistry | 3 |
| **Thesis** [1] | | |
| CHEM 701 | Master's Thesis | 6 |
| **Elective Courses** [2] | | |
| Four electives | | 12 |
| **Total Credits** | | **30** |

[1] Required of those receiving departmental or research-based support.

[2] A maximum of 6 elective credits may be taken from outside chemistry or chemical engineering; a maximum of 3 credits may be at the 500 level.

# M.S. in Environmental Science

## Degree Requirements

A minimum of 30 degree credits is required. Candidates must consult with the graduate advisor (not thesis advisor) in designing appropriate programs of study.

Students must attain a minimum GPA of 3.0 in the core courses listed below, and a minimum overall GPA of 3.0.

Seminar: In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in EVSC 600 Environmental Science Seminar.

## M.S. in Environmental Science (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| EVSC 610 | Environmental Chemical Science | 3 |
| EVSC 612 | Environmental Analysis | 3 |
| EVSC 616 | Toxicology for Engineers and Scientists | 3 |
| EVSC 627 | Environmental Microbiology | 3 |
| **Elective** [1] | | |

| | | |
|---|---|---|
| Select five of the following: | | 15 |
| EVSC 602 | Special Topics in Environmental Science I | |
| EVSC 611 | Hazardous Waste Management | |
| EVSC 613 | Environmental Problem Solving | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 615 | Global Environmental Problems | |
| EVSC 700 | Masters Project | |
| EVSC 702 | Special Topics in Environmental Science II | |
| EVSC 711 | Advanced Environmental Analysis | |
| EVSC 725 | Independent Study I | |
| EVSC 726 | Independent Study II | |
| ENE 673 | Sustainability and Life Cycle Analysis | |
| ENE 672 | Stormwater Management | |
| ENE 660 | Introduction to Solid and Hazardous Waste Problems | |
| ENE 662 | Site Remediation | |
| ENE 664 | Physical and Chemical Treatment | |
| ENE 665 | Biological Treatment | |
| CE 602 | Geographic Information System | |
| CHEM 664 | | |
| R120 551 | Biology Of Pollution | |
| R120 522 | Resource Sustainability | |
| R120 534 | Biological Invasion | |
| R120 523 | Scale Of Biodiversity | |
| IE 615 | Industrial Hygiene and Occupational Health | |
| EPS 612 | Introduction to Environmental Policy Studies | |
| EPS 622 | Sustainable Politics and Policy | |
| EPS 614 | Environmental Economics and Management | |
| EPS 638 | Physical Geography | |
| **Total Credits** | | **30** |

[1] Courses are offered at NJIT and Rutgers-Newark and selected with the graduate advisors (not thesis advisors) approval.

## M.S. in Environmental Science (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| EVSC 610 | Environmental Chemical Science | 3 |
| EVSC 612 | Environmental Analysis | 3 |
| EVSC 616 | Toxicology for Engineers and Scientists | 3 |
| EVSC 627 | Environmental Microbiology | 3 |
| **Thesis** [1] | | |
| EVSC 701 | Masters Thesis | 6 |
| **Elective** [2] | | |
| Select three of the following: | | 9 |
| EVSC 602 | Special Topics in Environmental Science I | |
| EVSC 611 | Hazardous Waste Management | |
| EVSC 613 | Environmental Problem Solving | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 615 | Global Environmental Problems | |
| EVSC 700 | Masters Project | |
| EVSC 702 | Special Topics in Environmental Science II | |
| EVSC 711 | Advanced Environmental Analysis | |
| EVSC 725 | Independent Study I | |

| | |
|---|---|
| EVSC 726 | Independent Study II |
| ENE 673 | Sustainability and Life Cycle Analysis |
| ENE 672 | Stormwater Management |
| ENE 660 | Introduction to Solid and Hazardous Waste Problems |
| ENE 662 | Site Remediation |
| ENE 664 | Physical and Chemical Treatment |
| ENE 665 | Biological Treatment |
| CE 602 | Geographic Information System |
| CHEM 664 | |
| R120 551 | Biology Of Pollution |
| R120 522 | Resource Sustainability |
| R120 534 | Biological Invasion |
| R120 523 | Scale Of Biodiversity |
| IE 615 | Industrial Hygiene and Occupational Health |
| EPS 612 | Introduction to Environmental Policy Studies |
| EPS 622 | Sustainable Politics and Policy |
| EPS 614 | Environmental Economics and Management |
| EPS 638 | Physical Geography |
| **Total Credits** | **30** |

[1] Required of those receiving departmental or research-based support.

[2] Courses are offered at NJIT and Rutgers-Newark and selected with the graduate advisors (not thesis advisors) approval.

# M.S. in Environmental and Sustainability Policy

## Degree Requirements

Students are required to complete a total of 30 graduate course credits: 18 credits of required core courses and 12 credits of elective application courses.

### M.S. in Environmental and Sustainability Policy (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| EPS 601 | Research Methods for Environment and Sustainability Policy | 3 |
| EPS 612 | Introduction to Environmental Policy Studies | 3 |
| EPS 614 | Environmental Economics and Management | 3 |
| EPS 622 | Sustainable Politics and Policy | 3 |
| EPS 638 | Physical Geography | 3 |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| **Electives** | | |
| Four elective application courses [1] | | 12 |
| **Total Credits** | | **30** |

[1] Subject to approval by the Program Director, students have the option to substitute up to two sections (6 credits) of EPS 725 Independent Study I and EPS 726 Independent Study II under faculty direction in place of elective application courses.

### M.S. in Environmental and Sustainability Policy (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| EPS 601 | Research Methods for Environment and Sustainability Policy | 3 |
| EPS 612 | Introduction to Environmental Policy Studies | 3 |
| EPS 614 | Environmental Economics and Management | 3 |
| EPS 622 | Sustainable Politics and Policy | 3 |
| EPS 638 | Physical Geography | 3 |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| **Electives** | | |

| | | |
|---|---|---|
| EPS 701B | Master'S Thesis [1] | 6 |
| Two elective application courses [2] | | 6 |
| **Total Credits** | | **30** |

1. Normally completed over two sequential semesters.
2. Subject to approval by the Program Director, students also have the option to substitute up to two sections (6 credits) of independent study under faculty direction in place of elective application courses.

## Elective Application Courses

The Graduate Program in Environmental and Sustainability Policy offers a regular series of special topics courses and students may also enroll in courses offered by other departments. **The website Green@NJIT** offers a comprehensive list of options. The selection of elective application courses is made in consultation with the Program Director.

Preparation of the thesis is conducted under the supervision of an advisor and presented to a three-member committee.

# M.S. in Pharmaceutical Chemistry

## M.S. in Pharmaceutical Chemistry (courses only)

| | | |
|---|---|---|
| **Required Core Courses** | | |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 673 | Biochemistry | 3 |
| CHEM 777 | Principles of Medicinal Chemistry | 3 |
| CHEM 714 | Pharmaceutical Analysis | 3 |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| **Elective Courses** | | |
| Select five of the following: | | 15 |
| CHEM 661 | Instrumental Analysis Laboratory | |
| CHEM 664 | | |
| CHEM 737 | Applications of Computational Chemistry and Molecular Modeling | |
| CHEM 610 | Advanced Inorganic Chemistry | |
| CHEM 658 | Advanced Physical Chemistry | |
| CHEM 748 | Nanomaterials | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| MATH 663 | Introduction to Biostatistics | |
| MATH 664 | Methods for Statistical Consulting | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I | |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | |
| ME 635 | Computer-Aided Design | |
| R120 572 | Concepts in Pharm Drug Dev (Rutgers) | |
| R160 515 | Chem Struct Determin (Rutgers) | |
| RBHS courses - PATH N5209: Molecules to Medicines, GSND-N5310: Clinical Trials Overview, PHPY Principles of Pharmacology | | |
| **Total Credits** | | **30** |

## M.S. in Pharmaceutical Chemistry (Master's project)

| | | |
|---|---|---|
| **Required Core Courses** | | |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 673 | Biochemistry | 3 |
| CHEM 777 | Principles of Medicinal Chemistry | 3 |
| CHEM 714 | Pharmaceutical Analysis | 3 |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| **Project** | | |
| CHEM 700B | Masters Project | 3 |

| | | |
|---|---|---|
| **Elective Courses** | | |
| Select four of the following: | | 12 |
| CHEM 661 | Instrumental Analysis Laboratory | |
| CHEM 664 | | |
| CHEM 737 | Applications of Computational Chemistry and Molecular Modeling | |
| CHEM 610 | Advanced Inorganic Chemistry | |
| CHEM 658 | Advanced Physical Chemistry | |
| CHEM 748 | Nanomaterials | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| MATH 663 | Introduction to Biostatistics | |
| MATH 664 | Methods for Statistical Consulting | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I | |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | |
| R120 572 | Concepts in Pharm Drug Dev (Rutgers) | |
| R160 515 | Chem Struct Determin (Rutgers) | |
| RBHS courses - PATH N5209: Molecules to Medicines, GSND-N5310: Clinical Trials Overview, PHPY Principles of Pharmacology | | |
| **Total Credits** | | **30** |

## M.S. in Pharmaceutical Chemistry (Master's thesis)

| | | |
|---|---|---|
| **Required Core Courses** | | |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 673 | Biochemistry | 3 |
| CHEM 777 | Principles of Medicinal Chemistry | 3 |
| CHEM 714 | Pharmaceutical Analysis | 3 |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| **Thesis** | | |
| CHEM 701C | Masters Thesis | 6 |
| **Elective Courses** | | |
| Select three of the following: | | 9 |
| CHEM 661 | Instrumental Analysis Laboratory | |
| CHEM 664 | | |
| CHEM 737 | Applications of Computational Chemistry and Molecular Modeling | |
| CHEM 610 | Advanced Inorganic Chemistry | |
| CHEM 658 | Advanced Physical Chemistry | |
| CHEM 748 | Nanomaterials | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| MATH 663 | Introduction to Biostatistics | |
| MATH 664 | Methods for Statistical Consulting | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I | |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | |
| R120 572 | Concepts in Pharm Drug Dev (Rutgers) | |
| R160 515 | Chem Struct Determin (Rutgers) | |
| RBHS courses - PATH N5209: Molecules to Medicines, GSND-N5310: Clinical Trials Overview, PHPY Principles of Pharmacology | | |
| **Total Credits** | | **30** |

# Ph.D. in Chemistry

## Ph.D. in Chemistry (students entering with bachelor's degree)

| | | |
|---|---|---|
| **Core Courses** | | |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |

| | | |
|---|---|---|
| CHEM 661 | Instrumental Analysis Laboratory | 3 |
| or CHEM 664 | | |
| CHEM 610 | Advanced Inorganic Chemistry | 3 |
| or CHEM 673 | Biochemistry | |
| CHEM 658 | Advanced Physical Chemistry | 3 |
| **Electives** | | |
| CHEM 7XX | 700-level chemistry courses | 6 |
| 700-level courses | | 6 |
| Chemistry or related courses [1] | | 18 |
| **Research** | | |
| CHEM 792 | Pre-Doctoral Research | 36 |
| **Total Credits** | | **78** |

1 Courses must be above the 500 level.

The qualifying examinations must be passed. A dissertation must be submitted and defended.

## Ph.D. in Chemistry (students entering with master's degree)

| | | |
|---|---|---|
| CHEM 7XX | 700-level chemistry courses | 6 |
| 700-level courses | | 6 |
| Chemistry or related courses | | 12 |
| **Research** | | |
| CHEM 792 | Pre-Doctoral Research | 36 |
| **Total Credits** | | **60** |

A dissertation must be submitted and defended.

While it is not required that the core courses be taken, students will have to pass qualifying examinations in these areas. Therefore, it is recommended that they take these courses unless they already have a strong background in these areas.

### Qualifying Examination

Within the first year after admission to the program, students must take a qualifying examination, which will include questions on the required core courses as well as recently offered elective courses. Students have two chances to pass all of the sections. If any section is failed or is not taken on the first trial, one more attempt is allowed. The examinations are given in January and June, and students should notify the Graduate Advisor for Chemistry of their intent to take the examinations at least a month before they are scheduled. After passing the qualifying examinations, students should select a research advisor and a doctoral research committee. The committee must meet the approval of the Departmental Graduate Advisor for Chemistry. It should consist of, at a minimum, the research advisor, three departmental faculty members and one person from outside the department. The graduate advisor should be notified of these selections. Forms are available from the departmental office to report the selections.

### Dissertation

Within six months of passing the qualifiers, the student must give an oral presentation to their research committee, detailing the background of the selected research project, and the student's plans for carrying out the research. The committee must formally approve the proposal. The committee may meet at other times to follow the student's progress, at the request of the student and the research advisor.

After the dissertation is completed, the student will present the research to the committee and the public, and defend it. It is expected that the committee will have been given copies of the document several weeks before the defense meeting to ensure that they have adequate time to review it. The date, time and place of the defense must be posted thoughout campus and e-mailed to the department at least two weeks ahead of time.

Obtaining a Ph.D. is expected to entail more than just fulfilling formal requirements. There are skills which students will develop while completing the formal program. We call these skills **"The Informal Requirements."**

### Seminar

Each semester, Ph.D. students must register for and attend departmental seminars. The credits awarded for this seminar are not applied to fulfillment of degree requirements.

## Grades

All students must maintain a grade point average of at least 3.0. Students entering without the MS degree must also attain a GPA of 3.0 in the core courses.

# Ph.D. in Environmental Science

## Ph.D. in Environmental Science (students entering with master's degree)

Specific degree requirements and dissertation topics are approved by the department on an individual basis. Students must attain a minimum overall GPA of 3.0 and earn a GPA of 3.0 in the required courses.

| | | |
|---|---|---|
| **Required Courses** | | |
| EVSC 600 | Environmental Science Seminar [1] | 0 |
| EVSC 610 | Environmental Chemical Science | 3 |
| EVSC 612 | Environmental Analysis | 3 |
| EVSC 616 | Toxicology for Engineers and Scientists | 3 |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| R120 604 | Microbio: Prin & Appl | 3 |
| **Electives** | | |
| 700-level courses [2] | | 12 |
| Courses beyond master's degree | | 12 |
| **Research** | | |
| EVSC 790C | Doct Dissertation & Res [3] | 36 |
| **Total Credits** | | **75** |

1 Registration in the seminar is required every semester.

2 Chosen in consultation with graduate advisor. No more than 6 credits may be in EVSC 725 Independent Study I.

3 If the 36 credits are completed before submission of the final dissertation document, students must register for a minimum of 3 credits of EVSC 790 Doctoral Dissertation per semester until it has been submitted and accepted.

## Qualifying Examination

All applicants are expected to pass a qualifying examination that tests general competence in environmental sciences at the master's level. It must be taken within the first year following admission to the program, and passed within two years. A student will be allowed only two attempts to pass the examination.

## Formation of Dissertation Committee

Within three months of passing the qualifying examination, doctoral students must form a dissertation committee that meets the approval of the graduate advisor (not the dissertation advisor) in environmental science. As a minimum, the committee must consist of the doctoral student's dissertation advisor, three additional faculty members from the program, and one member from outside the program and the Department of Chemical Engineering, Chemistry and Environmental Science.

## Research Proposal

Within six months of forming the dissertation committee, doctoral students must make a formal oral presentation to their dissertation committee and other interested persons on the scope of their proposed research. The committee must formally approve the proposal within a maximum of three additional months. This ensures meeting the requirements that doctoral students must have an approved dissertation committee and an approved dissertation proposal within a year of passing the qualifying examination.

## Dissertation Defense

An oral defense of the dissertation is required after submission of the final document to the dissertation committee for approval. Signatures of all members of the dissertation committee must be received for final approval to be granted.

## Ph.D. in Environmental Science (students entering with a bachelor's degree)

Students must attain a minimum overall GPA of 3.0 and earn a GPA of 3.0 in the required courses.

| | | |
|---|---|---|
| **Required Courses** | | |
| EVSC 600 | Environmental Science Seminar (required every semester) | 0 |

| | | |
|---|---|---|
| R120 604 | Microbio: Prin & Appl | 3 |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| EVSC 610 | Environmental Chemical Science | 3 |
| EVSC 612 | Environmental Analysis | 3 |
| EVSC 616 | Toxicology for Engineers and Scientists | 3 |
| **Research** | | |
| EVSC 790 | Doctoral Dissertation [1] | 36 |
| **Electives** | | |
| 12 credits from 700-level courses [2] | | 12 |
| 15 credits from 600- or 700-level courses [3] | | 15 |
| **Total Credits** | | **78** |

[1] If the 36 credits are completed before submission of the final dissertation document, students must register for a minimum of 3 credits of EVSC 790 Doctoral Dissertation per semester until it has been submitted and accepted.

[2] Chosen in consultation with graduate advisor. No more than 6 credits may be in EVSC 725 Independent Study I or EVSC 726 Independent Study II.

[3] May be from outside the department

## Qualifying Examination

A qualifying examination must be taken within three semesters of admission to the program, and passed within two years. A student will only be allowed two attempts to pass the examination.

## Formation of Dissertation Committee

Within three months of passing the qualifying examination, doctoral students must form a dissertation committee that meets the approval of the graduate advisor (not the dissertation advisor) in environmental science. As a minimum, the committee must consist of the doctoral student's dissertation advisor, three additional faculty members from the program, and one member from outside the program and the Department of Chemical Engineering, Chemistry and Environmental Science.

*Research Proposal* - Within six months of forming the dissertation committee, doctoral students must make an oral presentation to their dissertation committee and other interested persons on the scope of their proposed research. The committee must formally approve the proposal within a maximum of three additional months. This ensures meeting requirements that doctoral students must have an approved dissertation committee and an approved dissertation proposal within a year of passing the qualifying examination.

## Dissertation Defense

An oral defense of the dissertation is required after submission of the final document to the dissertation committee for approval. Signatures of all members of the dissertation committee must be received for final approval to be granted.

# History

The Federated History Department of NJIT and Rutgers-Newark offers the Master of Arts in History for generalists and for students interested in preparing for further graduate study in history, and the Master of Arts in Teaching for current and prospective secondary school teachers of history and social studies. The objective of the graduate history program is to furnish a broad yet rigorous course of study in preparation for careers in teaching, business, law, government, administration, and other fields related to history, as well as to enhance the professional experience and increase the opportunities for advancement of students who are already working as professionals in these fields.

Program administration and teaching are shared by faculty from both campuses, and the full resources of both universities are available to all history graduate students and faculty. Resources include access to the Rutgers University library system of more than three million volumes, to the outstanding collection in the history of medicine at UMDNJ, and to excellent history collections in the region. The program emphasizes hands-on learning and archival research in association with local institutions, such as the Thomas Edison National Historic Site in nearby West Orange and the Newark Museum and the New Jersey Historical Society in Newark.

The joint Rutgers-Newark/NJIT graduate history program is the largest and most diverse master's-level history program in New Jersey. Many of the graduate faculty have national or international reputations as scholars, representing a wide variety of time periods and fields of study. The program is particularly noted for its strengths in environmental history and the history of science, technology and medicine; the history of communication, cultural and intellectual history; diplomatic history; history of women; pre-Civil War and contemporary America; African and African-American history; legal history; and global and comparative history.

# Master of Arts in History

The M.A. in History furnishes a broad yet rigorous training in history in preparation for a wide variety of careers in education, law, business, medicine, and administration.

## Admission Requirements

Applicants must have an undergraduate degree from an accredited institution and favorable letters of recommendation from professors familiar with their work. An undergraduate GPA of at least 3.0 is normally required. Students must provide GRE scores.

## Application

Students interested in the program should contact the NJIT history graduate coordinator (http://directory.njit.edu/PersDetails.aspx?persid=maher), and apply to Rutgers-Newark (http://www.ncas.rutgers.edu/department-history/how-apply).

## Major Fields

### American History

See the **Federated History Department** (http://history.njit.edu/academics/graduate/ma-history.php#american) website for more information.

### World History

See the **Federated History Department** website for more information.

### History of Technology, Environment, and Medicine/Health

Based at NJIT, this concentration is a unique integration of three relatively new and increasingly important historical sub-disciplines. Students concentrating in the History of Technology, Environment, and Medicine/Health explore not only the interrelationships between environmental transformations, technology in society, and health and medicine, but also their social meanings, their cultural relations, their political, social, and gender histories, and their local, national, and global contexts. NJIT has a distinguished concentration of faculty in these areas, with particular strengths in American environmental and urban environmental history; the social and cultural history of medicine; and the history of technology and communication.

Students interested in pursuing this major field of concentration should contact the NJIT history graduate coordinator (http://directory.njit.edu/PersDetails.aspx?persid=maher). Additional information on the History of Technology, Environment, and Medicine/Health concentrations can also be found here (http://history.njit.edu/academics/graduate/ma-history.php#american).

# Master of Arts in Teaching (History)

The Master of Arts in Teaching is a terminal degree for students who are preparing for, or are already engaged in, careers in secondary school teaching in history and social studies. See the Federated History Department (http://history.njit.edu/academics/graduate/mat-history.php) website and the **Rutgers Graduate School-Newark** catalog for more information.

# NJIT History Faculty

## C

Çelik, Zeynep, Distinguished Professor (NJIT College of Architecture and Design)

## L

Lefkovitz, Alison L., Assistant Professor

## M

Maher, Neil M., Associate Professor

## N

Nocks, Lisa, Senior University Lecturer

## P

Pemberton, Stephen, Associate Professor

Petrick, Elizabeth R., Assistant Professor

## R

Riismandel, Kyle, University Lecturer

### S

Schweizer, Karl W., Professor

Sher, Richard B., Distinguished Professor

## Rutgers-Newark History Faculty

### A

Asen, Daniel, Assistant Professor

### C

Caplan, Karen, Associate Professor

Carruthers, Susan, Professor

Chang, Kornel, Associate Professor

Cowans, Jon, Associate Professor

### D

Diner, Steven J., University Professor

### F

Farney, Gary D., Associate Professor

Feldstein, Ruth, Professor

### G

Giloi, Eva, Associate Professor

Goodman, James, Distinguished Professor

### H

Diner, Steven J., University Professor

### K

Krasovic, Mark, Assistant Professor

### L

Lewis, Jan Ellen, Dean of Faculty and Professor

### M

Monteiro, Lyra D., Assistant Professor

### R

Rizzo, Mary, Assistant Professor

### S

Satter, Beryl, Professor

Stewart-Winter, Timothy, Associate Professor

Strub, Whitney, Associate Professor

### T

Truschke, Audrey, Assistant Professor

## V

Varlik, Nükhet, Associate Professor

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# History Courses

**HIST 620. City and Disease in History. 3 credits, 3 contact hours.**
Explores the dynamic interaction between the growth of cities and changes in the experience and location of disease. Presumes the intertwining of these two historical developments in the birth of a distinctly urban identity, one predicated on the notion that the modern city is somehow inherently diseased. Focuses on the New York and Newark metropolitan areas in the nineteenth and twentieth centuries. Among the topics considered are epidemic outbreaks, quarantines, the technology and organization of sanitation and hygiene, the professional formation of public, industrial and occupational medicine, and medical and popular responses to immigration.

**HIST 622. Culture and Science in the History of American Medicine. 3 credits, 3 contact hours.**
Provides an overview of American medical history and a familiarity with the theoretical and practical ramifications of different approaches to the complex relationships between medicine, science, and culture. Topics include: the extent to which medicine is or has been scientific; reasons why science has been considered so important to medicine's professional culture; and the degree to which medicine's professional culture has been shaped by science as well as other factors, such as economic and political self-interest, technology, class, race, gender, and other kinds of cultural values.

**HIST 624. Technology, Environment and Medicine in World History, 1500-1900. 3 credits, 3 contact hours.**
Examines the interrelationship between the emerging modern world system and changes in technology, environment, and medicine, with particular emphasis on European overseas expansion and its impact in non-Western regions.

**HIST 626. Social History of American Medicine Since 1800. 3 credits, 3 contact hours.**
Topics include the practices of 19th-century regular medicine; the relation between medical concepts and mainstream social thought; the treatment of women's health; antebellum alternative healers and alternative politics; the triumphs of late 19th- and early 20th-century medical therapeutics; the emergence of medicine as big business; medicine and racism; the emergence of nursing as a profession; modern medicine in an international perspective; New Age healing; the AIDS crisis and AIDS activism; and contemporary debates on the future of health care in the United States.

**HIST 628. Gender, Science and Technology in the Modern World. 3 credits, 3 contact hours.**
Introduction to a wide range of political and cultural analyses of science and technology, with an emphasis on recent feminist critiques of science. Explores the questions of scientific neutrality; the gendering of scientific knowledge; the relationship between science, technology, and capitalism; the role of science in international politics; and why science has not freed women.

**HIST 630. History of the Body in Modern Western Culture. 3 credits, 3 contact hours.**
Considers medical or scientific history primarily in terms of implications for bodily experience in everyday life. Begins with grand narratives of historical shifts in bodily perceptions and practices, and proceeds to more focused narratives of changing bodily experience, engaging key distinctions between genders, classes, and species as well as perceptions of pain and internal bodily structure. Materials will be drawn from early modern and modern Europe, as well as more recent bodily experience in the United States.

**HIST 632. Technology, Culture and History. 3 credits, 3 contact hours.**
Treats the relationship between technology and cultural values in a variety of historical and geographical settings, from early modern Japan to twentieth-century America. Examines the ways in which cultural ideals, conceptions, and preconceptions serve to influence the rate and manner of technological change, as well as the ways in which technology affects social and cultural life.

**HIST 634. Environmental History of North America. 3 credits, 3 contact hours.**
Explores the dialogue between humankind and the environment in North America over the course of the last four centuries. Examines the latest and most interesting work done in the new field of environmental history to see what such a perspective has to offer.

**HIST 635. History of Technology, Environment and Medicine: Theory and Method. 3 credits, 3 contact hours.**
A team-taught course which surveys the methods employed in the three fields. Explores the interdisciplinary nature of each field, and the value of interdisciplinary scholarship.

**HIST 637. Global Environmental History. 3 credits, 3 contact hours.**
This course takes a global view of human interaction with the natural world, mixing broad themes such as colonialism and industrialization with detailed case studies in an effort ot understand the ways that people and the environment have mutually shaped one another. Because environmental change often transcends national boundaries, this course places important subjects in environmental history such as disease, agriculture, pollution, and environmentalism into a global and transnational context.

**HIST 638. Social History of Communication. 3 credits, 3 contact hours.**
Treats selected themes in the history of communication in different social and cultural contexts, from the ancient world to the twentieth century. Topics include: orality, proto-literacy, and literacy in ancient and medieval cultures; printing and the development of print culture in the early modern world; the ?communication revolution? of the late 19th and early 20th centuries; and historiographical debates over the role of communication technologies in society.

**HIST 640. The Urban Environment. 3 credits, 0 contact hours.**
Examines the role of the economy, culture, and technology in shaping the urban environment. Makes extensive use of Newark and the New York metropolitan area, including field observations and local research. In addition to other topics, explores in detail spatial relationships, the role of transportation, and the development of suburbia.

**HIST 642. The History of Health and International Development. 3 credits, 3 contact hours.**
This course examines the history of western efforts to promote health and nutrition in the 'developing world" from the beginnings of tropical medicine. We will trace this history through its many permutations from the establishment of colonial health services to the development of the Global Programme on AIDS. In doing so, we will explore the various economic and political interests and underlying cultural assumptions that have shaped the development of ideas and practices associated with international health and development.

**HIST 644. War, Technology and Society, 1500-1914. 3 credits, 3 contact hours.**
Examines key themes in the interrelationship between warfare, technology and society from the beginnings of modern warfare until World War I. Primary emphasis placed on the historical connections between violent conflict, the technical means by which it is carried out, and the socio-political environment within which wars take place. The effect of technology upon war and considerations of the effect of war on technological change and development. Samples the rich tradition of thought and ideas produced by philosophers and theorists on these themes.

**HIST 645. American Legal History to 1860. 3 credits, 3 contact hours.**
Readings and discussion on the legacy of common law after the Revolution; the emergence of legal instrumentalism; and the evolution of tort, contract, and damages in the context of industrialism and economic growth.

**HIST 650. History of American Conservatism. 3 credits, 3 contact hours.**
This course examines postwar American conservatism through classic works and contemporary studies. Topics include the rise of conservatism, groups under the conservative umbrella, and the rise of the right as related to key events in postwar history (Cold War, McCarthysim, the '60s, the suburbs and urban change). Course interrogates postwar conservatism with respect to American political and intellectual history and in relation to histories of gender, race, class, sexuality, place and religion.

**HIST 652. Topics in the History of Technology. 3 credits, 3 contact hours.**
Selected topics in the history of technology.

**HIST 653. Topics in European Intellectual and Cultural History. 3 credits, 3 contact hours.**
Examination of issues and methods in European intellectual and cultural history, with a consideration of some leading problems in the field.

**HIST 654. Topics in American Intellectual and Cultural History. 3 credits, 3 contact hours.**
Examination of issues and methods in American intellectual and cultural history, with a consideration of some leading problems in the field.

**HIST 655. Topics in American Urban and Ethnic History. 3 credits, 3 contact hours.**
Examination of issues and methods in American urban and ethnic history, with a consideration of some leading problems in the field.

**HIST 656. Topics in the History of Health. 3 credits, 3 contact hours.**
Selected topics in the history of Health.

**HIST 657. Topics in Environmental History. 3 credits, 3 contact hours.**
Selected topics in environmental history.

**HIST 658. Topics in American Legal History. 3 credits, 3 contact hours.**
Readings and discussion on the growth of legal formalism, the evolution of substantive due process, changes in legal education and the legal profession, and the evolution of private law.

**HIST 660. The Enlightenment in Britain. 3 credits, 3 contact hours.**
The 18th century was the age of the Enlightenment. Great Britain became a unified polity and the most powerful imperial force in the world. We examine the Enlightenment in Britain against the backdrop of war and empire, imperial consumer culture, the growth and significance of sociability and politeness, representations of gender, the writing of cultural history, social uses of science/technology, print culture, and competition among varying notions of ethnic identity.

**HIST 661. Problems and Readings in European History since 1850. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in European history since 1850.

**HIST 662. Prob. and Read: Hist/US Foreighn Policy and Diplomacy. 3 credits, 3 contact hours.**
Examination of issues and methods in American diplomatic history, with a consideration of some leading problems in the field.

**HIST 663. Problems and Readings in American History, 1492-1789. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history rom 1492 to 1789.

**HIST 664. Problems and Readings in American History, 1789-1865. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history from 1789 to 1865.

**HIST 665. Problems and Readings in American History, 1865-1914. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history from 1865 to 1914.

**HIST 666. Problems and Readings in American History, 1890-1945. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literatue in American history from 1890 to 1945.

**HIST 667. Problems and Readings in American History, 1945-Present. 3 credits, 3 contact hours.**
Introduction to the major historiographical problems and recent literature in American history since 1945.

**HIST 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

**HIST 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Restriction: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

**HIST 701C. Master'S Thesis. 6 credits, 6 contact hours.**
Restriction: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

**HIST 702. Master's Essay. 3 credits, 3 contact hours.**
For those who don't write a 6 credit thesis, the 3 credit Master's Essay caps the M.A./M.A.T. A substantial work done with an advisor, may be: 1. Interpretive historical essay based on primary source research. 2. Narrative history based on primary source research. Prereq: R510:504, R510:505, or R510:506. 3. Historiographical essay. 4. Content-focused curriculum design, either a course or significant portion thereof. 5. Design for an historical museum exhibition/other work in public history. Prereq: R510:565.

**HIST 725. Independent Study. 3 credits, 1 contact hour.**
Restriction: permission of graduate history advisor and course instructor.

**HIST 726. Independent Study. 3 credits, 1 contact hour.**
Restriction: permission of graduate history advisor and course instructor.

**HIST 727. Independent Study. 3 credits, 3 contact hours.**
Restriction: permission of graduate history advisor and course instructor.

**HIST 791. Seminar in History of Technology, Environment and Medicine. 0 credits, 0 contact hours.**
Faculty, students and invited speakers present and discuss current topics of research in history, technology and medicine.

## Rutgers-Newark Courses

**R510 505. History, Fiction And Fact. 3 credits, 3 contact hours.**

**R510 506. Poetics Of History. 3 credits, 3 contact hours.**

**R510 515. Hist Of Gender. 3 credits, 0 contact hours.**

**R510 520. Topics/History. 3 credits, 3 contact hours.**

**R510 525. Colloq History Of Women. 3 credits, 0 contact hours.**

**R510 526. Rdngs Afro-Amer History. 3 credits, 0 contact hours.**

**R510 527. European Diplomatic Hist. 3 credits, 3 contact hours.**

**R510 528. Eur Polit & Diplom Hist. 3 credits, 0 contact hours.**

**R510 529. ST:Eur Intell&Cult Hist. 3 credits, 3 contact hours.**

**R510 531. Amer Diplomatic Hist. 3 credits, 0 contact hours.**

**R510 532. American Diplomatic History. 3 credits, 3 contact hours.**

**R510 533. Topics In Envir Hist. 3 credits, 3 contact hours.**

**R510 537. Problems Ancient World. 3 credits, 3 contact hours.**

**R510 539. Probs Medieval History. 3 credits, 0 contact hours.**

**R510 543. European Hist 1650. 3 credits, 3 contact hours.**

**R510 547. Comparative Colonial History. 3 credits, 3 contact hours.**

**R510 548. Amer Environmntl History. 3 credits, 3 contact hours.**

**R510 549. Mod Latin Am History. 3 credits, 3 contact hours.**

**R510 552. Topics-Amer Intell Cult Hist. 3 credits, 3 contact hours.**

**R510 553. Amer Polit & Legal Hist. 3 credits, 0 contact hours.**

**R510 555. Am Urban & Ethnic History. 3 credits, 3 contact hours.**

**R510 563. Heredity, Health And Disease. 3 credits, 3 contact hours.**

**R510 565. Public History. 3 credits, 3 contact hours.**

**R510 566. Writing American History. 3 credits, 3 contact hours.**

**R510 567. Global Environ. 3 credits, 3 contact hours.**

**R510 571. Historical & Social Theory. 3 credits, 3 contact hours.**

**R510 576. American Hist, 1492-1789. 3 credits, 0 contact hours.**

**R510 577. Prob Am Hist 1789-1865. 3 credits, 0 contact hours.**

**R510 581. Amer History 1865-1914. 3 credits, 0 contact hours.**

**R510 583. American History 1912 To 1945. 3 credits, 0 contact hours.**

**R510 585. Prob & Rdngs Amer Hist. 3 credits, 0 contact hours.**

**R510 589. Prob & Rdng African Hist. 3 credits, 0 contact hours.**

**R510 590. Prob & Read African Hist. 3 credits, 0 contact hours.**

**R510 593. Cult & Sc Hist Am Med. 3 credits, 3 contact hours.**

**R510 595. Soc Hist, Am Med-1800. 3 credits, 3 contact hours.**

**R510 598. Hist-Tech, Env & Med. 3 credits, 3 contact hours.**

**R510 599. Social History-Communic. 3 credits, 3 contact hours.**

**R510 618. Sem Teaching History. 3 credits, 3 contact hours.**

**R510 619. Intership In Public History. 3 credits, 3 contact hours.**

**R510 678. Advanced Topics In Hist. 3 credits, 3 contact hours.**

**R510 695. Independent Study In History. 3 credits, 3 contact hours.**

**R510 696. Adv Ind Study Hist. 3 credits, 3 contact hours.**

**R510 697. Adv Research. 3 credits, 3 contact hours.**

**R510 698. Research In History. 3 credits, 3 contact hours.**

# M.A. in History

## Degree Requirements

A minimum of 30 credits is required, including 18 in a major field and 6 in a minor field chosen in consultation with a faculty advisor. The remaining 6 credits may be completed through a Master's Thesis or a combination of a Master's Essay and an additional course.

The following is a sample curriculum for a student completing a major field of study (18 credits) in the History of Technology, Environment and Medicine/ Health.

### M.A. in History, History of Technology, Environment, and Medicine/Health (Master's essay)

| | | |
|---|---|---|
| **Major Field Courses** | | |
| HIST 622 | Culture and Science in the History of American Medicine | 3 |
| HIST 628 | Gender, Science and Technology in the Modern World | 3 |
| HIST 632 | Technology, Culture and History | 3 |
| HIST 634 | Environmental History of North America | 3 |
| HIST 635 | History of Technology, Environment and Medicine: Theory and Method | 3 |
| HIST 656 | Topics in the History of Health | 3 |
| **Minor Field Courses** | | |
| Two 600 or 700 level courses in either American History or World History | | 6 |
| **Elective Courses** | | |
| One 600 or 700 level course | | 3 |
| **Essay** | | |
| HIST 702 | Master's Essay | 3 |
| **Total Credits** | | **30** |

### M.A. in History, History of Technology, Environment, and Medicine/Health (Master's thesis)

| | | |
|---|---|---|
| **Major Field Courses** | | |
| HIST 622 | Culture and Science in the History of American Medicine | 3 |
| HIST 628 | Gender, Science and Technology in the Modern World | 3 |
| HIST 632 | Technology, Culture and History | 3 |
| HIST 634 | Environmental History of North America | 3 |
| HIST 635 | History of Technology, Environment and Medicine: Theory and Method | 3 |
| HIST 656 | Topics in the History of Health | 3 |
| **Minor Field Courses** | | |
| Two 600 or 700 level courses in either American History or World History | | 6 |
| **Thesis** | | |
| HIST 701C | Master'S Thesis | 6 |
| **Total Credits** | | **30** |

For additional information on the Master's Thesis and Master's Essay Options, see the Federated History Department (http://history.njit.edu/academics/graduate) website.

# Humanities

This program is designed to prepare students for careers in the field of technical communication. Students learn to approach communication issues in a scholarly and professional manner, developing abilities in critical thinking, problem solving, and navigating effectively and ethically through our scientific and technological society.

The program is intended for students and communication professionals who want to develop abilities in

- Social media
- User-centered design
- Usability testing and knowledge management
- Advanced communication theory and research methods
- Technical editing

- Writing and speaking in teams, in a wide range of professional environments

## Masters of Science in Professional and Technical Communication

Please see our web site http://www.njit.edu/MSPTC for updated information.

The Master of Science in Professional and Technical Communication (MSPTC) prepares students for careers in the rapidly growing field of technical communication. This degree enables students to acquire an understanding of information technologies and to approach communication issues with new problem-solving skills. Familiarity and technical proficiency with many different media tools and services will also be gained. Professional experts will provide strong theoretical foundations within a practical framework. The MSPTC is entirely and only available online (in distance learning format).

### Admission Requirements

Students must have an undergraduate degree in any field with strong interest in science and technology and/or communication and media and must submit the following.

- a statement outlining how the degree will meet personal and professional objectives;
- a current resume;
- one letter of recommendation;
- a portfolio of work (Three samples of writing, web development, CD-ROM, or other appropriate media that demonstrate abilities for clear expression);
- Graduate admission application;
- Official transcripts of all prior work and certificate of graduation;
- GRE scores (These scores are required of all international applicants, all applicants who have earned their last degree outside of the United States, and students who wish to apply for merit-based financial support on individual basis; other applicants do not need GRE scores);
- TOEFL scores of 550 (pencil and paper) or 79 (IBT) are required of all international applicants.

*Graduate Certificate Programs:* Two 12-credit graduate certificates are available as a step toward this degree

- Technical Communication Essentials
- Social Media Essentials

Please see **Graduate Certificates** for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; e-mail: cpe@njit.edu.

## NJIT Faculty

### B

Bodner, Janet, Associate Director

### C

Castronova, Louise, Senior University Lecturer

Cohen, Maurie, Professor

E
Egan, John A., University Lecturer

F

Funkhouser, Christopher T., Professor

### H

Holbrook, J. Britt, Assistant Professor

### J

Johnson, Carol S., Associate Professor

K

Katz, Eric, Professor and Chair

Kimmelman, Burt J., Professor

Klobucar, Philip Andrew, Associate Professor

Kmiec, David M., University Lecturer

## L

Lipuma, James M., Senior University Lecturer

Longo, Bernadette C., Associate Professor

## M

McRae, Calista A., Assistant Professor

## O

O'Neill, Megan E., Assistant Professor

P

Pardi, Nina L., Senior University Lecturer

Paris, Jerome, Director

## R

Rothenberg, David B., Professor

## S

Steffen, Nancy L., Associate Professor

- Professional and Technical Communication - M.S. (p. 773)

Technical Communication Essentials - Cert.

Instructional Design, Evaluation, and Assessment - Cert.

Social Media Essentials - Cert.

Digital Marketing Design Essentials - Cert.

# Humanities Courses

**PTC 601. Advanced Professional and Technical Communication. 3 credits, 3 contact hours.**
Provides the foundation and direction for all Professional and Technical Communication coursework. This course introduces students to the profession and the academic discipline of technical/professional communication. Modules include usability analysis; visual information; ethics; global diversity, global communication; report writing; information literacy; communicating with new technologies; and technical writing style. Students begin development of the MSPTC ePortfolio.

**PTC 603. Identity, Technology, and Communication. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601. Examines the complex ways in which technology constructs and is constructed by society, with emphasis on interrelationships between technology and communication. Discussions focus on how technological change is expressed in social and political movements, literature, art, architecture, and philosophy and how they, in turn, influence the future direction of technology. Design and updating of the MSPTC ePortfolio will be required in this seminar.

**PTC 604. Communication Theory and Research. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601Reviews the major theories of communication and provides strategies for research in the field of Professional and Technical Communication. The course focuses on these research methods: problem statement and hypothesis formulation derived from theory; research design and data generation; existing information sources and their acquisition; and analytic techniques. Students develop analytic methods necessary to create a well-considered thesis proposal. Design and updating of the MSPTC ePortfolio will be required in this seminar.

**PTC 605. Elements of Visual Design. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601. Provides an understanding of and competency in the visual presentation of information. Course integrates theories of design, techniques of composition, and technologies of electronic and print publishing. Modules include both design principles and hands-on practice in visual literacy, layout and design, and graphic tools. Design and updating of the MSPTC ePortfolio will be required in this seminar.

**PTC 606. Advanced Information Design. 3 credits, 3 contact hours.**
Develops online visual communication strategies and community building. The course will cover the design and creation of multimedia objects, usability heuristics, navigation theory, contemporary design practices and online community building. Students will be required to create media-rich multidimensional online projects that encourage and facilitate interaction and team-building in the online environment. Design and updating of the MSPTC ePortfolio will be required for this seminar.

**PTC 610. Research Methods for Information Design. 3 credits, 3 contact hours.**
Introduces user research methods such as contextual inquiry, ethnographic field studies, card sorting, affinity diagramming, and usability testing that provide the foundation for user- centered interaction design.

**PTC 612. Theory and Practice of Text Encoding. 3 credits, 3 contact hours.**
Students will learn to identify considerations and methods for efficient text encoding. Topics covered will include text encoding tools, markup languages, document analysis, and workflow design for text delivery. After taking this class, students should be able to analyze processes and technologyies that support the collection, management, and publishing of content in a variety of forms and media.

**PTC 620. Proposal Writing. 3 credits, 3 contact hours.**
Provides an understanding of and practice in proposal writing for corporations, foundations, and government agencies. Students build skills to create a range of persuasive documents including proposals for research grants, responses to requests for proposal, and government proposals.

**PTC 622. Working in Teams: Collaborative and Interpersonal Communications. 3 credits, 3 contact hours.**
Introduces interpersonal and collaborative communication topics relating to face-to-face and virtual teams. Covers communication and documentation functions in agile project environments. Examines mobile workplace communication strategies.

**PTC 624. Professional and Technical Editing. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601 . Presents the theory and practice of editing professional and technical writing. Topics include correctness and conciseness, hard copy and on-line editing, editing graphics, document management, editor-author relationships, and ethical considerations in editing. Students edit writing samples from a variety of technical fields.

**PTC 626. Communication Media Design Studio. 3 credits, 3 contact hours.**
This course integrates language and media in a studio approach to multimodal communication projects. Students work with instructor to design individual projects using current media applications.

**PTC 628. Analyzing Social Networks. 3 credits, 3 contact hours.**
Prerequisite: PTC 601 for MSPTC students; approval of instructor for non-MSPTC students. This course will provide students with an overview of social networks by introducing them to the unique terminology of social networks (centrality, boundary spanners, directional ties, etc.) Positive and negative characteristics of social networks will be discussed, followed by visualizations and analyses of those characteristics. Students will read selected journal articles explaining how social networks relate to communication and the flow of information within organizations. The culmination of the course will be a project in which students will create and analyze their own social network, most likely drawing their data from the popular social media site Facebook and using ORA, a freeware social network analysis application created by Carnegie Mellon University.

**PTC 629. Theory and Practice of Social Media. 3 credits, 3 contact hours.**
Introduces social media strategies for reading and writing in today's multi-cultural, screen-oriented, networked culture. Students study relationship between mediated communication and human community and gain hands-on experience with chatting, blogging, tagging, wiki writing, tweeting and social media presentation. Students strategize, plan, design and produce social media projects of their own.

**PTC 631. Communication and Environmental Problem Solving. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601. Develops critical thinking on ecological issues for problem solving by integrating technical information, human values, and communication with environmental change. Students combine theory, research and models, case studies, visual thinking, and scientific inquiry for application in individual decision-making course project.

**PTC 632. Content Management and Information Architecture. 3 credits, 3 contact hours.**
Prerequisite or Corequisite: PTC 601. Today's complex systems often produce complex information needs that require new technical communication methods and tools. This course will focus on the use of Information Architecture methodologies (such as, DITA or DocBook) to develop a structure for presenting technical information and on Content Management tools for creating a single source repository for this information. Students will also use theory and practical applications to design and develop a structured online Help module.

**PTC 640. Health Communications. 3 credits, 3 contact hours.**
This course will focus on the use of communication strategies to inform and influence individual and community decisions regarding health. The course will cover: the multidimensional nature of health communication, research in health communication, behavioral theories in health communication, rhetorical theories in health communication, legal and ethical concerns in health communication, the communication of risk and uncertainty, and the design of health campaigns. Students will be required to (a) research and prepare a health communication strategy for use in a specific context and (b) to design an accompanying print or hypertext document to be used in that context.

**PTC 642. Corporate Media and Communication. 3 credits, 3 contact hours.**
Introduces the dymanics of communication within complex organizations. Develops communication skills for contemporary global corporate and business markets. Focuses on the efforts of businesses and organizations to communicate and persuade in target audiences. Covers translation issues in developing corporate media.

**PTC 644. Communication in Technology Transfer and Innovation. 3 credits, 0 contact hours.**
Examine roles of communication in innovation development and technolgy transfer. Students review models of communication in technology transfer in global contexts. Issues such as audience analysis, user experience, participatory design, and knowledge transfer will be investigated.

**PTC 650. ELearning Design for Mobile. 3 credits, 3 contact hours.**
Designing eLearning for mobile platforms is a critical skill for today's technical communicator. Specific skills and tools are required to ensure a successful implementation. Based on proven user centered design concepts, this course provides the student with the skills necessary to create effective mobile training programs.

**PTC 672. Design Instruction Assess Meth. 3 credits, 3 contact hours.**
Prerequisite: Students must have a graduate standing and should be enrolled in MSPTC program or the Instructional Design and Educational Assessment certificate. Student must meet these requirements, approval of instructor is required. Examines planning and implementation of instruction to facilitate learning and analysis of methods of data gathering on learner progress and mastery, lessons and learning objects so appropriate instructional strategies with associated methods of formative and summative assessments that can yield data for learner assessment and course evaluation can be selected or develop to suit the instructional style, learner needs, and instructional situations.

**PTC 681. Tech in Class & Learning Envir. 3 credits, 3 contact hours.**
Prerequisite: Students must have a graduate standing and should be enrolled in MSPTC program or the Instructional Design and Educational Assessment certificate. Student must meet these requirements, approval of instructor is required. This course examines the various types of technology necessary to develop, use, and process the results of assessments as well as facilitate and augment instructional design. This course examines the integration of present and likely future technology into instruction to foster community, collaboration, conceptual development, and exceptional academic performance as well as a more effective and well-understood assessment system.

**PTC 691. ePortfolio Capstone Seminar. 0 credits, 0 contact hours.**
This course is taken in the student's final semester before graduation. Students complete final revisions of the ePortfolio of work completed in MSPTC seminars (may also include professional and service projects). Student ePortfolios must successfully demonstrate MSPTC core competencies and be presented in an oral presentaiton for faculty and other students.

**PTC 698. Selected Topics in Professional and Technical Communication. 3 credits, 3 contact hours.**
Prerequisite or corequisite: PTC 601 This is a Special Topics course (does not require CGE approval). It was presented to CGE in an effort to attract more students. Students will learn approaches to understanding and producing the forms of writing central to academic research. They will review literature, peer-review the work of others, prepare conference material, and produce a submission-quality journal or conference paper in their field of study. The current plan is to run the course every Spring.

**PTC 700. Master'S Project. 0 credits, 0 contact hours.**
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation.

**PTC 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation.

**PTC 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**PTC 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**PTC 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

**PTC 725. Independent Study in Professional and Technical Communication. 3 credits, 3 contact hours.**
Prerequisite: approval of graduate advisor and supervising faculty.Allows development of areas of specialization for Master's Project or for areas of study in communication in which one or more students may be interested but which are not of sufficiently broad interest to warrant a regular course offering.

**PTC 726. Independent Study II. 3 credits, 3 contact hours.**

# M.S. in Professional and Technical Communication

## Degree Requirements

Students must complete a minimum of 30 degree credits taken over a minimum of two semesters. Five core courses must be completed by all students; five elective courses allow students to specialize in selected areas of professional and technical communication.

Students must design and maintain an ePortfolio of work completed within the courses. This work, organized around core competencies within each seminar in the program, will be reviewed by the instructional faculty every semester. In the final semester before graduation, students are required to submit their portfolio for non-credit assessment in PTC 691 ePortfolio Capstone Seminar.

| | | |
|---|---|---|
| **Core Courses** | | |
| PTC 601 | Advanced Professional and Technical Communication | 3 |
| PTC 603 | Identity, Technology, and Communication | 3 |
| PTC 604 | Communication Theory and Research | 3 |
| PTC 605 | Elements of Visual Design | 3 |
| PTC 606 | Advanced Information Design | 3 |
| **ePortfolio** | | |
| PTC 691 | ePortfolio Capstone Seminar | 0 |
| **Elective Courses** | | |
| Select five of the following: | | 15 |
| PTC 610 | Research Methods for Information Design | |
| PTC 620 | Proposal Writing | |
| PTC 622 | Working in Teams: Collaborative and Interpersonal Communications | |
| PTC 624 | Professional and Technical Editing | |
| PTC 626 | Communication Media Design Studio | |
| PTC 628 | Analyzing Social Networks | |
| PTC 629 | Theory and Practice of Social Media | |
| PTC 631 | Communication and Environmental Problem Solving | |
| PTC 632 | Content Management and Information Architecture | |
| PTC 640 | Health Communications | |
| PTC 642 | Corporate Media and Communication | |
| PTC 644 | Communication in Technology Transfer and Innovation | |
| PTC 650 | ELearning Design for Mobile | |
| PTC 698 | Selected Topics in Professional and Technical Communication | |
| PTC 700 | Master'S Project | |
| PTC 701 | Master'S Thesis | |
| PTC 725 | Independent Study in Professional and Technical Communication | |
| **Total Credits** | | **30** |

# Mathematical Sciences

## Master of Science in Applied Mathematics

This program is intended for students with a strong interest in Applied Mathematics. Applied Mathematics is the application of classical and modern mathematical techniques to the solution of practical problems in the physical and biological sciences and engineering. The applied mathematician develops and analyzes mathematical models of physical and biological phenomena and engineering systems, interprets solutions to mathematical problems and uses the results to identify relationships, patterns, and the effects of altering one or more variables or modeling assumptions. Many of the courses in the program illustrate how mathematics can be used to predict the behavior of physical, biological, and engineering systems.

The Master of Science in Applied Mathematics, with its areas of specialization in analysis, applied mathematics, computational methods, and mathematical biology is designed to serve the needs of students who may be interested in pursuing a doctoral degree in the mathematical, physical, or biological sciences. The program also strengthens the quantitative and analytical skills of students with a baccalaureate degree who are planning to work in industry, commerce, or education, as well as practicing engineers and others already employed in industry and commerce.

## Admission Requirements

It is expected that students applying for admission will have an undergraduate education in mathematics, the physical or biological sciences, or engineering. For additional information, see the Admissions section of this catalog. An undergraduate GPA of at least 2.8 on a 4.0 scale or equivalent is normally required.  GRE scores are required for those students applying for financial support, or if the most recent degree was earned at a school outside the United States. Applications are considered on a case-by-case basis.

# Master of Science in Applied Statistics

The objective of the Master of Science in Applied Statistics is to prepare students for a wide range of professional activities as practicing statisticians in both academia and industry. A statistician develops and analyzes models of data-driven situations where uncertainty of the outcomes plays a major role, identifies statistical relationships among observable variables, forecasts probable future outcomes, and draws inferences about background parameters that impact the phenomenon of interest. Thus the program is designed to provide students with the comprehensive knowledge and technical skills that are needed for the planning, execution, and analysis of statistical studies. These statistical studies are increasingly used as advisory instruments for policy decisions in the corporate and other sectors of the economy.

The Master of Science in Applied Statistics program will serve the needs of students with a baccalaureate degree who are planning to work in industry, commerce, or education, as well as practicing engineers and others already employed in industry and commerce. The program also strengthens the analytical and quantitative skills of graduate students who may be interested in pursuing a doctoral degree in Applied Probability and Statistics, since it equips them with basic training in the foundations of statistics in preparation for further advanced studies and research.

## Admission Requirements

Applicants must have a degree from an accredited institution with at least 12 credits in mathematics, including calculus. Students who do not meet these requirements may be admitted if they satisfy the university's requirements for admission. An undergraduate GPA of at least 2.8 on a 4.0 scale or equivalent is normally required.  GRE scores are required for those students applying for financial support, or if the most recent degree was earned at a school outside the United States. Applications are considered on a case-by-case basis.

*Bridge Program:* Students who do not satisfy the credit requirement in mathematics will be required to take a bridge program of six credits in appropriate mathematics courses. Such courses do not count towards a graduate degree.

# Master of Science in BioStatistics

The Master of Science program in Biostatistics will provide advanced graduate education and training to students interested in applying statistical methods to the health sciences in general and clinical studies in particular. It will focus on training students in quantitative methods that will prepare them for careers in the health, life sciences, and pharmaceutical areas. Graduates, upon satisfactory completion of the degree program, are expected to have acquired appropriate skills in data analysis and computing that are typically required in their profession. This program will address the growing demand for trained biostatisticians in these fields, especially in New Jersey.

## Admission Requirements

Applicants must have a baccalauareate degree in Statistics, Mathematics, Sciences, or Engineering, with at least 12 credits in mathematics, including calculus and at least one upper division course in statistics. Applicants with other baccalaureate degrees will also be considered and may be subject to a suitable bridge program. An undergraduate GPA of at least 3.0 on a 4.0 scale or equivalent is required.

*Bridge Program:* Students who do not satisfy the credit requirement in mathematics will be required to take a suitable bridge program of appropriate mathematics/statistics courses. Such courses do not count towards the graduate degree.

# Master of Science in Mathematical and Computational Finance

(33 credits)

In the past several decades the field of Mathematical and Computational Finance has developed into a well established discipline of great importance within the financial, investment and banking industries and increasingly in regulatory agencies. Practitioners of this field combine high-level analytical, computational and modeling skills with a thorough understanding of financial markets and instruments to assess value and risk. These assessments are needed to structure solutions to financial problems, to manage risk and to identify and exploit financial opportunities. As the financial industry is highly concentrated around the New York City area, practitioners of Mathematical and Computational Finance are in high demand locally.

The M.S. in Mathematical and Computational Finance delivers the theoretical knowledge, the practical methods and the essential skills needed for students to begin or enhance careers as quantitative analysts in the financial industry. Students graduating from this program will possess a broad knowledge of financial and capital markets including understanding of systemic risks, the ability to develop quantitative models of financial markets and instruments and the analytical, statistical and computational capabilities to analyze those models to obtain practical information of value in the financial industry. Due to the evolving nature of financial markets and institutions, practitioners in this field must be ready to learn new ideas and methods across a broad range of disciplines including mathematics, statistics, computational science, finance, and economics. The program aims to provide the multidisciplinary foundations preparing quantitative analysts for this life-long development of skills and understanding and for responsible participation in the financial system.

## Admission Requirements

Applicants must have earned an undergraduate degree with an overall GPA of 2.8 (on a 4.0 scale) and are expected to have fulfilled the following program prerequisites:

- undergraduate finance (FIN 315 Fundamentals of Corporate Finance or equivalent),
- practical computer programming skills in C/C++,
- two semesters of calculus-based undergraduate courses in probability or statistics,
- undergraduate calculus and multivariate calculus (MATH 111 Calculus I, MATH 112 Calculus II and MATH 213 Calculus III B or equivalent),
- undergraduate differential equations (MATH 222 Differential Equations or equivalent),
- undergraduate linear algebra (MATH 337 Linear Algebra or equivalent),
- experience with partial differential equations as models such as is typical in undergraduate courses in electromagnetism, heat transfer, fluid dynamics, elasticity and quantum mechanics.

A GPA of at least 3.0 (on a 4.0 scale) is expected in the courses fulfilling these prerequisites. GRE  or GMAT scores are required for those students applying for financial support, or if the most recent degree was earned at a school outside the United States. Applications are considered on a case-by-case basis. Required courses for the program are generally offered in the evenings and part-time study is possible.

*Bridge Program:* Students with a baccalaureate degree not fully covering the prerequisites listed above may be admitted and required by the department to take an individually-designed program of courses that may include undergraduate courses before proceeding to the graduate curriculum. Such courses do not count towards a graduate degree.

# Doctor of Philosophy in Mathematical Sciences

The Doctor of Philosophy in Mathematical Sciences is offered in collaboration with the Department of Mathematics and Computer Science at Rutgers University-Newark. The doctoral program in Mathematical Sciences is designed to prepare students for a wide range of professional activities in science and engineering. Prospective students must choose one of the following tracks:

- Applied Mathematics
- Applied Probability and Statistics
- Pure Mathematics

The doctoral program reflects the research interests of the faculty and is focused on the development and use of mathematical tools for solving modern scientific, technological and industrial problems, and advancing the research knowledge and methodology in various fields of specialization.

The Applied Mathematics track emphasizes the applications of mathematical methods to the physical and biological sciences and engineering, including acoustics, electromagnetics, fluid dynamics, materials science, biology, and medicine. Mathematical modeling, asymptotic analysis, and scientific computing are emphasized. Students are expected to develop a broad range of capabilities both in mathematics and in an area of application.

The Applied Probability and Statistics track emphasizes directed instruction and independent research in areas that are specializations of the faculty. Current research interest areas of the faculty include applied probability, non-parametric statistics, and statistical reliability theory and applications

The Pure Mathematics track offers research opportunities in many fields of specialization, including representation theory, number theory, low-dimensional topology, Riemann surfaces and Kleinian groups, geometric group theory, and 4-manifolds.

## Admission Requirements

Admission to the program is based on a review of the applicant's credentials and interests as expressed in academic transcripts, GRE scores, letters of recommendation, statement of interests, and TOEFL scores (for students whose native language is not English). Applicants with strong academic records whose abilities and interests complement the research of the faculty are sought. In general, applicants should have a bachelor's or master's degree in mathematics, an engineering discipline, or a branch of the natural sciences. Students choosing the Applied Mathematics track or the Applied Probability and Statistics track must fulfill the admissions requirements specified in the Admissions section of this catalog.

**Students interested in either the Applied Mathematics track or the Applied Probability and Statistics track should apply to NJIT. Students interested in the Pure Mathematics track should apply to Rutgers-Newark.**

# NJIT Faculty

## A

Afkhami, Shahriar Zakerzadeh, Associate Professor

Ahluwalia, Daljit Singh, Professor

Andrushkiw, Roman, Professor Emeritis

## B

Batson II, William Richard, Post Doctoral Fellow

Bechtold, John K., Professor

Blackmore, Denis L., Professor

Booty, Michael R., Professor

Bose, Amitabha K., Professor

Boubendir, Yassine, Associate Professor

Brown, Ronald Robert, University Lecturer

Bukiet, Bruce G., Associate Professor

## C

Choi, Wooyoung, Professor

Cummings, Linda J., Professor

## D

Dhar, Sunil K., Professor

Diekman, Casey O., Assistant Professor

Dios, Rose, Associate Professor

## F

Fang, Yixin, Associate Professor

Froese, Brittany, Assistant Professor

## G

Garfield, Ralph, Associate Professor Emeritus

Goodman, Roy H., Associate Professor

Guo, Wenge, Associate Professor

## H

Hayes, Jimmy L., University Lecturer

Horntrop, David J., Associate Professor

Horwitz, Kenneth A., University Lecturer

Hunter, John, University Lecturer

## J

Jiang, Shidong, Associate Professor

## K

Kappraff, Jay M., Associate Professor

Kelly, Rudy, University Lecturer

Kondic, Lou, Professor

Kriegsmann, Gregory A., Distinguished Professor Emeritus

## L

Loh, Ji Meng, Associate Professor

Luke, Jonathan H. C., Professor

## M

Matveev, Victor V., Associate Professor

Michalopoulou, Zoi-Heleni, Professor

Milojevic, Petronije, Professor

Miura, Robert M., Distinguished Professor Emeritus

Mohebbi Forushani, Soroosh, University Lecturer

Moore, Richard O., Associate Professor

Muratov, Cyrill B., Professor

## N

Natarajan, Padma, University Lecturer

## P

Perez, Manuel, Professor

Petropoulos, Peter G., Associate Professor

Plastock, Roy A., Associate Professor

Pole, Andrew, MSMCF Coordinator

Porus, Jonathan J, Math Tutoring Center Director

Potocki-Dul, Magdallena M., University Lecturer

## R

Rappaport, Karen D., Senior University Lecturer

Ratnaswamy, Jeyakumaran, Senior University Lecturer

Rotstein, Horacio G., Professor

## S

Shirokoff, David, Assistant Professor

Siegel, Michael S., Professor

Stickler, David, Professor Emeritus

Subramanian, Sundarraman, Associate Professor

## T

Tavantzis, John, Professor Emeritus

Turc, Catalin C., Associate Professor

### V

Voronka, Roman W., Professor Emeritus

### W

Wang, Antai, Associate Professor

### Y

Young, Yuan-Nan, Associate Professor

### Z

Zaleski, Joseph, University Lecturer

## Programs


- Applied Mathematics - M.S. (p. 784)
- Applied Statistics - M.S. (p. 786)
- BioStatistics - M.S. (p. 788)
- Computational Biology - M.S. (p. 788)
- Mathematical and Computational Finance - M.S. (p. 790)
- Mathematical Sciences - Ph.D. (p. 791)


Applied Statistical Methods - Cert.

Financial Mathematics - Cert.

Quantitative Tools in Finance - Cert.

Biostatistics Essentials - Cert.

## Mathematical Sciences Courses

**MATH 545. Introductory Mathematical Analysis. 3 credits, 3 contact hours.**
Prerequisite: MATH 211 or MATH 213, and departmental approval. Rigorous treatment of the calculus of real-valued functions of one real variable: the real number system, epsilon-delta theory of limit, continuity, derivative, and the Riemann integral. The fundamental theory of calculus. Series and sequences including Taylor series and uniform convergence. The inverse and implicit function theorems.

**MATH 546. Advanced Calculus. 3 credits, 3 contact hours.**
Prerequisite: MATH 545 or MATH 480. Rigorous treatment of the calculus of real-valued functions of several real variables: the geometry and algebra of n-dimensional Euclidean space, limit, continuity, derivative, and the Riemann integral of functions of several variables, the inverse and implicit function theorems, series, including Taylor series, optimization problems, integration on curves and surfaces, the divergence and related theorems.

**MATH 573. Intermediate Differential Equations. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 337, or departmental approval. Methods and applications for systems of ordinary differential equations: existence and uniqueness for solutions of ODEs, linear systems, stability analysis, phase plane and geometrical methods, Sturm-Liouville eigenvalue problems.

**MATH 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services. Cooperative education/internship providing on-the-job complement to academic programs in mathematics. Work assignments and projects are developed by the Co-op Office in consultation with the Department of Mathematical Sciences.

**MATH 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

**MATH 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

**MATH 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**MATH 599. Teaching in Mathematics. 3 credits, 3 contact hours.**
Required of all master's and doctoral students in Mathematical Sciences who are receiving departmental or research-based awards. Provides students with the skills needed to communicate effectively and to perform their teaching and related duties. Students are exposed to strategies and methods for communicating and for teaching undergraduate mathematics, and they are required to practice and demonstrate these techniques. Not counted for degree credit.

**MATH 604. Mathematical Finance. 3 credits, 3 contact hours.**
Prerequisites: FIN 641 Derivatives, MATH 605 Stochastic Calculus, or permission of the instructor. This course will explore the structure, analysis, and use of financial derivative instruments deployed in investment strategies and portfolio risk management. Topics include continuous time dynamics, arbitrage pricing, martingale methods, and valuation of European, American, and path dependent derivatives.

**MATH 605. Stochastic Calculus. 3 credits, 3 contact hours.**
This course provides an introduction to stochastic calculus. Topics include conditioning, Poisson processes, martingales, Brownian motion, Ito integrals, Ito's formula, stochastic differential equations, Feynman-Kac formula, Girsanov's theorem, and the martingale representation theorem. Financial applications include pricing, hedging, and interest rate models.

**MATH 606. Term Structure Models. 3 credits, 3 contact hours.**
Prerequisites: MATH 605, or permission of the instructor. Corequisite: MATH 608. This course will develop the mathematical structure of interest rate models and explore the considerable hurdles involved in practical implementation. Short rate models, single and multifactor; the Heath-Jarrow-Morton framework; and modern Libor market models will be examined.

**MATH 607. Credit Risk Models. 3 credits, 3 contact hours.**
Prerequisites: MATH 604, MATH 605, MATH 606 or permission of the instructor. This course explores mathematical models and methods for credit risk measurement and rating. The nature of credit risk is reviewed through examination of credit instruments, including credit default swaps, collateralized debt obligations, and basket credit derivatives. These instruments, through which risk exposure opportunities and hedging possibilities are created and managed, are explored with respect to dynamics and valuation techniques, applying PDE methods and stochastic processes.

**MATH 608. Partial Differential Equations for Finance. 3 credits, 3 contact hours.**
This course presents the subject of partial differential equations (PDE's) with a strong emphasis on the PDE's arising in the study of stochastic processes and finance. The focus is on analytical and numerical methods for obtaining solutions in a form useful for solving problems in financial engineering. Topics include modeling with PDE's, classification of PDE's, analytical and numerical methods for PDE's and application to finance.

**MATH 609. Projects in Mathematical and Computational Finance. 3 credits, 3 contact hours.**
Prerequisites: MATH 604 Mathematical Finance, MATH 605 Stochastic Calculus, MATH 606 Term Structure Models, or permission of the instructor. This project course requires students to demonstrate attained mastery of the material studies in the prerequisite courses. Projects also extend students? knowledge of specific areas beyond that covered in earlier courses into areas such as particle filtering or optimization techniques for term structure model calibration. The aim is to broaden the students? classroom focus to the more unconstrained, open ended and less well defined contexts that are frequently encountered in practice.

**MATH 610. Graduate Research Methods. 3 credits, 0 contact hours.**
Prerequisite: MATH 614, MATH 671, and MATH 690. Acquaints second-year graduate students with the techniques and vocabulary of a field in applied mathematics. Each student contacts a designated faculty member and is given several basic papers or books on a research topic of current interest. The student prepares two lectures on his/her topic to be given at the end of the semester. A sample list of active fields of research includes acoustics, electromagnetic theory, elasticity, fluid dynamics, combustion, and mathematical biology.

**MATH 611. Numerical Methods for Computation. 3 credits, 3 contact hours.**
This course provides a practical introduction to numerical methods. Numerical solution of linear systems. Interpolation and quadrature. Interative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial and boundary value problems for ODE's. Introduction to numerical solution of PDE's. Applicatons drawn from science, engineering, and finance.

**MATH 613. Advanced Applied Mathematics I: Modeling. 3 credits, 3 contact hours.**
Prerequisites: MATH 331 and MATH 337, or departmental approval. Concepts and strategies of mathematical modeling are developed by investigation of case studies in a selection of areas. Consistency of a model, nondimensionalization and scaling, regular and singular effects are discussed. Possible topics include continuum mechanics (heat and mass transfer, fluid dynamics, elasticity), vibrating strings, population dynamics, traffic flow, and the Sommerfeld problem.

**MATH 614. Numerical Methods I. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 337, MATH 340, and proficiency in a computer language (FORTRAN, C, or C++), or departmental approval. Theory and techniques of scientific computation, with more emphasis on accuracy and rigor than MATH 611. Machine arithmetic. Numerical solution of a linear system and pivoting. Interpolation and quadrature. Iterative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial- and boundary-value problems for systems of ODEs. Applications. The class includes examples requiring student use of a computer.

**MATH 615. Approaches to Quantitative Analysis in the Life Sciences. 3 credits, 3 contact hours.**
A graduate seminar-style course based around case studies of common data analytic methods used in the life sciences. The case studies are designed to help students who are interested in applications of statistical thinking to biological sciences appreciate the scope of quantitative methods, their underlying concepts, assumptions and limitations. While the mathematics of specific methods are not covered, students of the course will get an understanding of the diverse approaches to statistical inference in the life sciences.

**MATH 630. Linear Algebra and Applications. 3 credits, 3 contact hours.**
Prerequisites: (This course is not intended for students in the Master's in Applied Mathematics program or in the doctoral program in Mathematical Sciences.) Math 211 or Math 213, and Math 222. Development of the concepts needed to study applications of linear algebra and matrix theory to science and engineering. Topics include linear systems of equations, matrix algebra, orthogonality, eigenvalues and eigenvectors, diagonalization, and matrix decomposition.

**MATH 631. Linear Algebra. 3 credits, 3 contact hours.**
Prerequisites: MATH 222 and MATH 337, or departmental approval. Similar in aim and content to MATH 630 but with more emphasis on mathematical rigor. Linear systems of equations, matrix algebra, linear spaces, orthogonality, eigenvalues and eigenvectors, diagonalization, and matrix decomposition. Applications.

**MATH 635. Analytical Computational Neuroscience. 3 credits, 0 contact hours.**
Prerequisites: MATH 211 or 213, MATH 337, and CS 113 or MATH 240, or departmental approval. This course will provide an intermediate-level mathematical and computational modeling background for small neuronal systems. Models of biophysical mechanisms of single and small networks of neurons are discussed. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, single- and multi-compartmental modeling, synaptic transmission, mathematical treatment of 2-cell inhibitory or excitatory networks. In this course, the students will be required to build computer models of neurons and networks and analyze these models using geometric singular-perturbation analysis and dynamical systems techniques.

**MATH 636. Systems Computational Neuroscience. 3 credits, 3 contact hours.**
Prerequisites: MATH 635. This course covers mathematical and computational modeling of neuronal networks. Topics covered include central pattern generators, models of visual processes, models of learning and memory, neural coding and mathematics of neural networks, models of oscillations in sensory, thalamic and thalamo-cortical networks, neuronal wave propagation.

**MATH 637. Foundations of Mathematical Biology. 3 credits, 3 contact hours.**
Prerequisites: MATH 222 and MATH 337, or departmental approval. This course provides an introduction to the use of mathematical techniques applied to solve problems in biology. Models discussed fall into 3 categories: discrete, continuous, and spatially distributed. Biological topics discussed range from the subcellular molecular systems and cellular behavior to physiological problems, population biology and developmental biology.

**MATH 639. Mathematical Modeling II. 3 credits, 3 contact hours.**
Continuation of MATH 613 (Advanced Applied Mathematics I, Modeling). Concepts and strategies of Mathematical modeling are developed by case studies in a selection of areas. Topics will be complementary to those presented in MATH 613, and include for example, the mathematical theory of elasticity and electromagnetism.

**MATH 644. Regression Analysis Methods. 3 credits, 3 contact hours.**
Prerequisite: MATH 661. Regression models and the least squares criterion. Simple and multiple linear regression. Regression diagnostics. Confidence intervals and tests of parameters, regression and analysis of variance. Variable selection and model building. Dummy variables and transformations, growth models. Other regression models such as logistic regression. Using statistical software for regression analysis.

**MATH 645. Analysis I. 3 credits, 3 contact hours.**
Prerequisite: MATH 546 or departmental approval. Review and extension of the fundamental concepts of advanced calculus: the real number system, limit, continuity, differentiation, the Riemann integral, sequences and series. Point set topology in metric spaces. Uniform convergence and its applications.

**MATH 646. Time Series Analysis. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or departmental approval. Time series models, smoothing, trend and removal of seasonality. Naive forecasting models, stationarity and ARMA models. Estimation and forecasting for ARMA models. Estimation, model selection, and forecasting of nonseasonal and seasonal ARIMA models.

**MATH 647. Time Series Analysis II. 3 credits, 3 contact hours.**
Prerequisite: MATH 646. Continuation of MATH 646. Covers methods of time series analysis useful in engineering, the sciences, economics, and modern financial analysis. Topics include spectral analysis, transfer functions, multivariate models, state space models and Kalman filtering. Selected applications from topics such as intervention analysis, neural networks, process control, financial volatility analysis.

**MATH 651. Methods of Applied Mathematics I. 3 credits, 3 contact hours.**
Prerequisite: MATH 222 or departmental approval. A survey of mathematical methods for the solution of problems in the applied sciences and engineering. Topics include: ordinary differential equations and elementary partial differential equations. Fourier series, Fourier and Laplace transforms, and eigenfunction expansions.

**MATH 654. Clinical Trials Design and Analysis. 3 credits, 3 contact hours.**
Prerequisites: MATH 665 or equivalent with Departmental approval. Statistical methods and issues in the design of clinical trials and analysis of their data. Topic include clinical trial designs for phases 1-4, randomization principle and procedures, analysis of pharmacokinetic data for bioequivalence, multi-center trials, categorical data analysis, survival analysis, longitudinal data analysis, interim analysis, estimation of sample size and power, adjustment for multiplicity, evaluation of adverse events, and regulatory overview.

**MATH 656. Complex Variables I. 3 credits, 3 contact hours.**
Prerequisite: MATH 545 or MATH 645 or departmental approval. The theory and applications of analytic functions of one complex variable: elementary properties of complex numbers, analytic functions, elementary complex functions, conformal mapping, Cauchy integral formula, maximum modulus principle, Laurent series, classification of isolated singularities, residue theorem, and applications.

**MATH 659. Survival Analysis. 3 credits, 3 contact hours.**
Prerequisites: MATH 665 or equivalent with Departmental approval. Introduction to statistical methods for modeling time-to-event data in the presence of censoring and truncation, with emphasis on applications to the health sciences. Topics include survival and hazard functions, censoring and truncation, parametric and nonparametric models for survival data, competing-risks, regression models including Cox proportional hazards model and time-dependent covariates, one and two sample tests, and use of appropriate statistical software for computations.

**MATH 660. Introduction to statistical Computing with SAS and R. 3 credits, 3 contact hours.**
Prerequisite: Basic knowledge in statistical concepts or instructor approval. This course will study SAS and R programming and emphasize the SAS and R data steps including getting data into the SAS and R environments, working and combining data using control flows, merge and subsets, etc. as well as learning to export data and to generate high resolution graphics. Several SAS and R statistical procedures or functions will also be discussed and illustrated. Finally, interactive statistical software JMP and Minitab are briefly introduced.

**MATH 661. Applied Statistics. 3 credits, 3 contact hours.**
Prerequisite: MATH 112. Role and purpose of applied statistics. Data visualization and use of statistical software used in course. Descriptive statistics, summary measures for quantitative and qualitative data, data displays. Modeling random behavior: elementary probability and some simple probability distribution models. Normal distribution. Computational statistical inference: confidence intervals and tests for means, variances, and proportions. Linear regression analysis and inference. Control charts for statistical quality control. Introduction to design of experiments and ANOVA, simple factorial design and their analysis. MATH 661 and MATH 663 cannot both be used toward degree credits at NJIT.

**MATH 662. Probability Distributions. 3 credits, 3 contact hours.**
Prerequisite: MATH 341 or MATH 333, and departmental approval. Probability, conditional probability, random variables and distributions, independence, expectation, moment generating functions, useful parametric families of distributions, transformation of random variables, order statistics, sampling distributions under normality, the central limit theorem, convergence concepts and illustrative applications.

**MATH 663. Introduction to Biostatistics. 3 credits, 3 contact hours.**
Prerequisites: Undergraduate Calculus. Introduction to statistical techniques with emphasis on applications in health related sciences. This course will be accompanied by examples from biological, medical and clinical applications. Summarizing and displaying data; basic probability and inference; Bayes' theorem and its application in diagonostic testing; estimation, confidence intervals, and hypothesis testing for means and proportions; contingency tables; regression and analysis of variance; logistic regression and survival analysis; basic epidemiologic tools; use of statistical software. Math 661 and Math 663 cannot both be used toward degree credits at NJIT.

**MATH 664. Methods for Statistical Consulting. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or departmental approval. Communicating with scientists in other disciplines. Statistical tools for consulting. Using statistical software such as JMP, SAS, and S-plus. Case studies which illustrate using statistical methodology and tools are presented by the instructor and guest speakers from academia and industry. Assignments based on case studies with use of statistical software is required.

**MATH 665. Statistical Inference. 3 credits, 3 contact hours.**
Prerequisite: MATH 662 or departmental approval. Review of sampling distributions. Data reduction principles: sufficiency and likelihood. Theory and methods of point estimation and hypothesis testing, interval estimation, nonparametric tests, introduction to linear models.

**MATH 666. Simulation for Finance. 3 credits, 3 contact hours.**
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/MATH 666.

**MATH 671. Asymptotic Methods I. 3 credits, 3 contact hours.**
Prerequisite: MATH 645 or MATH 545, and MATH 656, or departmental approval. Asymptotic sequences and series. Use of asymptotic series. Regular and singular perturbation methods. Asymptotic methods for the solution of ODEs, including: boundary layer methods and asymptotic matching, multiple scales, the method of averaging, and simple WKB theory. Asymptotic expansion of integrals, including: Watson's lemma, stationary phase, Laplace's method, and the method of steepest descent.

**MATH 672. Biomathematics I: Biological Waves and Oscillations. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 331, and MATH 337, or departmental approval. Models of wave propagation and oscillatory phenomena in nerve, muscle, and arteries: Hodgkin-Huxley theory of nerve conduction, synchronization of the cardiac pacemaker, conduction and rhythm abnormalities of the heart, excitation-contraction coupling, and calcium induced waves, wave propagation in elastic arteries, models of periodic human locomotion.

**MATH 673. Biomathematics II: Pattern Formation in Biological Systems. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 331, and MATH 337, or departmental approval. Emergence of spatial and temporal order in biological and ecological systems: Hopf and Turing bifurcation in reaction-diffusion systems, how do zebras get their stripes, patterns on snake skins and butterfly wings, spatial organization in the visual cortex, symmetry breaking in hormonal interactions, how do the ovaries count. Basic techniques of mathematics are introduced and applied to significant biological phenomena that cannot be fully understood without their use.

**MATH 675. Partial Differential Equations. 3 credits, 3 contact hours.**
Prerequisite: MATH 690 or departmental approval. A survey of the mathematical theory of partial differential equations: first-order equations, classification of second-order equations, the Cauchy-Kovalevsky theorem, properties of harmonic functions, the Dirichlet principle. Initial- and boundary-value problems for hyperbolic, elliptic, and parabolic equations. Systems of equations.

**MATH 676. Advanced Ordinary Differential Equations. 3 credits, 3 contact hours.**
Prerequisites: MATH 222, MATH 337, and MATH 545 or MATH 645. A rigorous treatment of the theory of systems of differential equations: existence and uniqueness of solutions, dependence on initial conditions and parameters. Linear systems, stability, and asymptotic behavior of solutions. Nonlinear systems, perturbation of periodic solutions, and geometric theory of systems of ODEs.

**MATH 677. Calculus of Variations. 3 credits, 3 contact hours.**
Prerequisite: MATH 545 or MATH 645 or departmental approval. Necessary conditions for existence of extrema. Variation of a functional, Euler's equation, constrained extrema, first integrals, Hamilton-Jacobi equation, quadratic functionals. Sufficient conditions for the existence of extrema. Applications to mechanics.

**MATH 678. Intro to Stat Methods in Data. 3 credits, 3 contact hours.**
Prerequisite: MATH 661 or MATH 663, or permission by instructor. This course introduces students to concepts in statistical methods used in data science, including data collection, data visualization and data analysis. Emphasis is on model building and statistical concepts related to data analysis methods. The course provides the basic foundational tools on which to pursue statistics, data analysis and data science in greater depth. Topics include sampling and experimental design, understanding the aims of a study, principles of data analysis, linear and logistic regression, resampling methods, and statistical learning methods. Students will use the R statistical software.

**MATH 687. Quantitative Analysis for Environmental Design Research. 3 credits, 3 contact hours.**
Prerequisites: MATH 333 and departmental approval. Fundamental concepts in the theory of probability and statistics including descriptive data analysis, inferential statistics, sampling theory, linear regression and correlation, and analysis of variance. Also includes an introduction to linear programming and nonlinear models concluding with some discussion of optimization theory.

**MATH 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 0 contact hours.**
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science.

**MATH 689. Advanced Applied Mathematics II: Ordinary Differential Equations. 3 credits, 3 contact hours.**
Prerequisites: MATH 545 or MATH 645, MATH 613, and MATH 631. A practical and theoretical treatment of boundary-value problems for ordinary differential equations: generalized functions, Green's functions, spectral theory, variational principles, and allied numerical procedures. Examples will be drawn from applications in science and engineering.

**MATH 690. Advanced Applied Mathematics III: Partial Differential Equations. 3 credits, 3 contact hours.**
Prerequisite: MATH 689. A practical and theoretical treatment of initial- and boundary-value problems for partial differential equations: Green's functions, spectral theory, variational principles, transform methods, and allied numerical procedures. Examples will be drawn from applications in science and engineering.

**MATH 691. Stochastic Processes with Applications. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Renewal theory, renewal reward processes and applications. Homogeneous, non-homogeneous, and compound Poisson processes with illustrative applications. Introduction to Markov chains in discrete and continuous time with selected applications.

**MATH 692. MSMCF Forum. 0 credits, 0 contact hours.**
Forum comprises informal discussions and debates engaging students in the realities of living and working in the world, with a focus on economics and finance. These realities include broad awareness of contemporary events, ethical implications of decisions, proper implementation and use of models, the research process and the critical skills of communication. Forum meetings are designed to promote understanding and build experience in all these areas.

**MATH 698. Sampling Theory. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Role of sample surveys. Sampling from finite populations. Sampling designs, the Horowitz-Thompson estimator of the population mean. Different sampling methods, simple random sampling, stratified sampling, ratio and regression estimates, cluster sampling, systematic sampling.

**MATH 699. Design and Analysis of Experiments. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Statistically designed experiments and their importance in data analysis, industrial experiments. Role of randomization. Fixed and random effect models and ANOVA, block design, latin square design, factorial and fractional factorial designs and their analysis.

**MATH 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisites: Matriculation for the Master of Science in Applied Mathematics or in Applied Statistics and departmental approval. Work must be initiated with the approval of a faculty member, who will be the student's project advisor. Work of sufficient quality may qualify for extension into a master's thesis, see Math 701.

**MATH 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisites: Matriculation for the Master of Science in Applied Mathematics or in Applied Statistics and departmental approval. Work must be initiated with the approval of a faculty member, who will be the student's project advisor. Work of sufficient quality may qualify for extension into a master's thesis, see MATH 701.

**MATH 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: Matriculation for the master's degree and departmental approval. Students must register for a minimum of 3 credits per semester until completion. The work is carried out under the supervision of a designated member of the faculty.

**MATH 707. Advanced Applied Mathematics IV: Special Topics. 3 credits, 3 contact hours.**
Prerequisite: Departmental approval. A current research topic of interest to departmental faculty. Typical topics include: computational fluid dynamics, theoretical fluid dynamics, acoustics, wave propagation, dynamical systems, theoretical and numerical aspects of combustion, mathematical biology, and various topics in statistics.

**MATH 712. Numerical Methods II. 3 credits, 3 contact hours.**
Prerequisites: MATH 614, MATH 331 or departmental approval, and proficiency in a computer programming language (FORTRAN, C, or C++). Numerical methods for the solution of initial- and boundary-value problems for partial differential equations, with emphasis on finite difference methods. Consistency, stability, convergence, and implementation are considered.

**MATH 713. Advanced Scientific Computing: Multi-Dimensional Finite-Difference Schemes and Spectral Methods. 3 credits, 3 contact hours.**
Prerequisite: MATH 712 and proficiency in a computer programming language (FORTRAN, C, or C++). Derivation and analysis of finite difference schemes for systems of partial differential equations in two and three spatial dimensions and time. Issues pertaining to efficient implementation of algorithms and to stability of physical and numerical boundary conditions. Pseudo-spectral and spectral methods to solve partial differential equations. Approximation properties of Fourier and Chebyshev series and techniques based on the Fast Fourier Transform (FFT) and on matrix multiplication to numerically compute partial derivatives. Time-discretization techniques suitable for use with pseudo-spectral and spectral methods. Model systems arising in wave propagation, fluid dynamics, and mathematical biology will be considered.

**MATH 715. Mathematical Fluid Dynamics I. 3 credits, 3 contact hours.**
Introduction to the basic ideas of fluid dynamics, with an emphasis on rigorous treatment of fundamentals and the mathematical developments and issues. The course focuses on the background and motivation for recent mathematical and numerical work on the Euler and Navier-Stokes equations, and presents a mathematically intensive investigation of various model equations of fluid dynamics (e.g., the Korteweg-de-Vries equations).

**MATH 716. Mathematical Fluid Dynamics II. 3 credits, 0 contact hours.**
Continuation of MATH 715. Further development of the ideas of fluid dynamics, with an emphasis on mathematical developments and issues. A selection of topics will be developed in some detail, for example: Stokes flow and low-Reynolds-number hydrodynamics; flow at high Reynolds number and boundary layers; shock waves and hyperbolic systems; dynamics of interfacial flows; hydrodynamic stability; rotating fluids.

**MATH 717. Inverse Problems and Global Optimization. 3 credits, 3 contact hours.**
Introduction to inverse problems and global optimization. Linear, quasi-linear, and nonlinear inverse problems are studied with emphasis on regularization techniques. Bayesian statistical approaches and Monte Carlo methods are introduced and discussed in the context of inverse problems. The mathematical foundations of simulated annealing, genetic algorithms, and TABU are presented.

**MATH 720. Tensor Analysis. 3 credits, 3 contact hours.**
Prerequisite: MATH 613 and MATH 631, or departmental approval. Review of vector analysis in general curvilinear coordinates. Algebra and differential calculus of tensors. Applications to differential geometry, analytical mechanics, and mechanics of continuous media. The choice of applications will be determined by the interests of the class.

**MATH 722. Wave Propagation. 3 credits, 3 contact hours.**
Derivation of linear wave equations describing acoustic, electromagnetic, elastodynamic and hydrodynamic phenomena. Fundamental solutions and their application to initial value problems. Applications and solution of boundary value problems using Green's functions, image and spectral methods. Related time harmonic problems, including radiation, scattering, diffraction and transmission phenomena. Dispersive waves and the method of stationary phase. Linear waves in anisotropic media.

**MATH 725. Independent Study I. 3 credits, 3 contact hours.**

**MATH 745. Analysis II. 3 credits, 3 contact hours.**
Prerequisite: MATH 645. Lebesgue measure and integration, including the Lebesgue dominated convergence theorem and Riesz-Fischer theorem. Elements of Hilbert spaces and Lp-spaces. Fourier series and harmonic analysis. Multivariate calculus.

**MATH 756. Complex Variables II. 3 credits, 3 contact hours.**
Prerequisite: MATH 656. Selected topics from: conformal mapping and applications of the Schwarz-Christoffel transformation, applications of calculus of residues, singularities, principle of the argument, Rouche's theorem, Mittag-Leffler's theorem, Casorati-Weierstrass theorem, analytic continuation, and applications, Schwarz reflection principle, monodromy theorem, Wiener-Hopf technique, asymptotic expansion of integrals; integral transform techniques, special functions.

**MATH 761. Statistical Reliability Theory and Applications. 3 credits, 3 contact hours.**
Prerequisite: MATH 662 or departmental approval. Survival distributions, failure rate and hazard functions, residual life. Common parametric families used in modeling life data. Introduction to nonparametric aging classes. Coherent structures, fault tree analysis, redundancy and standby systems, system availability, repairable systems, selected applications such as software reliability.

**MATH 763. Generalized Linear Models. 3 credits, 3 contact hours.**
Prerequisites: MATH 662 and MATH 665 or departmental approval. Theoretical and applied aspects of generalized linear models. Classical linear models, nonlinear regression models, and generalized estimating equations.

**MATH 767. Fast Numerical Algorithms. 3 credits, 3 contact hours.**
The course covers state-of-the-art, analysis-based, fast numerical algorithms for computing discrete summations/transforms and for solving differential/integral equations. In particular, this course presents fast multiple methods and their descendants, including fast Fourier transform for nonequispaced data, fast Gauss transform, fast iterative solver and direct solver for elliptic boundary value problems.

**MATH 768. Probability Theory. 3 credits, 3 contact hours.**
Prerequisite: MATH 645 or departmental approval. Measure theoretic introduction to axiomatic probability. Probability measures on abstract spaces and integration. Random variables and distribution functions, independence, 0-1 laws, basic inequalities, modes of convergence and their interrelationships, Laplace-Stieltjes transforms and characteristic functions, weak and strong laws of large numbers, conditional expectation, discrete time martingales.

**MATH 771. Asymptotic Methods II. 3 credits, 3 contact hours.**
Prerequisite: MATH 671. Continuation of MATH 671. Asymptotic methods for the solution of PDEs, including: matched asymptotic expansions, multiple scales, the WKB method or geometrical optics, and near-field far-field expansions. Applications to elliptic, parabolic, and hyperbolic problems. Further topics in the asymptotic expansion of integrals and the WKB method. Emphasis on examples drawn from applications in science and engineering.

**MATH 786. Large Sample Theory and Inference. 3 credits, 3 contact hours.**
Prerequisites: MATH 665 and MATH 768. Limit theorems, central limit theorem, asymptotic expansions and large deviations, limit theorems in martingales and semi-martingales and stochastic differential equations, asymptotic expansions of functions of statistics, linear parametric estimation, asymptotic efficiency, martingale approach to inference: test for homogeneity and goodness of fit, decomposable statistics, inference for counting processes and censored data, inference in nonlinear regression, existence and consistency of least squares estimator (LSE), asymptotic properties of LSE, Von Mises functionals, estimation of parameters of stable laws, empirical characteristics function for inference, generalized least squares for linear models.

**MATH 787. Non-Parametric Statistics. 3 credits, 3 contact hours.**
Prerequisite: MATH 662. Wilcoxon signed-ranks test, Mann-Whitney U test, binomial sign test for single sample and two dependent samples, McNemar's test, Cochran Q test, Wilcoxon matched-pairs signed-ranks test, Kruskal-Wallis one-way analysis of variance, Friedman two-way analysis of variance, Siegel-Tukey test for equal variability, chi-squared goodness-of-fit test, test for homogeneity and independence, single-sample runs test and other tests of randomness, correlation tests: Spearman's rank-order correlation, coefficient and Kendall's tau, Kendall's coefficient of concordance, and Goodman and Kruskal's gamma, comparing power efficiency.

**MATH 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 790E. Doctoral Dissertation. 12 credits, 12 contact hours.**
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

**MATH 791. Graduate Seminar. 0 credits, 1 contact hour.**
All master's and doctoral students receiving departmental or research-based awards must register for this course each semester.

**MATH 792B. Pre Doctoral Research. 3 credits, 3 contact hours.**

**MATH 792D. Pre Doctoral Research. 9 credits, 9 contact hours.**

# M.S. in Applied Mathematics

## Degree Requirements

Students with a baccalaureate degree in an area different from mathematics may be admitted and required by the department to take an individually-designed program of bridge courses that may include undergraduate courses before proceeding to the graduate curriculum. Such courses do not count towards a graduate degree.

The Master of Science in Applied Mathematics requires 30 credits: 15 credits in core courses, 15 credits in an area of specialization, of which six credits are required and nine credits are electives. Students must successfully complete at least 24 of these credits at the 600-level or higher, and no more than six credits at the 500-level will be counted towards the degree. Specific course requirements depend on the area of specialization. A master's thesis or a master's project is optional. (Advisor's permission is required)

*Seminar:* In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll every semester in MATH 791 Graduate Seminar.

## M.S. in Applied Mathematics (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 613 | Advanced Applied Mathematics I: Modeling | 3 |
| MATH 631 | Linear Algebra | 3 |
| MATH 645 | Analysis I [1] | 3 |
| MATH 656 | Complex Variables I | 3 |
| MATH 689 | Advanced Applied Mathematics II: Ordinary Differential Equations | 3 |
| **Required Courses in Areas of Specialization** | | |
| Select one of the following Areas of Specialization: | | 6 |
| **Analysis** | | |
| MATH 745 | Analysis II | |
| MATH 756 | Complex Variables II | |
| **Applied Mathematics** | | |
| MATH 614 | Numerical Methods I | |
| MATH 690 | Advanced Applied Mathematics III: Partial Differential Equations | |
| **Computational Mathematics** | | |
| MATH 614 | Numerical Methods I | |
| MATH 712 | Numerical Methods II | |
| **Mathematical Biology** | | |
| MATH 635 | Analytical Computational Neuroscience | |
| MATH 637 | Foundations of Mathematical Biology | |
| **Electives** | | |
| Select three courses with approval of graduate advisor | | 9 |
| **Total Credits** | | **30** |

1 Students specializing in Applied Mathematics or Computational Mathematics may take MATH 545 Introductory Mathematical Analysis and MATH 546 Advanced Calculus, instead of MATH 645 Analysis I and 3 credits of elective.

## M.S. in Applied Mathematics (Master's project)

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 613 | Advanced Applied Mathematics I: Modeling | 3 |
| MATH 631 | Linear Algebra | 3 |
| MATH 645 | Analysis I [1] | 3 |
| MATH 656 | Complex Variables I | 3 |
| MATH 689 | Advanced Applied Mathematics II: Ordinary Differential Equations | 3 |
| **Project** | | |
| MATH 700 | Master's Project | 3 |
| **Required Courses in Areas of Specialization** | | |
| Select one of the following Areas of Specialization: | | 6 |
| **Analysis** | | |
| MATH 745 | Analysis II | |
| MATH 756 | Complex Variables II | |
| **Applied Mathematics** | | |
| MATH 614 | Numerical Methods I | |
| MATH 690 | Advanced Applied Mathematics III: Partial Differential Equations | |
| **Computational Mathematics** | | |

| | | |
|---|---|---|
| MATH 614 | Numerical Methods I | |
| MATH 712 | Numerical Methods II | |
| **Mathematical Biology** | | |
| MATH 635 | Analytical Computational Neuroscience | |
| MATH 637 | Foundations of Mathematical Biology | |
| **Electives** | | |
| Select three courses with approval of graduate advisor. | | 9 |
| **Total Credits** | | **33** |

[1] Students specializing in Applied Mathematics or Computational Mathematics may take MATH 545 Introductory Mathematical Analysis and MATH 546 Advanced Calculus, instead of MATH 645 Analysis I and 3 credits of elective.

## M.S. in Applied Mathematics (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 613 | Advanced Applied Mathematics I: Modeling | 3 |
| MATH 631 | Linear Algebra | 3 |
| MATH 645 | Analysis I [1] | 3 |
| MATH 656 | Complex Variables I | 3 |
| MATH 689 | Advanced Applied Mathematics II: Ordinary Differential Equations | 3 |
| **Thesis** | | |
| MATH 701 | Master's Thesis | 6 |
| **Required Courses in Areas of Specialization** | | |
| Select one of the following Areas of Specialization: | | 6 |
| **Analysis** | | |
| MATH 745 | Analysis II | |
| MATH 756 | Complex Variables II | |
| **Applied Mathematics** | | |
| MATH 614 | Numerical Methods I | |
| MATH 690 | Advanced Applied Mathematics III: Partial Differential Equations | |
| **Computational Mathematics** | | |
| MATH 614 | Numerical Methods I | |
| MATH 712 | Numerical Methods II | |
| **Mathematical Biology** | | |
| MATH 635 | Analytical Computational Neuroscience | |
| MATH 637 | Foundations of Mathematical Biology | |
| **Electives** | | |
| Select three courses with approval of graduate advisor. | | 9 |
| **Total Credits** | | **36** |

[1] Students specializing in Applied Mathematics or Computational Mathematics may take MATH 545 Introductory Mathematical Analysis and MATH 546 Advanced Calculus, instead of MATH 645 Analysis I and 3 credits of elective.

Electives are chosen in consultation with a Departmental Graduate Advisor and consist of advanced courses in mathematics and advanced courses from biology, physics, computer science, and engineering, for example. Courses offered by appropriate departments at NJIT, RBHS, and Rutgers-Newark can be used as electives within the limits of the NJIT transfer policy. All elective courses must be approved by the graduate advisor.

# M.S. in Applied Statistics

## Degree Requirements

The Master of Science in Applied Statistics requires 30 credits: 21 credits in core courses and 9 credits of elective courses. Students must successfully complete at least 24 of these credits at the 600-level or higher, and no more than six credits at the 500-level will be counted towards the degree. A master's thesis or a master's project is optional.

*Seminar:* In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll every semester in MATH 791 Graduate Seminar.

## M.S. in Applied Statistics (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 611 | Numerical Methods for Computation | 3 |
| or MATH 630 | Linear Algebra and Applications | |
| MATH 644 | Regression Analysis Methods | 3 |
| MATH 661 | Applied Statistics [1] | 3 |
| MATH 662 | Probability Distributions | 3 |
| MATH 664 | Methods for Statistical Consulting | 3 |
| MATH 665 | Statistical Inference | 3 |
| MATH 699 | Design and Analysis of Experiments | 3 |
| **Electives** | | |
| Select three courses with approval of graduate advisor | | 9 |
| **Total Credits** | | **30** |

1. MATH 661 Applied Statistics and MATH 663 Introduction to Biostatistics cannot both be used toward degree credits at NJIT. The requirements of MATH 661 Applied Statistics may, in individual cases, be substituted by MATH 663 Introduction to Biostatistics, at the discretion of the Graduate Advisor.

## M.S. in Applied Statistics (M.S. project)

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 611 | Numerical Methods for Computation | 3 |
| or MATH 630 | Linear Algebra and Applications | |
| MATH 644 | Regression Analysis Methods | 3 |
| MATH 661 | Applied Statistics [1] | 3 |
| MATH 662 | Probability Distributions | 3 |
| MATH 664 | Methods for Statistical Consulting | 3 |
| MATH 665 | Statistical Inference | 3 |
| MATH 699 | Design and Analysis of Experiments | 3 |
| **Master's Project** | | |
| MATH 700 | Master's Project | 3 |
| **Electives** | | |
| Select two courses with approval of graduate advisor | | 6 |
| **Total Credits** | | **30** |

1. MATH 661 Applied Statistics and MATH 663 Introduction to Biostatistics cannot both be used toward degree credits at NJIT. The requirements of MATH 661 Applied Statistics may, in individual cases, be substituted by MATH 663 Introduction to Biostatistics, at the discretion of the Graduate Advisor.

## M.S. in Applied Statistics (M.S. thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 611 | Numerical Methods for Computation | 3 |
| or MATH 630 | Linear Algebra and Applications | |
| MATH 644 | Regression Analysis Methods | 3 |
| MATH 661 | Applied Statistics [1] | 3 |
| MATH 662 | Probability Distributions | 3 |
| MATH 664 | Methods for Statistical Consulting | 3 |
| MATH 665 | Statistical Inference | 3 |
| MATH 699 | Design and Analysis of Experiments | 3 |
| **Master's Thesis** | | |
| MATH 701 | Master's Thesis | 6 |
| **Electives** | | |

| | |
|---|---|
| Select one course with approval of graduate advisor | 3 |
| **Total Credits** | **30** |

1 MATH 661 Applied Statistics and MATH 663 Introduction to Biostatistics cannot both be used toward degree credits at NJIT. The requirements of MATH 661 Applied Statistics may, in individual cases, be substituted by MATH 663 Introduction to Biostatistics, at the discretion of the Graduate Advisor.

Electives are chosen in consultation with a departmental graduate advisor and consist of advanced courses in mathematics and statistics and advanced courses from engineering, computer science, and biology that have a significant statistics content. Students are encouraged to choose courses in application areas. Courses offered by appropriate departments at NJIT, RBHS, and Rutgers University-Newark can be used as electives within the limits of the NJIT transfer policy. All elective courses must be approved by the graduate advisor.

# M.S. in Biostatistics

## Degree Requirements

A minimum of 30 credits is required for the degree. Bridge courses, if any, will not count toward degree credits. The graduate curriculum consists of seven core courses in background statistical theory and biostatistics, as described in the curriculum below. The remaining courses are electives, chosen in consultation with a departmental graduate advisor and consist of topics courses in statistics, biostatistics, epidemiology and biology that have significant statistics content or/and applications thereof. Students will be encouraged to choose courses in application areas. Courses offered by appropriate departments at NJIT, RBHS, and Rutgers University-Newark can be used as electives within the limits of the NJIT transfer policy. A masters project is optional, and is in addition to the minimum 30 approved credits, required for the degree.

| | | |
|---|---|---|
| **Core Courses** | | |
| MATH 644 | Regression Analysis Methods | 3 |
| MATH 654 | Clinical Trials Design and Analysis | 3 |
| MATH 659 | Survival Analysis | 3 |
| MATH 662 | Probability Distributions | 3 |
| MATH 663 | Introduction to Biostatistics [1] | 3 |
| MATH 665 | Statistical Inference | 3 |
| MATH 699 | Design and Analysis of Experiments | 3 |
| **Electives** | | |
| Select at least three of the following illustrative list: | | 9 |
| MATH 664 | Methods for Statistical Consulting | |
| MATH 691 | Stochastic Processes with Applications | |
| MATH 698 | Sampling Theory | |
| MATH 707 | Advanced Applied Mathematics IV: Special Topics (Advanced Applied Mathematics IV) | |
| MATH 763 | Generalized Linear Models | |
| MATH 786 | Large Sample Theory and Inference | |
| MATH 787 | Non-Parametric Statistics | |
| RBHS | RBHS Courses | |
| Introduction to Epidemiology | | |
| **Total Credits** | | **30** |

1 MATH 661 Applied Statistics and MATH 663 Introduction to Biostatistics cannot both be used toward degree credits at NJIT. The requirements of MATH 663 Introduction to Biostatistics may, in individual cases, be substituted by MATH 661 Applied Statistics, at the discretion of the Graduate Advisor.

# M.S. in Computational Biology

## Degree Requirements

A minimum of 30 credits is required for the degree, excluding bridge courses. The graduate curriculum consists of seven core courses and additional elective courses, with an optional thesis (six credits) or research project (three credits).

### M.S. in Computational Biology (courses only)

| | | |
|---|---|---|
| **Required Courses** | | |
| BIOL 630 | Critical Thinking for the Life Sciences | 3 |

| | | |
|---|---|---|
| MATH 611 | Numerical Methods for Computation | 3 |
| MATH 630 | Linear Algebra and Applications | 3 |
| MATH 635 | Analytical Computational Neuroscience | 3 |
| MATH 663 | Introduction to Biostatistics | 3 |
| or MATH 615 | Approaches to Quantitative Analysis in the Life Sciences | |
| BIOL 638 | Computational Ecology | 3 |
| BNFO 601 | Foundations of Bioinformatics I | 3 |
| **Electives** | | |
| Select three of the following: | | 9 |
| MATH 637 | Foundations of Mathematical Biology | |
| MATH 644 | Regression Analysis Methods | |
| MATH 699 | Design and Analysis of Experiments | |
| CHEM 658 | Advanced Physical Chemistry | |
| R120 512 | Cell Biology: Methods & Appl | |
| R120 530 | Cell Surface Recept | |
| BIOL 641 | Systems Neuroscience | |
| MATH 636 | Systems Computational Neuroscience | |
| BIOL 612 | Comparative Animal Physiology | |
| MATH 573 | Intermediate Differential Equations | |
| MATH 672 | Biomathematics I: Biological Waves and Oscillations | |
| **Total Credits** | | **30** |

## M.S. in Computational Biology (Master's project)

| | | |
|---|---|---|
| **Required Courses** | | |
| BIOL 630 | Critical Thinking for the Life Sciences | 3 |
| MATH 611 | Numerical Methods for Computation | 3 |
| MATH 630 | Linear Algebra and Applications | 3 |
| MATH 635 | Analytical Computational Neuroscience | 3 |
| MATH 663 | Introduction to Biostatistics | 3 |
| or MATH 615 | Approaches to Quantitative Analysis in the Life Sciences | |
| BIOL 638 | Computational Ecology | 3 |
| BNFO 601 | Foundations of Bioinformatics I | 3 |
| **Master's Project** [1] | | |
| MATH 700 | Master's Project (Advisor's permission is required) | 3 |
| **Electives** | | |
| Select two of the following: | | 6 |
| MATH 637 | Foundations of Mathematical Biology | |
| MATH 644 | Regression Analysis Methods | |
| MATH 699 | Design and Analysis of Experiments | |
| CHEM 658 | Advanced Physical Chemistry | |
| R120 512 | Cell Biology: Methods & Appl | |
| R120 530 | Cell Surface Recept | |
| BIOL 601 | Computational Biology I | |
| BIOL 641 | Systems Neuroscience | |
| MATH 636 | Systems Computational Neuroscience | |
| BIOL 612 | Comparative Animal Physiology | |
| MATH 573 | Intermediate Differential Equations | |
| MATH 672 | Biomathematics I: Biological Waves and Oscillations | |
| **Total Credits** | | **30** |

1 Other courses may be taken with advisor's approval. Advisor's permission is required for project.

## M.S. in Computational Biology (Master's thesis)

| | | |
|---|---|---|
| **Required Courses** | | |
| BIOL 630 | Critical Thinking for the Life Sciences | 3 |
| MATH 611 | Numerical Methods for Computation | 3 |
| MATH 630 | Linear Algebra and Applications | 3 |
| MATH 635 | Analytical Computational Neuroscience | 3 |
| MATH 663 | Introduction to Biostatistics | 3 |
| or MATH 615 | Approaches to Quantitative Analysis in the Life Sciences | |
| BIOL 638 | Computational Ecology | 3 |
| BNFO 601 | Foundations of Bioinformatics I | 3 |
| **Master's Thesis** [1] | | |
| MATH 701 | Master's Thesis | 6 |
| **Electives** | | |
| Select one of the following: | | 3 |
| MATH 637 | Foundations of Mathematical Biology | |
| MATH 644 | Regression Analysis Methods | |
| MATH 699 | Design and Analysis of Experiments | |
| CHEM 658 | Advanced Physical Chemistry | |
| R120 512 | Cell Biology: Methods & Appl | |
| R120 530 | Cell Surface Recept | |
| BIOL 601 | Computational Biology I | |
| BIOL 641 | Systems Neuroscience | |
| MATH 636 | Systems Computational Neuroscience | |
| BIOL 612 | Comparative Animal Physiology | |
| MATH 573 | Intermediate Differential Equations | |
| MATH 672 | Biomathematics I: Biological Waves and Oscillations | |
| **Total Credits** | | **30** |

[1] Other courses may be taken with advisor's approval. Advisor's permission is required for thesis.

# M.S. in Mathematical and Computational Finance

## Degree Requirements

The Master of Science in Mathematical and Computational Finance requires 33 credits: 27 credits in core courses, 3 credits in an approved elective, and 3 credits in a project course.

| **Semester I** | | **Term Credits** |
|---|---|---|
| FIN 641 | Derivatives Markets | 3 |
| MATH 605 | Stochastic Calculus | 3 |
| MATH 611 | Numerical Methods for Computation | 3 |
| MATH 646 | Time Series Analysis | 3 |
| | **Term Credits** | **12** |
| **Semester II** | | |
| MATH 604 | Mathematical Finance | 3 |
| MATH 606 | Term Structure Models | 3 |
| MATH 608 | Partial Differential Equations for Finance | 3 |
| CS 666<br>or MATH 666 | Simulation for Finance<br>or Simulation for Finance | 3 |
| | **Term Credits** | **12** |
| **Semester III** | | |
| MATH 607 | Credit Risk Models | 3 |
| Approved Elective | | 3 |

| | | |
|---|---|---|
| MATH 609 | Projects in Mathematical and Computational Finance | 3 |
| | **Term Credits** | **9** |
| | **Total Credits** | **33** |

For students having already successfully completed the equivalent of a course required for the program, more advanced courses can be substituted with departmental approval.

## Electives

| | | |
|---|---|---|
| EM 602 | Management Science | 3 |
| FIN 624 | Corporate Finance II | 3 |
| FIN 626 | Financial Investment Institutions | 3 |
| FIN 650 | Investment Analysis and Portfolio Theory | 3 |
| MATH 644 | Regression Analysis Methods | 3 |
| MATH 647 | Time Series Analysis II | 3 |
| MATH 662 | Probability Distributions | 3 |
| MATH 665 | Statistical Inference | 3 |
| MATH 691 | Stochastic Processes with Applications | 3 |
| MATH 699 | Design and Analysis of Experiments | 3 |
| MATH 712 | Numerical Methods II | 3 |

Electives must be selected with the approval of the Program Director/Advisor.

# Ph.D. in Mathematical Sciences

## Degree Requirements

### Applied Mathematics Track (NJIT)

Students choosing the applied mathematics track must fulfill the requirements for the doctor of philosophy as specified in this catalog. Specific courses of study are planned in consultation with a faculty advisor and are subject to approval. In general, students are encouraged to take courses both in mathematics and in areas of application.

*Seminar:* In addition to the minimum degree credits required, all doctoral students must enroll each semester in MATH 791 Graduate Seminar.

*Courses:* A typical schedule of courses for the first four semesters in Applied Mathematics consists of the following:

| **Semester I** | | **Term Credits** |
|---|---|---|
| MATH 599 | Teaching in Mathematics | 3 |
| MATH 613 | Advanced Applied Mathematics I: Modeling [1] | 3 |
| MATH 631 | Linear Algebra [2] | 3 |
| MATH 645 | Analysis I [3] | 3 |
| MATH 651 | Methods of Applied Mathematics I [1] | 3 |
| | **Term Credits** | **15** |
| **Semester II** | | |
| MATH 614 | Numerical Methods I [2] | 3 |
| MATH 656 | Complex Variables I [3] | 3 |
| MATH 689 | Advanced Applied Mathematics II: Ordinary Differential Equations | 3 |
| MATH 745 | Analysis II [3] | 3 |
| | **Term Credits** | **12** |
| **Semester III** | | |
| MATH 671 | Asymptotic Methods I | 3 |
| MATH 676 | Advanced Ordinary Differential Equations | 3 |
| MATH 690 | Advanced Applied Mathematics III: Partial Differential Equations | 3 |
| MATH 712 | Numerical Methods II | 3 |
| | **Term Credits** | **12** |
| **Semester IV** | | |

| | | |
|---|---|---|
| MATH 707 | Advanced Applied Mathematics IV: Special Topics (Advanced Applied Mathematics IV) | 3 |
| MATH 713 | Advanced Scientific Computing: Multi-Dimensional Finite-Difference Schemes and Spectral Methods | 3 |
| MATH 756 | Complex Variables II | 3 |
| Course from Natural Sciences or Engineering relevant to student's interests. | | 3 |
| | **Term Credits** | **12** |
| | **Total Credits** | **51** |

[1] Helps to prepare for applied mathematics preliminary examination.

[2] Helps to prepare for linear algebra-numerical methods preliminary examination.

[3] Helps to prepare for analysis preliminary examination.

In addition to these courses, there are advanced courses in:

| | | |
|---|---|---|
| **Mathematical Fluid Dynamics I and Mathematical Fluid Dynamics II** | | |
| MATH 715 | Mathematical Fluid Dynamics I | 3 |
| MATH 716 | Mathematical Fluid Dynamics II | 3 |
| **Mathematical Biology** | | |
| MATH 637 | Foundations of Mathematical Biology | 3 |
| MATH 672 | Biomathematics I: Biological Waves and Oscillations | 3 |
| MATH 673 | Biomathematics II: Pattern Formation in Biological Systems | 3 |
| **Wave Propagation** | | |
| MATH 722 | Wave Propagation | 3 |
| **Asymptotic Methods II** | | |
| MATH 771 | Asymptotic Methods II | 3 |
| **Mathematical Modeling II** | | |
| MATH 639 | Mathematical Modeling II | 3 |
| Partial Differential Equations | | |
| MATH 675 | Partial Differential Equations | 3 |
| **Inverse Problems and Global Optimization** | | |
| MATH 717 | Inverse Problems and Global Optimization | 3 |

Also, there are special topics courses in:

- computational electromagnetics
- computational fluid dynamics
- computational neuroscience
- financial mathematics
- integral equations
- materials science
- microwave processing of materials
- courses in probability and statistics

## Qualifying Examination

The qualifying examination for the applied mathematics track consists of a preliminary examination in three parts and an oral examination. The three components of the preliminary examination are: Applied Mathematics, Analysis, and Linear Algebra-Numerical Methods. Students must achieve a grade of A in each component to pass the preliminary examination and proceed to the oral examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components before taking the oral examination. The qualifying examination must be passed by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Applied Mathematics (January and May), Analysis and Linear Algebra-Numerical Methods (May and August). The oral examination is usually offered in January and May.

Topics for the oral examination are:

1. Applied Mathematics, based on the courses MATH 689 Advanced Applied Mathematics II: Ordinary Differential Equations and MATH 690 Advanced Applied Mathematics III: Partial Differential Equations
2. choice of two out of the following three:
   a. Ordinary Differential Equations, based on MATH 676 Advanced Ordinary Differential Equations

b. Asymptotic Methods, based on MATH 671 Asymptotic Methods I
c. Numerical Methods, based on MATH 614 Numerical Methods I and MATH 712 Numerical Methods II

It should be noted that taking the above courses is not mandatory but students are strongly encouraged to take them before attempting the qualifying examinations. The scope of the qualifying examinations is not limited to the specific list of topics covered in these courses, but these topics are indicative of the overall scope of the examinations.

## Dissertation Committee

The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. According to the regulations specified in this catalog, doctoral students are required to have a dissertation advisor selected, a dissertation committee formed, and research proposal approved within one year of passage of the qualifying examination.

## Dissertation Proposal

Doctoral students must prepare a research proposal for approval by their dissertation committee. The student must offer an oral defense of this proposal before the dissertation committee and obtain its approval within one year of passing the qualifying examination. The committee determines if the proposal has an appropriate objective, if there is a reasonable plan to reach that objective, and if the student possesses the knowledge and skills needed to carry out the plan. The dissertation proposal can only be approved by unanimous consent of the committee members.

## Dissertation Defense

A public oral defense of the dissertation before the dissertation committee is required. All members of the committee must be present for the defense. Success of the defense is determined by a majority vote of the dissertation committee.

# Applied Probability and Statistics Track (NJIT)

Students choosing the applied probability and statistics track must fulfill the requirements for the doctor of philosophy as specified in this catalog. Specific courses of study are planned in consultation with a faculty graduate advisor and are subject to approval. In general, students are encouraged to take courses both in mathematics and in areas of application.

*Seminar:* In addition to the minimum degree credits required, all doctoral students must enroll each semester in MATH 791 Graduate Seminar

*Courses:* A typical schedule of courses for the first four semesters in Applied Probability and Statistics consists of the following:

| **Semester I** | | **Term Credits** |
|---|---|---|
| MATH 599 | Teaching in Mathematics | 3 |
| MATH 631 | Linear Algebra | 3 |
| MATH 644 | Regression Analysis Methods [1] | 3 |
| MATH 645 | Analysis I [2] | 3 |
| MATH 662 | Probability Distributions [1] | 3 |
| | **Term Credits** | **15** |
| **Semester II** | | |
| MATH 665 | Statistical Inference [2] | 3 |
| MATH 699 | Design and Analysis of Experiments [3] | 3 |
| MATH 745 | Analysis II [2] | 3 |
| MATH 768 | Probability Theory [3] | 3 |
| | **Term Credits** | **12** |
| **Semester III** | | |
| MATH 659 | Survival Analysis | 3 |
| MATH 691 | Stochastic Processes with Applications | 3 |
| MATH 707 | Advanced Applied Mathematics IV: Special Topics | 3 |
| Course in statistics/mathematics/engineering/computing sciences relevant to student's interest | | 3 |
| | **Term Credits** | **12** |
| **Semester IV** | | |
| MATH 664 | Methods for Statistical Consulting | 3 |
| MATH 698 | Sampling Theory | 3 |
| Two Courses in statistics/mathematics/engineering/computer science relevant to student's interest | | 6 |
| | **Term Credits** | **12** |
| | **Total Credits** | **51** |

[1] Helps to prepare for probability distributions and regression analysis methods preliminary examination.
[2] Helps to prepare for real analysis and statistical inference preliminary examination.
[3] Helps to prepare for probability theory and design and analysis of experiments preliminary examination.

In addition to these courses, there are advanced courses in:

| | | |
|---|---|---|
| **Time Series Analysis** | | |
| MATH 646 | Time Series Analysis | 3 |
| **Clinical Trials Design and Analysis** | | |
| MATH 654 | Clinical Trials Design and Analysis | 3 |
| **Statistical Reliability Theory and Applications** | | |
| MATH 761 | Statistical Reliability Theory and Applications | 3 |
| **Large Sample Theory and Inference** | | |
| MATH 786 | Large Sample Theory and Inference | 3 |
| **Non-Parametric Statistics** | | |
| MATH 787 | Non-Parametric Statistics | 3 |

## Qualifying Examination

The qualifying examination for the applied probability and statistics track consists of a preliminary examination in three parts and an oral examination. The three components of the preliminary examination are: Probability Distributions and Regression Analysis Methods, Real Analysis and Statistical Inference, Probability Theory and Design and Analysis of Experiments. Students must achieve a grade of A in each component to pass the preliminary examination and proceed to the oral examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components before taking the oral examination. The qualifying examination must be passed by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Probability Distributions and Regression Analysis Methods (January and May), Real Analysis and Statistical Inference and Probability Theory and Design and Analysis of Experiments (May and August). The oral examination is usually offered in January and May.

Topics for the oral examination are:

1. Stochastic Processes, based on MATH 691 Stochastic Processes with Applications
2. Survival Analysis, based on MATH 659 Survival Analysis
3. Generalized Linear Models, based on MATH 707 Advanced Applied Mathematics IV: Special Topics.

It should be noted that taking the above courses is not mandatory but students are strongly encouraged to take them before attempting the qualifying examinations. The scope of the qualifying examinations is not limited to the specific list of topics covered in these courses, but these topics are indicative of the overall scope of the examinations.

## Dissertation Committee

The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. According to the regulations specified in this catalog, doctoral students are required to have a dissertation advisor selected, a dissertation committee formed, and a research proposal approved within one year of passage of the qualifying examination.

## Dissertation Proposal

Doctoral students must prepare a research proposal for approval by their dissertation committee. The student must offer an oral defense of this proposal before the dissertation committee and obtain its approval within one year of passing the qualifying examination. The committee determines if the proposal has an appropriate objective, if there is a reasonable plan to reach that objective, and if the student possesses the knowledge and skills needed to carry out the plan. The dissertation proposal can only be approved by unanimous consent of the committee members.

## Dissertation Defense

A public oral defense of the dissertation before the dissertation committee is required. All members of the committee must be present for the defense. Success of the defense is determined by a majority vote of the dissertation committee.

# Pure Mathematics Track (Rutgers-Newark)

Students interested in the Pure Mathematics track should contact the Department of Mathematics and Computer Science at Rutgers-Newark.

# Physics

## Applied Physics

The NJIT and Rutgers-Newark departments of physics offer a unique opportunity to pursue master's and doctoral degree physics in a joint program combining the resources of two of New Jersey's public research universities.

Interdisciplinary  physics research is available in collaboration with faculties of NJIT, Rutgers-Newark and Rutgers-New Brunswick, and RBHSin areas such as device physics, materials research, ultrafast optical and optoelectronic phenomena, imaging technology, surface physics, free electron laser physics, biophysics, discharge physics, solar physics, and applied laser physics. Cooperative research efforts are underway with the National Renewable Energy Laboratory, National Solar Observatory, Lucent Technologies Bell Labs Innovations, U.S. Army Research Laboratory, and other industrial and federal research laboratories.

### Master of Science in Applied Physics

The program is for students with an undergraduate degree in physics, applied physics, or engineering, who wish to apply physics to biological problems, optical science, microelectronics, device physics, materials science, solar cells, surface science, laser physics, solar phenomena, and other related areas.

#### Admission Requirements

A bachelor's degree in physics, applied physics, or related areas from an accredited institution is required. An undergraduate GPA above 3.0 is required. Students must submit GRE (general test) scores. In addition, applicants are required to provide letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550 (pencil and paper) and 213 (computer-based).

### Doctor of Philosophy in Applied Physics

This program is for students in applied physics that are interested in and committed to scholarly research.

#### Admission Requirements

Applicants are expected to have a master's degree in physics, applied physics, or related engineering disciplines from an accredited institution. Highly qualified students with bachelor's degrees may be accepted directly into the doctoral program. A GPA of at least 3.5 in undergraduate and previous graduate studies is normally required for admission. The GRE (general test) and advanced (physics) test scores are required. Applicants are required to provide three letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550 (pencil and paper) and 213 (computer-based).

## Materials Science and Engineering

This intercollegiate (CSLA and NCE), interdepartmental, and interdisciplinary degree program is intended for individuals with a strong background in science and/or engineering.

### Master of Science in Materials Science and Engineering

#### Admissions Requirement

Applicants are expected to have an undergraduate degree from an accredited institution. A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent is normally required for admission. An undergraduate major in physics, chemistry, materials science, or a related engineering discipline is preferred. GRE quantitative scores of 700 or higher are highly desirable. Students from countries where English is not the native language should demonstrate TOEFL scores higher than 550 (pencil and paper) and 213 (computer-based).

### Doctor of Philosophy in Materials Science and Engineering

This is an intercollegiate (CSLA and NCE), interdepartmental, and interdisciplinary degree program for superior students who wish to do advanced research in an area of materials science and engineering. Current areas of research include electronic and photonic materials, nano and particulate materials, polymer and biomaterials, and other areas of materials science and engineering.

#### Admission Requirements

Applicants are expected to have an appropriate master's degree in materials science or related field, physics, chemistry, or engineering from an accredited institution. Students entering with a master's degree must have at least a 3.5 GPA on a 4.0 scale in previous graduate study. Highly qualified students with bachelor's degrees may be accepted directly into the doctoral program. These students must have at least a 3.5 GPA in undergraduate work.

# NJIT Faculty

## A

Ahn, Keun Hyuk, Associate Professor

Ahn, Kwangsu, Assistant Research Professor

## C

Cao, Wenda, Associate Professor

Chin, Ken K., Professor

Chen, Bin, Assistant Professor

## D

Delahoy, Alan E., Research Professor

Deng, Na, Research Professor

Dias, Cristiano Luis, Assistant Professor

## F

Farrow, Reginald C., Research Professor

Federici, John F., Distinguished Professor

Fleishman, Gregory David, Distinguished Research Professor

## G

Gary, Dale E., Distinguished Professor

Gatley, Ian, Distinguished Professor

Georgiou, George E., University Lecturer

Gerrard, Andrew J., Professor

Gokce, Oktay Huseyin, Senior University Lecturer

Goode, Philip R., Distinguished Research Professor

## J

Janow, Richard H., University Lecturer

Jerez, Andres, University Lecturer

Jing, Ju, Research Professor

## K

Kosovichev, Alexander G., Professor

## L

Lanzerotti, Louis J., Distinguished Research Professor

Levy, Roland A., Distinguished Professor

Liu, Chang, Research Professor

## M

Maljian, Libarid A., University Lecturer

## N

Nita, Gelu M., Research Professor

## O

Opyrchal, Halina, Senior University Lecturer

## P

Piatek, Slawomir, Senior University Lecturer

Prodan, Camelia, Associate Professor

## R

Ravindra, N. M., Professor

Russo, Onofrio L., Associate Professor

## S

Shneidman, Vitaly A., Senior University Lecturer

Sirenko, Andrei, Professor

## T

Thomas, Benjamin, Assistant Professor

Thomas, Gordon A., Professor

Towfik, Nissim M., Associate Professor

Tyson, Trevor A., Distinguished Professor

## V

Varsik, John R., Research Professor

## W

Wang, Haimin, Distinguished Professor

## X

Xu, Yan, Research Professor

## Y

Yurchyshyn, Vasyl, Research Professor

## Z

Zhou, Tao, Associate Professor

# Programs

- Applied Physics - M.S. (p. 800)
- Materials Science and Engineering - M.S. (p. 801)

# Programs

- Applied Physics - Ph.D. (p. 809)
- Materials Science & Engineering - Ph.D. (p. 810)

# Physics Courses

**PHYS 590. Graduate Coop Work Exp I. 3 credits, 3 contact hours.**

**PHYS 591. Graduate Coop Work Exp II. 3 credits, 3 contact hours.**

**PHYS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**PHYS 607. Topics in Astronomy and Cosmology. 3 credits, 3 contact hours.**
Prerequisites: college-level physics and mathematics. A survey of recent progress in astronomy, the physical principles involved, and the impact these new discoveries have on our understanding of the universe. Includes results from recent and ongoing planetary probes of our solar system, discovery of planetary systems around other stars, the evolution of stars, exotic objects such as neutron stars and black holes, the formation of galaxies, and current understanding of the birth and final fate of the universe. Observing sessions familiarize students with the sun, moon, and night sky.

**PHYS 611. Adv Classical Mechanics. 3 credits, 3 contact hours.**

**PHYS 621. Classical Electrodynamic. 3 credits, 3 contact hours.**

**PHYS 641. Statistical Mechanics. 3 credits, 3 contact hours.**

**PHYS 661. Solid-State Physics. 3 credits, 3 contact hours.**
Properties of solid state materials are explained based on principles of physics. Electronic, magnetic, thermal, optical, and lattice properties of materials are studied. Various experimental and theoretical approaches are introduced.

**PHYS 681. Solar Phys & Instrumentn. 3 credits, 3 contact hours.**

**PHYS 682. Introduction To Mems. 3 credits, 3 contact hours.**

**PHYS 687. Physics of Materials. 3 credits, 3 contact hours.**
Prerequisite: PHYS 441 or equivalent (see undergraduate catalog for description). Fundamentals of quantum mechanics; energy bands in crystals; electrical conduction in metals and alloys, semiconductors; optical properties of materials; quantum mechanical treatment of optical properties; magnetic properties of materials; thermal properties, heat capacity, and thermal expansion in solids.

**PHYS 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 3 contact hours.**
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science.

**PHYS 690. Directed Study Appl Phys. 3 credits, 3 contact hours.**

**PHYS 698. ST:. 3 credits, 3 contact hours.**

**PHYS 700. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take Phys 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

**PHYS 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take PHYS 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

**PHYS 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

**PHYS 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

**PHYS 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

**PHYS 721. Classical Electrodynamics II. 3 credits, 3 contact hours.**
Prerequisite: PHYS 621 or equivalent; basic knowledge of tensor analysis. Simple radiating systems, scattering and diffraction; special theory of relativity; dynamics of relativistic particles and electromagnetic fields; collisions between charged particles, energy loss, and scattering; radiation from accelerated charge, synchrotron radiation, and bremsstrahlung.

**PHYS 725. Independent Study. 3 credits, 1 contact hour.**
Prerequisites: permission from the graduate advisor (not thesis advisor) in Physics, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**PHYS 726. Independent Study II. 3 credits, 3 contact hours.**

**PHYS 728. Radio Astronomy. 3 credits, 3 contact hours.**
Prerequisites: PHYS 621and PHYS 641 or the equivalent, or approval of the instructor. An introduction to radio emission processes, radiative transfer, radio diagnostics, and radio instrumentation. Topics include radio flux measurements with single antenna, radio imaging with interferometer arrays ( Fourier Transform imaging), and image reconstruction techniques (CLEAN, MEM). Application is to astronomical objects with special emphasis on the Sun.

**PHYS 731. Quantum Mechanics II. 3 credits, 3 contact hours.**
Prerequisite: PHYS 631 or equivalent. Review of quantum mechanics and theory of special relativity; second quantization; relativistic one-particle problem; Klein-Gordon equation and Dirac equation; canonical field theory; relativistic scattering theory; introduction to quantum electrodynamics and quantum field theory; Feynman diagrams and applications.

**PHYS 741. Basic Plasma Phys w Space, Lab. 3 credits, 3 contact hours.**
Prerequisites: Phys 611, 621 or other equivalent, or approval of the instructor. The course will introduce students to basic concepts of plasma physics and its applications to laboratory experiments and space research. The course will cover the following topics: particle motions in magnetic field, adiabatic invariants, magnetic traps, radiation belts, electromagnetic waves in plasma, electrostatic oscillations, waves in magnetized plasma, collisional processes in plasma, kinetic effects on plasma waves, Landau damping, wave instabilities, plasma as fluid, magnetohydrodynamics, magnetic configurations of laboratory and space plasma, MHD instabilities, reconnection, helicity, dynamo theories, the origin of cosmic magnetic fields, stochastic processes, Fermi process, particle acceleration, and cosmic rays.

**PHYS 747. Intro to Helioseismology. 3 credits, 3 contact hours.**
Prerequisites: Phys 611, Phys 621 or other equivalent The course will introduce the physical principles and methods to study wave oscillations, and the interior structure of the Sun. The course covers processes of acoustic and gravity wave excitation and propagation, interaction with turbulence and magnetic fields, oscillation spectrum, sunquakes, inferences of the structure and composition, the differential rotation, large-scale flows and meridional circulation. It includes the theory of normal modes, inversion techniques, wave dispersion analysis, acoustic tomography and holography, applications to the solar dynamo and magnetic activity.

**PHYS 774. Fundamentals of Spectroscopy. 3 credits, 3 contact hours.**
The major objectives of this course are to integrate theory and practice and to bring together different branches of Academic Studies and Industrial Research through the presentation of critical aspects of modern Spectroscopy. The course will provide a valuable theoretical introduction and an overview of modern topics in spectroscopy, which are of current interest and importance in Semiconductor Industry and Biomedicine. A wide range of techniques is considered, including optical Near field spectroscopy, X-ray, Raman, Neutron scattering, and FT-IR spectroscopy.

**PHYS 780. Curr Topics Applied Phys. 3 credits, 3 contact hours.**

**PHYS 787. New Concepts of Semiconductor. 3 credits, 3 contact hours.**
Prerequisite: PHYS 687 and ECE 657. This is an advanced course on semiconductor physics targeted at describing polycrystalline materials, e.g. cadmium telluride or copper indium diselenide, that are currently used in thin-gilm photovoltiac panels. An overview of classical semiconductor and solar cell theory is followed by topics such as non-shallow dopants, multi-level defects, defect transition energy level, and metastability. These concepts are applied to examine minority carrier lifetime and carrier collection in devices, and to extend the theories of admittance and deep level transient spectroscopy.

**PHYS 789. Physics of Advanced Semiconductor Device Processing. 3 credits, 3 contact hours.**
Prerequisites: NJIT: EE 657, R755 687; or equivalent. Intended for doctoral students in applied physics, electrical engineering, and materials science. (Rutgers = R755 789)Silicon and GaAS technologies: crystal growth methods, epitaxy, oxidation, lithography, dry and wet etching techniques, polysilicon, diffusion, ion implantation, metallization (including silicidation), process integration, analytical characterization techniques, assembly and packaging, and yield and reliability.

**PHYS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Prerequisites: passing grade on departmental qualifying examination and approval of doctoral candidacy. Corequisite: PHYS 791. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester. Registration for additional credits, up to 12 per semester, is permitted with the approval of the department graduate advisor. Experimental or theoretical investigation of a topic in applied physics, including microelectronics, materials science, and laser physics. Cooperative projects with industry or government agencies may be acceptable. Research and writing are carried out under the supervision of a designated graduate faculty member. The completed written dissertation should be a substantial contribution to the knowledge of the topic under research, and should be of sufficient merit to warrant publication in a leading scientific or technical journal.

**PHYS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**PHYS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**PHYS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**PHYS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**PHYS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**PHYS 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.**

**PHYS 790G. Doct Dissertation & Res. 18 credits, 3 contact hours.**

**PHYS 791. Doctoral Seminar. 0 credits, 0 contact hours.**

**PHYS 792. Pre-Doctoral Research. 3 credits, 0 contact hours.**

## Rutgers-Newark Courses

**R750 501. Quantum Mechanics. 3 credits, 3 contact hours.**

**R750 509. Physics Appli Cmptrs. 3 credits, 3 contact hours.**

**R750 537. Recent Intl. Relations. 3 credits, 0 contact hours.**

**R750 543. Galaxies And Milky Ways. 3 credits, 3 contact hours.**

**R750 601. Solid State Physics I. 3 credits, 0 contact hours.**

**R750 602. Solid State Physics II. 3 credits, 3 contact hours.**

**R750 617. Genl Theo Relativity. 3 credits, 0 contact hours.**

**R750 620. Many Body Physics. 3 credits, 3 contact hours.**

**R750 621. Adv Many Body. 3 credits, 3 contact hours.**

**R750 681. Adv Top Sol State. 3 credits, 3 contact hours.**

**R750 771. Quantum Electronics. 3 credits, 3 contact hours.**

**R755 631. Quantum Mechanics. 3 credits, 3 contact hours.**

**R755 701. Dissertation Research. 3 credits, 0 contact hours.**

**R755 702. Diss Research. 3 credits, 0 contact hours.**

**R755 771. Quantum Electronics. 3 credits, 0 contact hours.**

**R755 772. Plasma Physics. 3 credits, 0 contact hours.**

**R755 774. Intro To Spectro. 3 credits, 0 contact hours.**

**R755 780. Adv Quantum Mech. 3 credits, 3 contact hours.**

**R755 866. Grad Assistant. 6 credits, 3 contact hours.**

# M.S. in Applied Physics

A minimum of 30 degree credits (600 or 700 level), including a 6-credit thesis or a 3-credit project is required. Of the 30 credits, 18 must be physics courses (including 3 credits of mathematical physics or applied mathematics). The remaining 12 to 15 credits are elective courses.

*Seminar:* In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in PHYS 791 Doctoral Seminar.

## M.S. in Physics (Master's project)

| Required Courses | | |
|---|---|---|
| PHYS 611 | Adv Classical Mechanics | 3 |
| PHYS 621 | Classical Electrodynamic | 3 |

| | | |
|---|---|---|
| R755 631 | Quantum Mechanics | 3 |
| PHYS 641 | Statistical Mechanics | 3 |
| **Project** | | |
| PHYS 700 | Master'S Project | 3 |
| **Electives** | | |
| Five electives [1] | | 15 |
| **Total Credits** | | **30** |

[1] Selected in consultation with a graduate advisor.

## M.S. in Physics (Master's thesis)

| **Required Courses** | | |
|---|---|---|
| PHYS 611 | Adv Classical Mechanics | 3 |
| PHYS 621 | Classical Electrodynamic | 3 |
| R755 631 | Quantum Mechanics | 3 |
| PHYS 641 | Statistical Mechanics | 3 |
| **Thesis** | | |
| R755 701 | Dissertation Research | 6 |
| **Electives** | | |
| Four electives [1] | | 12 |
| **Total Credits** | | **30** |

[1] Selected in consultation with a graduate advisor.

# M.S. in Materials Science and Engineering

## Degree Requirements

Students who lack appropriate undergraduate preparation for the program may be admitted and required to make up deficiencies by taking a program of bridge courses which is designed in consultation with the graduate advisor. These courses are taken in addition to the degree requirements and may include undergraduate courses.

Candidates must complete a minimum of 30 credits, including 18 credits of required materials science courses and 12 credits in an area of specialization, which are selected in consultation with the program director or graduate advisor.

### Seminar

In addition to the minimum 30 degree credits required, all students who receive program or research-based awards must enroll each semester in MTSE 791 Graduate Seminar.

## M.S. in Materials Science and Engineering (courses only)

| **Required Courses** | | |
|---|---|---|
| MTSE 601 | Fundamentals of Engineering Materials | 3 |
| MTSE 602 | Thermodynamics of Materials | 3 |
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| Select three of the following: | | 9 |
| MTSE 610 | Mechanical Properties of Materials | |
| MTSE 655 | Diffusion and Solid State Kinetics | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| BME 672 | Biomaterials | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| CHE 602 | Selected Topics in Chemical Engineering I | |
| ECE 657 | Semiconductor Devices | |

| | | |
|---|---|---|
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| **Area of Specialization** [1] | | |
| Select four courses from one of the following areas: | | 12 |
| **Electronic and Photonic Materials** | | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 687 | Glass Science and Engineering | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| MTSE 719 | Physical Principles of Characterization of Solids | |
| MTSE 722 | Science and Technology of Thin Films | |
| MTSE 723 | Defects in Solids | |
| MTSE 724 | Transport of Electrons and Phonons in Solids | |
| MTSE 725 | Crystallography and Diffraction | |
| PHYS 661 | Solid-State Physics | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| PHYS 789 | Physics of Advanced Semiconductor Device Processing | |
| CHE 702 | Selected Topics in Chemical Engineering II ( Selected Topics in Chemical Engineering II) | |
| ECE 623 | Fourier Optics | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 626 | Optoelectronics | |
| ECE 657 | Semiconductor Devices | |
| ECE 658 | VLSI Design I | |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | |
| ECE 739 | Laser Systems | |
| ECE 760 | Solid-State Image Sensors | |
| **Polymer and Biomaterials** [2] | | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 687 | Glass Science and Engineering | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| MTSE 719 | Physical Principles of Characterization of Solids | |
| MTSE 722 | Science and Technology of Thin Films | |
| MTSE 655 | Diffusion and Solid State Kinetics | |
| BME 669 | Engineering Physiology | |
| BME 672 | Biomaterials | |
| BME 667 | Bio-Control Systems | |
| BME 698 | Selected Topics | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| CHE 627 | Introduction to Biomedical Engineering | |
| CHE 702 | Selected Topics in Chemical Engineering II | |
| CHEM 661 | Instrumental Analysis Laboratory | |
| CHEM 673 | Biochemistry | |
| MATH 661 | Applied Statistics | |
| ME 670 | Introduction to Biomechanical Engineering | |
| ME 671 | Biomechanics of Human Structure and Motion | |
| ME 675 | Mechanics of Fiber Composites | |
| ME 676 | Applied Plasticity | |
| ME 678 | Engineering Design of Plastic Products | |
| ME 679 | Polymer Processing Techniques | |

| | |
|---|---|
| ME 680 | Polymer Processing Equipment |
| **Particulate and Nano Materials** | |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |
| MTSE 722 | Science and Technology of Thin Films |
| MTSE 655 | Diffusion and Solid State Kinetics |
| BME 669 | Engineering Physiology |
| BME 672 | Biomaterials |
| CHE 681 | Polymerization-Principles and Practice |
| CHE 682 | Polymer Structures and Properties |
| CHE 627 | Introduction to Biomedical Engineering |
| PHYS 661 | Solid-State Physics |
| PHYS 682 | Introduction To Mems |
| PHYS 687 | Physics of Materials |
| ME 675 | Mechanics of Fiber Composites |
| ME 676 | Applied Plasticity |
| ME 678 | Engineering Design of Plastic Products |
| **Other Fields of Materials Science and Engineering** | |
| MTSE 655 | Diffusion and Solid State Kinetics |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |
| MTSE 722 | Science and Technology of Thin Films |
| MTSE 723 | Defects in Solids |
| MTSE 724 | Transport of Electrons and Phonons in Solids |
| MTSE 725 | Crystallography and Diffraction |
| PHYS 661 | Solid-State Physics |
| CHE 681 | Polymerization-Principles and Practice |
| CHE 682 | Polymer Structures and Properties |
| BME 672 | Biomaterials |
| BME 667 | Bio-Control Systems |
| BME 698 | Selected Topics |
| CHE 627 | Introduction to Biomedical Engineering |
| CHE 702 | Selected Topics in Chemical Engineering II (Selected Topics in Chemical Engineering II ) |
| CHEM 661 | Instrumental Analysis Laboratory |
| CHEM 673 | Biochemistry |
| MATH 661 | Applied Statistics |
| ME 670 | Introduction to Biomechanical Engineering |
| ME 671 | Biomechanics of Human Structure and Motion |
| ME 675 | Mechanics of Fiber Composites |
| ME 676 | Applied Plasticity |
| ME 678 | Engineering Design of Plastic Products |
| ME 679 | Polymer Processing Techniques |
| ME 680 | Polymer Processing Equipment |
| PHYS 682 | Introduction To Mems |

| | | |
|---|---|---|
| PHYS 687 | Physics of Materials | |
| **Total Credits** | | **30** |

[1] The range of possible specialization is broad. Students should consult the graduate advisor in designing the area of specialization and related degree requirements. Three areas and suggested courses are listed.

[2] Courses in metallic biomaterials and polymeric biomaterials offered at the University of Medicine and Dentistry of New Jersey may be taken as electives. See the program director/graduate advisor for information on how to register for them.

## M.S. in Materials Science and Engineering (Master's project)

| | | |
|---|---|---|
| **Required Courses** | | |
| MTSE 601 | Fundamentals of Engineering Materials | 3 |
| MTSE 602 | Thermodynamics of Materials | 3 |
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| Select three of the following: | | 9 |
| MTSE 610 | Mechanical Properties of Materials | |
| MTSE 655 | Diffusion and Solid State Kinetics | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| BME 672 | Biomaterials | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| CHE 602 | Selected Topics in Chemical Engineering I | |
| ECE 657 | Semiconductor Devices | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| **Project** | | |
| MTSE 700 | Master'S Project | 3 |
| **Area of Specialization** [1] | | |
| Select four courses from one of the following areas: | | 12 |
| **Electronic and Photonic Materials** | | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 687 | Glass Science and Engineering | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| MTSE 719 | Physical Principles of Characterization of Solids | |
| MTSE 722 | Science and Technology of Thin Films | |
| MTSE 723 | Defects in Solids | |
| MTSE 724 | Transport of Electrons and Phonons in Solids | |
| MTSE 725 | Crystallography and Diffraction | |
| PHYS 661 | Solid-State Physics | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| PHYS 789 | Physics of Advanced Semiconductor Device Processing | |
| CHE 702 | Selected Topics in Chemical Engineering II ( Selected Topics in Chemical Engineering II) | |
| ECE 623 | Fourier Optics | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 626 | Optoelectronics | |
| ECE 657 | Semiconductor Devices | |
| ECE 658 | VLSI Design I | |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | |
| ECE 739 | Laser Systems | |
| ECE 760 | Solid-State Image Sensors | |

| | |
|---|---|
| **Polymer and Biomaterials** [2] | |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |
| MTSE 722 | Science and Technology of Thin Films |
| MTSE 655 | Diffusion and Solid State Kinetics |
| BME 669 | Engineering Physiology |
| BME 672 | Biomaterials |
| BME 667 | Bio-Control Systems |
| BME 698 | Selected Topics |
| CHE 681 | Polymerization-Principles and Practice |
| CHE 682 | Polymer Structures and Properties |
| CHE 627 | Introduction to Biomedical Engineering |
| CHE 702 | Selected Topics in Chemical Engineering II |
| CHEM 661 | Instrumental Analysis Laboratory |
| CHEM 673 | Biochemistry |
| MATH 661 | Applied Statistics |
| ME 670 | Introduction to Biomechanical Engineering |
| ME 671 | Biomechanics of Human Structure and Motion |
| ME 675 | Mechanics of Fiber Composites |
| ME 676 | Applied Plasticity |
| ME 678 | Engineering Design of Plastic Products |
| ME 679 | Polymer Processing Techniques |
| ME 680 | Polymer Processing Equipment |
| **Particulate and Nano Materials** | |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |
| MTSE 722 | Science and Technology of Thin Films |
| MTSE 655 | Diffusion and Solid State Kinetics |
| BME 669 | Engineering Physiology |
| BME 672 | Biomaterials |
| CHE 681 | Polymerization-Principles and Practice |
| CHE 682 | Polymer Structures and Properties |
| CHE 627 | Introduction to Biomedical Engineering |
| PHYS 661 | Solid-State Physics |
| PHYS 682 | Introduction To Mems |
| PHYS 687 | Physics of Materials |
| ME 675 | Mechanics of Fiber Composites |
| ME 676 | Applied Plasticity |
| ME 678 | Engineering Design of Plastic Products |
| **Other Fields of Materials Science and Engineering** | |
| MTSE 655 | Diffusion and Solid State Kinetics |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |

| | | |
|---|---|---|
| MTSE 722 | Science and Technology of Thin Films | |
| MTSE 723 | Defects in Solids | |
| MTSE 724 | Transport of Electrons and Phonons in Solids | |
| MTSE 725 | Crystallography and Diffraction | |
| PHYS 661 | Solid-State Physics | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| BME 672 | Biomaterials | |
| BME 667 | Bio-Control Systems | |
| BME 698 | Selected Topics | |
| CHE 627 | Introduction to Biomedical Engineering | |
| CHE 702 | Selected Topics in Chemical Engineering II (Selected Topics in Chemical Engineering II ) | |
| CHEM 661 | Instrumental Analysis Laboratory | |
| CHEM 673 | Biochemistry | |
| MATH 661 | Applied Statistics | |
| ME 670 | Introduction to Biomechanical Engineering | |
| ME 671 | Biomechanics of Human Structure and Motion | |
| ME 675 | Mechanics of Fiber Composites | |
| ME 676 | Applied Plasticity | |
| ME 678 | Engineering Design of Plastic Products | |
| ME 679 | Polymer Processing Techniques | |
| ME 680 | Polymer Processing Equipment | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| **Total Credits** | | **33** |

1 The range of possible specialization is broad. Students should consult the graduate advisor in designing the area of specialization and related degree requirements. Three areas and suggested courses are listed.

2 Courses in metallic biomaterials and polymeric biomaterials offered at the University of Medicine and Dentistry of New Jersey may be taken as electives. See the program director/graduate advisor for information on how to register for them.

## M.S. in Materials Science and Engineering (Master's thesis)

| | | |
|---|---|---|
| **Required Courses** | | |
| MTSE 601 | Fundamentals of Engineering Materials | 3 |
| MTSE 602 | Thermodynamics of Materials | 3 |
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| Select three of the following: | | 9 |
| MTSE 610 | Mechanical Properties of Materials | |
| MTSE 655 | Diffusion and Solid State Kinetics | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| BME 672 | Biomaterials | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| CHE 602 | Selected Topics in Chemical Engineering I | |
| ECE 657 | Semiconductor Devices | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| **Thesis** | | |
| MTSE 701 | Master'S Thesis | 6 |
| **Area of Specialization** [1] | | |
| Select four courses from one of the following areas: | | 12 |

| | |
|---|---|
| **Electronic and Photonic Materials** | |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |
| MTSE 722 | Science and Technology of Thin Films |
| MTSE 723 | Defects in Solids |
| MTSE 724 | Transport of Electrons and Phonons in Solids |
| MTSE 725 | Crystallography and Diffraction |
| PHYS 661 | Solid-State Physics |
| PHYS 682 | Introduction To Mems |
| PHYS 687 | Physics of Materials |
| PHYS 789 | Physics of Advanced Semiconductor Device Processing |
| CHE 702 | Selected Topics in Chemical Engineering II ( Selected Topics in Chemical Engineering II) |
| ECE 623 | Fourier Optics |
| ECE 625 | Fiber and Integrated Optics |
| ECE 626 | Optoelectronics |
| ECE 657 | Semiconductor Devices |
| ECE 658 | VLSI Design I |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices |
| ECE 739 | Laser Systems |
| ECE 760 | Solid-State Image Sensors |
| **Polymer and Biomaterials** [2] | |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |
| MTSE 687 | Glass Science and Engineering |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science |
| MTSE 719 | Physical Principles of Characterization of Solids |
| MTSE 722 | Science and Technology of Thin Films |
| MTSE 655 | Diffusion and Solid State Kinetics |
| BME 669 | Engineering Physiology |
| BME 672 | Biomaterials |
| BME 667 | Bio-Control Systems |
| BME 698 | Selected Topics |
| CHE 681 | Polymerization-Principles and Practice |
| CHE 682 | Polymer Structures and Properties |
| CHE 627 | Introduction to Biomedical Engineering |
| CHE 702 | Selected Topics in Chemical Engineering II |
| CHEM 661 | Instrumental Analysis Laboratory |
| CHEM 673 | Biochemistry |
| MATH 661 | Applied Statistics |
| ME 670 | Introduction to Biomechanical Engineering |
| ME 671 | Biomechanics of Human Structure and Motion |
| ME 675 | Mechanics of Fiber Composites |
| ME 676 | Applied Plasticity |
| ME 678 | Engineering Design of Plastic Products |
| ME 679 | Polymer Processing Techniques |
| ME 680 | Polymer Processing Equipment |
| **Particulate and Nano Materials** | |
| MTSE 681 | Composite Materials |
| MTSE 682 | Introduction to Ceramics |

| | | |
|---|---|---|
| MTSE 687 | Glass Science and Engineering | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| MTSE 719 | Physical Principles of Characterization of Solids | |
| MTSE 722 | Science and Technology of Thin Films | |
| MTSE 655 | Diffusion and Solid State Kinetics | |
| BME 669 | Engineering Physiology | |
| BME 672 | Biomaterials | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| CHE 627 | Introduction to Biomedical Engineering | |
| PHYS 661 | Solid-State Physics | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| ME 675 | Mechanics of Fiber Composites | |
| ME 676 | Applied Plasticity | |
| ME 678 | Engineering Design of Plastic Products | |
| **Other Fields of Materials Science and Engineering** | | |
| MTSE 655 | Diffusion and Solid State Kinetics | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 687 | Glass Science and Engineering | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| MTSE 719 | Physical Principles of Characterization of Solids | |
| MTSE 722 | Science and Technology of Thin Films | |
| MTSE 723 | Defects in Solids | |
| MTSE 724 | Transport of Electrons and Phonons in Solids | |
| MTSE 725 | Crystallography and Diffraction | |
| PHYS 661 | Solid-State Physics | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| BME 672 | Biomaterials | |
| BME 667 | Bio-Control Systems | |
| BME 698 | Selected Topics | |
| CHE 627 | Introduction to Biomedical Engineering | |
| CHE 702 | Selected Topics in Chemical Engineering II (Selected Topics in Chemical Engineering II ) | |
| CHEM 661 | Instrumental Analysis Laboratory | |
| CHEM 673 | Biochemistry | |
| MATH 661 | Applied Statistics | |
| ME 670 | Introduction to Biomechanical Engineering | |
| ME 671 | Biomechanics of Human Structure and Motion | |
| ME 675 | Mechanics of Fiber Composites | |
| ME 676 | Applied Plasticity | |
| ME 678 | Engineering Design of Plastic Products | |
| ME 679 | Polymer Processing Techniques | |
| ME 680 | Polymer Processing Equipment | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| **Total Credits** | | **36** |

[1] The range of possible specialization is broad. Students should consult the graduate advisor in designing the area of specialization and related degree requirements. Three areas and suggested courses are listed.

2 Courses in metallic biomaterials and polymeric biomaterials offered at the University of Medicine and Dentistry of New Jersey may be taken as electives. See the program director/graduate advisor for information on how to register for them.

# Ph.D. in Applied Physics

## Degree Requirements

### Ph.D. in Applied Physics (with bachelor's degree)

| Course Work [1] | | |
|---|---|---|
| PHYS 611 | Adv Classical Mechanics | 3 |
| PHYS 621 | Classical Electrodynamic | 3 |
| R755 631 | Quantum Mechanics | 3 |
| PHYS 641 | Statistical Mechanics | 3 |
| PHYS 721 | Classical Electrodynamics II | 3 |
| PHYS 731 | Quantum Mechanics II | 3 |
| Two physics courses | | 6 |
| Electives | | 15 |
| PHYS 790 | Doct Dissertation & Res | 36 |
| PHYS 791 | Doctoral Seminar [2] | 0 |
| **Total Credits** | | **75** |

1 No less than 12 credits must be at the 700 level.

2 All doctoral students must enroll in each semester, including each semester they are enrolled in .

### Ph.D. in Applied Physics (with master's degree)

(54 credits)

| Course Work [1] | | |
|---|---|---|
| PHYS 611 | Adv Classical Mechanics [2] | 3 |
| PHYS 621 | Classical Electrodynamic [2] | 3 |
| PHYS 641 | Statistical Mechanics [2] | 3 |
| R755 631 | Quantum Mechanics [2] | 3 |
| PHYS 721 | Classical Electrodynamics II | 3 |
| PHYS 731 | Quantum Mechanics II | 3 |
| Electives | | 9 |
| PHYS 790 | Doct Dissertation & Res | 36 |
| PHYS 791 | Doctoral Seminar [3] | 0 |
| **Total Credits** | | **63** |

1 No less than 12 credits must be at the 700 level.

2 Can be replaced by other courses for students with M.S. degrees who have taken these courses in the master's program.

3 All doctoral students must enroll in PHYS 791 Doctoral Seminar each semester, including each semester they are enrolled in PHYS 790 Doct Dissertation & Res.

### Qualifying Examination and Research Examination

The student must pass a written qualifying examination and oral research examination. The written qualifying examination is administered yearly to test general academic preparation and competence for research in applied physics. Within one year after passing the written qualifying examination, the student is required to pass the oral qualifying examination to achieve Ph.D. candidacy, in which the prospective Ph.D. candidate presents a preliminary research proposal for approval by the dissertation committee. The student will be allowed two attempts to pass the written or oral qualifying examination.

### Dissertation and Defense

An oral presentation and defense of the doctoral dissertation is required. A five-member committee, chaired by the dissertation advisor, must approve the content and presentation of the dissertation research.

# Ph.D. in Materials Science and Engineering

## Degree Requirements

Students with an appropriate master's degree in materials science or related field, physics, chemistry or engineering, are required to complete a minimum of 60 credits beyond the master's degree. Specific course selection, the area of specialization and dissertation topics are approved by the program advisor on an individual basis.

Students entering with bachelor's degrees are required to complete a minimum of 78 credits: 42 credits of course work and 36 credits of doctoral dissertation research. For the course work, the required courses for the M.S. in Materials Science and Engineering are mandatory; no less than 24 credits must be materials science and engineering courses, and no less than 12 credits must be at the 700 level and none at the 500 level. Specific course selection, the area of specialization, and dissertation topics are approved by the program advisor on an individual basis.

## Ph.D. in Materials Science and Engineering (entering with master's degree)

| | | |
|---|---|---|
| 600- or 700-level course work [1] | | 12 |
| 700-level courses [1] | | 12 |
| MTSE 790 | Doc Dissertation & Res | 36 |
| MTSE 791 | Graduate Seminar (every semester) | 0 |
| **Total Credits** | | **60** |

1 Minimum of 9 credits must be in MTSE courses.

## Ph.D. in Materials Science and Engineering (entering with bachelor's degree)

| | | |
|---|---|---|
| **Required Courses** | | |
| MTSE 601 | Fundamentals of Engineering Materials | 3 |
| MTSE 602 | Thermodynamics of Materials | 3 |
| MTSE 619 | Nano-scale Characterization of Materials | 3 |
| Select three of the following: | | 9 |
| MTSE 610 | Mechanical Properties of Materials | |
| MTSE 681 | Composite Materials | |
| MTSE 682 | Introduction to Ceramics | |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | |
| BME 672 | Biomaterials | |
| BME 667 | Bio-Control Systems | |
| BME 698 | Selected Topics | |
| CHE 681 | Polymerization-Principles and Practice | |
| CHE 682 | Polymer Structures and Properties | |
| CHE 602 | Selected Topics in Chemical Engineering I | |
| ECE 657 | Semiconductor Devices | |
| PHYS 682 | Introduction To Mems | |
| PHYS 687 | Physics of Materials | |
| **Remaining Courses** | | |
| 600- or 700-level course work [1] | | 12 |
| 700-level courses [1] | | 12 |
| MTSE 790 | Doc Dissertation & Res | 36 |
| MTSE 791 | Graduate Seminar (every semester) | 0 |
| **Total Credits** | | **78** |

1 Minimum of 24 credits must be in MTSE courses.

## Areas of Specializations

The range of possible specializations is broad. Students should consult the graduate advisor in designing the area of specializations and related degree requirements. Three focused areas and suggested courses are listed below.

## Electronic and Photonic Materials

| | | |
|---|---|---|
| MTSE 681 | Composite Materials | 3 |
| MTSE 682 | Introduction to Ceramics | 3 |
| MTSE 687 | Glass Science and Engineering | 3 |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | 3 |
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| MTSE 722 | Science and Technology of Thin Films | 3 |
| MTSE 723 | Defects in Solids | 3 |
| MTSE 724 | Transport of Electrons and Phonons in Solids | 3 |
| MTSE 725 | Crystallography and Diffraction | 3 |
| PHYS 661 | Solid-State Physics | 3 |
| PHYS 682 | Introduction To Mems | 3 |
| PHYS 687 | Physics of Materials | 3 |
| PHYS 789 | Physics of Advanced Semiconductor Device Processing | 3 |
| PHYS 661 | Solid-State Physics | 3 |
| CHE 627 | Introduction to Biomedical Engineering | 3 |
| CHE 702 | Selected Topics in Chemical Engineering II (Selected Topics in Chemical Engineering II) | 3 |
| ECE 623 | Fourier Optics | 3 |
| ECE 625 | Fiber and Integrated Optics | 3 |
| ECE 626 | Optoelectronics | 3 |
| ECE 657 | Semiconductor Devices | 3 |
| ECE 658 | VLSI Design I | 3 |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | 3 |
| ECE 739 | Laser Systems | 3 |
| ECE 760 | Solid-State Image Sensors | 3 |

## Particulate and Nano Materials

| | | |
|---|---|---|
| MTSE 681 | Composite Materials | 3 |
| MTSE 682 | Introduction to Ceramics | 3 |
| MTSE 687 | Glass Science and Engineering | 3 |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | 3 |
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| MTSE 722 | Science and Technology of Thin Films | 3 |
| MTSE 725 | Crystallography and Diffraction | 3 |
| BME 672 | Biomaterials | 3 |
| CHE 681 | Polymerization-Principles and Practice | 3 |
| CHE 682 | Polymer Structures and Properties | 3 |
| BME 669 | Engineering Physiology | 3 |
| BME 672 | Biomaterials | 3 |
| CHE 627 | Introduction to Biomedical Engineering | 3 |
| PHYS 661 | Solid-State Physics | 3 |
| PHYS 682 | Introduction To Mems | 3 |
| PHYS 687 | Physics of Materials | 3 |
| ME 675 | Mechanics of Fiber Composites | 3 |
| ME 676 | Applied Plasticity | 3 |
| ME 678 | Engineering Design of Plastic Products | 3 |

## Polymers and Biomaterials

| | | |
|---|---|---|
| MTSE 681 | Composite Materials | 3 |
| MTSE 682 | Introduction to Ceramics | 3 |
| MTSE 687 | Glass Science and Engineering | 3 |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | 3 |

| | | |
|---|---|---|
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| MTSE 722 | Science and Technology of Thin Films | 3 |
| MTSE 725 | Crystallography and Diffraction | 3 |
| BME 672 | Biomaterials | 3 |
| BME 667 | Bio-Control Systems | 3 |
| BME 698 | Selected Topics | 3 |
| CHE 681 | Polymerization-Principles and Practice | 3 |
| CHE 682 | Polymer Structures and Properties | 3 |
| BME 669 | Engineering Physiology | 3 |
| CHE 627 | Introduction to Biomedical Engineering | 3 |
| CHE 702 | Selected Topics in Chemical Engineering II | 3 |
| CHEM 661 | Instrumental Analysis Laboratory | 3 |
| CHEM 673 | Biochemistry | 3 |
| MATH 661 | Applied Statistics | 3 |
| ME 670 | Introduction to Biomechanical Engineering | 3 |
| ME 671 | Biomechanics of Human Structure and Motion | 3 |
| ME 675 | Mechanics of Fiber Composites | 3 |
| ME 676 | Applied Plasticity | 3 |
| ME 678 | Engineering Design of Plastic Products | 3 |
| ME 679 | Polymer Processing Techniques | 3 |
| ME 680 | Polymer Processing Equipment | 3 |

Courses in metallic biomaterials and polymeric biomaterials offered at Rutgers Biomedical and Health Sciences may be taken as electives. See the graduate advisor for information on how to register for them.

## Other Fields of Materials Science and Engineering

| | | |
|---|---|---|
| MTSE 681 | Composite Materials | 3 |
| MTSE 682 | Introduction to Ceramics | 3 |
| MTSE 687 | Glass Science and Engineering | 3 |
| MTSE 688 | Mathematical and Statistical Methods in Materials Science | 3 |
| MTSE 719 | Physical Principles of Characterization of Solids | 3 |
| MTSE 722 | Science and Technology of Thin Films | 3 |
| MTSE 723 | Defects in Solids | 3 |
| MTSE 724 | Transport of Electrons and Phonons in Solids | 3 |
| MTSE 725 | Crystallography and Diffraction | 3 |
| PHYS 661 | Solid-State Physics | 3 |
| BME 672 | Biomaterials | 3 |
| BME 667 | Bio-Control Systems | 3 |
| BME 698 | Selected Topics | 3 |
| CHE 681 | Polymerization-Principles and Practice | 3 |
| CHE 682 | Polymer Structures and Properties | 3 |
| CHE 627 | Introduction to Biomedical Engineering | 3 |
| CHE 702 | Selected Topics in Chemical Engineering II (Selected Topics in Chemical Engineering II ) | 3 |
| CHEM 661 | Instrumental Analysis Laboratory | 3 |
| CHEM 673 | Biochemistry | 3 |
| MATH 661 | Applied Statistics | 3 |
| ME 670 | Introduction to Biomechanical Engineering | 3 |
| ME 671 | Biomechanics of Human Structure and Motion | 3 |
| ME 675 | Mechanics of Fiber Composites | 3 |
| ME 676 | Applied Plasticity | 3 |
| ME 678 | Engineering Design of Plastic Products | 3 |
| ME 679 | Polymer Processing Techniques | 3 |
| ME 680 | Polymer Processing Equipment | 3 |

| | | |
|---|---|---|
| PHYS 682 | Introduction To Mems | 3 |
| PHYS 687 | Physics of Materials | 3 |

## Qualifying Examination

The student must pass a written and an oral qualifying examination. The written qualifying exam given every summer is administered to test general academic preparation and competence in the research of materials science and engineering. Within one year after passing the written qualifying exam, the student is required to pass the oral qualifying exam to achieve Ph.D. candidacy, in which the potential Ph.D. candidate presents a preliminary research proposal for approval by the dissertation committee. The student will be allowed two attempts to pass the written or oral qualifying exam.

The 4 topics of written qualifying exam are:

| | | |
|---|---|---|
| MTSE 601 | Fundamentals of Engineering Materials | 3 |
| MTSE 602 | Thermodynamics of Materials | 3 |
| MTSE 619 | Nano-scale Characterization of Materials | 3 |
| Select one of the following: | | |
| MTSE 722 | Science and Technology of Thin Films | |
| CHE 681 | Polymerization-Principles and Practice | |
| BME 672 | Biomaterials | |

## Formation of Dissertation Committee

Within one year of passing the written qualifying examination, doctoral students must form a five-member dissertation committee that meets the approval of the graduate program director for materials science and engineering. The committee must include the dissertation advisor, three additional faculty members from the program, and at least one member from outside the program or NJIT.

## Dissertation and Defense

An oral presentation and public defense of the doctoral dissertation is required.

# Newark College of Engineering

One of the oldest and largest professional engineering schools in the United States, Newark College of Engineering offers 10 undergraduate degree programs, 21 master’s and 9 doctoral degree programs. Undergraduate enrollment is more than 3,500, and more than 1,400 are enrolled in graduate study. The 150-member faculty includes engineers and scholars who are widely recognized in their fields.

## Programs

- Biomedical Engineering - M.S. (p. 864)
- Biopharmaceutical Engineering - M.S. (p. 875)
- Chemical Engineering - M.S. (p. 879)
- Civil Engineering - M.S. (p. 901)
- Civil Engineering - M.S. online (p. 900)
- Computer Engineering - M.S. (p. 934)
- Critical Infrastructure Systems - M.S. (p. 909)
- Electrical Engineering - M.S. (p. 936)
- Engineering Management - M.S. (p. 972)
- Engineering Science - M.S. (p. 989)
- Environmental Engineering - M.S. (p. 910)
- Healthcare Systems Management - M.S. (p. 974)
- Industrial Engineering - M.S. (p. 976)
- Internet Engineering - M.S. (p. 949)
- Manufacturing Systems Engineering - M.S. (p. 978)
- Mechanical Engineering - M.S. (p. 981)
- Occupational Safety and Health Engineering - M.S. (p. 983)
- Pharmaceutical Engineering - M.S. (p. 880)
- Pharmaceutical Systems Management - M.S. (p. 985)
- Power and Energy Systems - M.S. (p. 952)
- Telecommunications - M.S. (p. 953)

## Double Majors (p. 589)



## Programs



Pharmaceutical Technology - Cert.

Pharmaceutical Management - Cert.

Biomedical Device Development - Cert.

Power Systems Engineering - Cert.

Transportation Studies - Cert.

Intelligent Transportation Systems - Cert.

Supply Chain Engineering - Cert.

Project Management - Cert.

**BME 590. Graduate Co-Op Work Exper I. 3 credits, 3 contact hours.**

**BME 592. Graduate Co-Op Work Exper III. 3 credits, 3 contact hours.**

**BME 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer and approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**BME 601. Seminar. 1 credit, 1 contact hour.**
Required every semester of all master's students in biomedical engineering who receive departmental or research-based support and all doctoral students. To receive a satisfactory grade, students must attend at least five seminars per semester, as approved by the seminar supervisor.

**BME 611. Engineering Aspect of Molecular and Cellular Bio I. 1 credit, 1 contact hour.**
Molecular and cellular biology is a foundation of the understanding of the biological sciences and is vital to the study of advanced biomedical engineering. This course is to be taken simultaneously with UMDNJ N551 to enrich the crossover between engieering and life sciences. Course topics parallel those covered in N551 and both add engineering relevance, and provide engineering students with a stronger understanding of molecular and cellular biology. For students in joint BME PhD program.

**BME 612. Engineering Aspects of Molecular and Cellular Bio 2. 1 credit, 1 contact hour.**
Molecular and cellular biology is a foundation of the understanding of the biological sciences and is vital to the study of advanced biomedical engineering. This course is to be taken simultaneously with UMDNJ N552 to enrich the crossover between engineering and life sciences. Course topics parallel those covered in N552 and both add engineering relevance, and provide engineering students with a stronger understanding of molecular and cellular biology. For students in joint BME PhD program.

**BME 651. Principles of Tissue Engineering. 3 credits, 3 contact hours.**
Tissue Engineering is a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated using living cells combined with a scaffolding material to guide tissue development. Such scaffolds can be synthetic, natural, or a combination of both. This course will cover the advances in the fields of cell biology, molecular biology, and materials science towards developing novel "tissue engineered" materials.

**BME 652. Cellular and Molecular Tissue Engineering. 3 credits, 3 contact hours.**
This course explores molecular, cellular and tissue level interactions that are an important component of all tissue engineering strategies. Topics include how a cell moves, reacts and maintains viability and function based on its surroundings. We will discuss how to engineer our materials, tissue grafts and implants to integrate with the body. We will also liearn about bodily reactions and the biocompatibility of tissue engineered devices such as immunoreactivity and blood coagulation.

**BME 653. Micro/Nanotechnologies for Interfacing Live Cells. 3 credits, 3 contact hours.**
In this course, we will study technologies and tools available for interfacing live cells from a sub-cellular, single-cell, and multi-cellular (tissue models) approach. We will introduce key concepts of the biology of cells and tissues and will explore the technologies (micro-/nanotechnologies) and tools (sensors and actuators) available for the investigation of cell and tissue biology. Same as ECE 653.

**BME 654. Cardiovascular Mechanic. 3 credits, 3 contact hours.**
Fundamental biomechanical mechanisms at work in the cardiovascular system. Topics include the fundamental molecular structure of heart muscle, the biomechanical principles that transform the contraction of heart muscle into stress-strain functions of muscle fibers, pressure-volume flow relations in the vasculature when it is considered as a hemodynamic (blood hydraulic) system, growth and disease of the cardiovascular system, resistance, compliance, inertance, and catheter-tip transducers.

**BME 655. Advanced Characterization of Biomaterials. 3 credits, 3 contact hours.**
Methods used to discover the structures of proteins, enzymes, DNA, and carbohydrates at the molecular level, as well as complex structures such as collagen, the chromosome, and the cell. Topics will include protein and DNA sequencing, separation methods, and spectroscopies such as 2 and 3D NMR, x-ray diffraction, SEM, AFM and microscopic imaging techniques.

**BME 656. Research Skills in Stem Cell. 3 credits, 3 contact hours.**
Stem cells have emerged as new therapeutic potential and offer great opportunities for regenerative medicine, biotechnology and the pharmaceutical industry. This course is intended for graduate students interested in stem cell bioengineering and tissue engineering. The course will cover stem cell biology and biomedical engineering applications for cell-based regeneration therapies. It will discuss techniques for engineering of stem cells and the current literature in this rapidly evolving field.

**BME 661. Neural Engineering. 3 credits, 3 contact hours.**
Neural Engineering focuses on understanding how the brain functions using engineering principles. The course discusses different instrumentation and signal processing algorithms to study how the brain functions, how to detect different pathologies and new applications for research. Topics include; basic overview of neurology, vector populations, neural networks, vision research, functional MRI, functional electrical stimulation, neural prosthetics, and other advanced research topics studying neurology.

**BME 667. Bio-Control Systems. 3 credits, 3 contact hours.**
The course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves which govern the basic operations of all living organisms and especially higher order life forms. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Same as ECE 667.

**BME 668. Medical Imaging Systems. 3 credits, 3 contact hours.**
This course provides a detailed introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound and optical imaging modalities are included. Same as ECE 668.

**BME 669. Engineering Physiology. 3 credits, 3 contact hours.**
To enable students to apply basic tools in engineering analysis, mathematics, computer science, general physics and chemistry courses so that they can develop models that quantitatively predict the functioning of physiological systems in the human body. To enable students to apply engineering systems analysis to systematic physiology and employ the ideas of feedback control, signal procession, mathematical modeling and numerical simulation. Same as ECE 669.

**BME 670. Introduction to Biomechanical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate thermodynamics, statics, and dynamics. Introduction to biomechanical engineering of physiological systems; fluid flow, structural, motion, transport, and material aspects; energy balance of the body, and the overall interaction of the body with the environment. Same as ME 670.

**BME 671. Biomechanics of Human Structure and Motion. 3 credits, 0 contact hours.**
Prerequisite: undergraduate statics, kinematics, and dynamics. Principles of engineering mechanics and materials science applied to human structural and kinematic systems and to the design of prosthetic devices. Topics include anatomy; human force systems; human motion; bioengineering materials; and design of implants, supports, braces, and replacements limbs.

**BME 672. Biomaterials. 3 credits, 3 contact hours.**
Prerequisite: MECH 320 (see undergraduate catalog for description) or the equivalent. Materials and processes used to develop devices that are implanted in the human body; clinical aspects of biomechanical engineering; federal government requirements for design and testing of human implant devices; biocompatibility, metal implant devices, material design parameters, plastic and ceramic devices, sterilization techniques, and their effect on biocompatibility.

**BME 673. Biorobotics. 3 credits, 3 contact hours.**
Basics of control of a robot and telemanipulation are studied. Computer simulations, MATLAB are used to explore biomimetic autonomous robots. This is a studio-based course with hands-on exercises with small robots and actuators. Topics include understanding how biological robots (humans and animals) differ from designed robots, as well as sensors (touch, stereo and position), actuators (muscles, smart materials), and intelligent (neural and computer controlled systems.

**BME 674. Principles of Neuromuscular Engineering. 3 credits, 3 contact hours.**
Neurophysiology, motor control and robotics are used to study the human motor system. Sensorimotor learning and acquisition of new motor skills are emphasized. Topics include the central nervous system, muscle properties, spinal motor circuitry and dynamics of limb motion. The relation of motor control problems to neurophysiology of the motor system and how motor disorders affect movement control are studied. MATLAB and Simulink are used in simulations and movement date analysis.

**BME 675. Computer Methods in Biomedical Engineering. 3 credits, 3 contact hours.**
This course uses MATLAB to concentrate on methods that allow students to produce original software that can be used to acquire, process, analyze and present data. Topics include advanced graphics and animation, graphical user interfaces, interfacing to and data acquisition from laboratory instrumentation, filtering and processing of acquired data, and interfacing to user interfaces (e.g. joysticks). Applications in speech, bioelectrical signals, images and virtual reality will be included.

**BME 676. Computational Biomechanics. 3 credits, 3 contact hours.**
Prerequisites: BME 670 or equivalent. The use of commercially available software to solve complex engineering problems has become standard practice to reduce time and cost and results in a better product. This is an intro course on computational methods and the use of commercial software such as ANSYS, Fluent, and MATLAB to solve problems related to the BME device industry. Suitable for students interested in Computer Aided Design and Engineering (CAD/CAE).

**BME 677. CAD for Biomechanics and Biomaterials. 3 credits, 3 contact hours.**
Introduction to Computer Aided Design theory and application using software. Topics include datum planes, extrude, cut, sweep, swept cuts, and parallel, rotational, and general blends. Assemblies and generating, dimensioning, editing, and modifying drawing views and creation of balloons, imaging and scanning techniques of anatomical structures such as bone and arteries and 3D printing are also covered.

**BME 678. Design of Orthopedic Implants. 3 credits, 3 contact hours.**
Prerequisites: BME 677. First of a two part course on design of orthopedic implants using ProEngineer. Additional topics include machanical properties of implant materials, material selection and introduction to FEA. Methods for prototype development with the use of 3D printing will also be discussed. A critical objective of this course is the preparetion of design reports and project presentations.

**BME 679. Advanced Design of Orthopedic Implants. 3 credits, 3 contact hours.**
Prerequisites: BME 677, BME 678 or equivalent. Advanced modeling techniques for the design of hip, knee, and spine implants. Mechanical properties of materials, including wear and failure modes associated with typical implants. Kinematics and surgical protocols of implants will be discussed. Course will cover assemblies and FEA analysis of implants. Additional topics include large deformations, fatigue, optimization, review and analysis of results.

**BME 680. BioMEMS Design and Applications. 3 credits, 3 contact hours.**
The advance of bioMEMS (Micro Electrical Mechanical Systems) technology is a key component in making the next generation medical diagnostic tools possible. We will learn how bioMEMS devices are fabricated and combine engineering analysis with knowledge of known biological responses and biomolecule interactions to understand how bioMEMS are designed and function. Topics will include biological, mechanical, electrical, and chemical biosensors, and microfluidics as applied to biotechnology.

**BME 682. System Mgmt for Medical Device. 3 credits, 3 contact hours.**
This course will provide a detailed overview of Project Management techniques and methods applied to medical devices and show the integration of medical device Design Controls from 21 CFR820.30. General knowledge from the field of Project Management will be conveyed from the perspective of engineering or science personnel in the industrial medical field, particularlywith regard to FDA Quality System Regulations (QSR), ISO 13485 guidelines, and Good Clinical Practices (GCP's) for running clinical trials. Students will also take part in practical problem solving simulations based on real-world examples of medical device project anomalies. The combination of specialized project management knowledge for a heavily regulated area and realistic classroom simulation will provide a basis for those interested in commercial medical device development.

**BME 684. Medical Device Development. 3 credits, 3 contact hours.**
This course will provide a detailed overview of medical device development from a realistic industrial and academic perspective. The processes used in corporations and academic laboratories to conceive and develop devices will be explored from a research, regulatory, clinical, QA/QC, marketing, engineering, and legal perpective under the umbrella of project management techniques. Material will be presented as an aide to students who wish to decide on careers in either industry or academia.

**BME 686. Intro. to Instrumentation for Physiomeasurements. 3 credits, 3 contact hours.**
Introduction to instrumentation for students without instrumentation background only. This course teaches the hardware and instrumentation needed to measure variables from different physiological systems. Electrodes, sensors and transducers, bioelectric amplifiers safety and digital acquisition will be discussed. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system, clinical laboratory instruments, electrical safety and computers in biomedical instrumentation.

**BME 687. Design of Medical Instrumentation. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electronics. Principles and practice of medical instrumentation. Instrument components and medical instrument systems design. Examples taken from electrocardiography, clinical chemistry, medical imaging. Microprocessor-based systems emphasized.

**BME 688. Virtual Biomedical Instrument. 3 credits, 3 contact hours.**
Introductory course to the programming language, LabVIEWTM. Topics include loops, arrays, clusters, data acquisition, and file input/output. Students will learn how to apply these basic concepts into the development of algorithms. Examples relevant to the biomedical industry will be given how to debug and solve complex programming problems. By the completion of the course, students will be able to develop programs to automate processes and experimental designs.

**BME 698. Selected Topics. 3 credits, 3 contact hours.**
Selected topics for Biomedical Engineering.

**BME 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 700B. Master's Project. 3 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 701. Master's Thesis. 6 credits, 0 contact hours.**
Prerequisite: written permission from thesis advisor. Projects include design, construction, experimental or theoretical investigation of the engineering applications to the diagnosis and/or treatment of disease. Research may be in cooperation with industry or medical institutions. Completed work should be of sufficient quality to be acceptable for publication. Oral presentations are required.

**BME 701B. Master's Thesis. 3 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 701C. Master's Thesis. 6 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Master's degree students cannot count BME 725 as degree credit but can count these credits to qualify for full-time status.

**BME 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Master's degree students cannot count BME 725 as degree credit but can count these credits to qualify for full-time status. This course is not available to master's students.

**BME 760. Modeling in Func Brain Imaging. 3 credits, 3 contact hours.**
Prerequisites: Although no prerequisites are required, BME 310, ECE640 or other undergraduate and graduate courses covering knowledge on signals and systems in discrete time domain are suggested to prepare for this course. This course will focus on introducing biomedical computing techniques needed for functional MRI data pre-processing, and individual-level and group-level analyses. Several projects will be assigned for hands-on training in implementing the introduced knowledge.

**BME 772. Adv Biomats for Lab and Clinic. 3 credits, 3 contact hours.**
Prerequisite: BME 672 or equivalent. Background in Materials Science is encouraged. Advanced course on the design, characterization and clinical/research performance of biomaterials that have or may receive acceptance in medicine or as a biomedical research tool. The course requires the student to integrate background in chemistry, physics, cell and molecular biology, tissue engineering and materials science to review and summarize the scientific rationale for materials that have gained acceptance as medical devices, cell culture or diagnostic tools.

**BME 774. Principles of Neurorehabilitation. 3 credits, 3 contact hours.**
This is a research-focused course providing in-depth review of current studies in the following fields: Pathophysiology of disability; Advanced therapeutic interventions; Emerging neurorehabilitation technologies that are intended to encourage neural reorganization and relearning; Novel interfaces through chronic implementation in the brain, spinal cord and muscles used in deep brain stimulation, brain-machine interfaces, and functional electrical stimulation and Methods of assessing outcomes.

**BME 788. Selected Topics. 3 credits, 3 contact hours.**
Selected topics for Biomedical Engineering.

**BME 790. Doctoral Dissertation. 0 credits, 0 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790C. Doctoral Dissertation. 6 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790D. Doctoral Dissertation. 9 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790E. Doctoral Dissertation. 12 credits, 12 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790F. Doct Dissertation & Research. 15 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 791. Graduate Seminar. 0 credits, 0 contact hours.**

**BME 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Restriction: Permission of the department. For students admitted to the program leading to the Ph.D. in Computer Engineering or Electrical Engineering. Research carried on under the supervision of a designated member of the department faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied toward the 36 credits required under BME 790 after the student fulfills requirements of doctoral candidacy.

**CE 501. Introduction to Soil Behavior. 3 credits, 4 contact hours.**
Prerequisites: MECH 320, MECH 235 with a grade of C or better and MECH 236 with a grade of C or better(see undergraduate catalog for descriptions). Open only to the students in bridge program. Permission from CEE department graduate advisor is required. Covers the necessary concepts in strength of materials, geology and soil mechanics required for the bridge program in M.S. in Environmental Engineering and Geoenvironmental Engineering option.

**CE 502. Civil Construction Methods. 3 credits, 3 contact hours.**
Prerequisites: PHYS 111 and MATH 112, or equivalents Open only to students in Online M.S. in Civil Engineering, Construction Management Option. Covers essential concepts in civil and construction engineering including site surveys, construction materials, and soil behavior to partially satisfy bridge requirements.

**CE 506. Remote Sensing of Environment. 3 credits, 3 contact hours.**
Prerequisite: PHYS 234 (see undergraduate catalog for description). Covers the principles of remote sensing, general concepts, data acquisition procedures, data analysis and role of remote sensing in terrain investigations for civil engineering practices. Data collection from airborne and satellite platforms will be emphasized. Photographic and non-photographic sensing methodologies will be covered as well as manual and computer assisted data analysis techniques for site investigations and examination of ground conditions.

**CE 531. Design of Masonry and Timber Structures. 3 credits, 3 contact hours.**
Prerequisite: CE 332 (see undergraduate catalog for description). Study of basic properties of clay and concrete masonry units and wood. The masonry segment includes discussion of unreinforced bearing walls subjected to concentric as well as eccentric loads. Lateral-force resistance of unreinforced and reinforced masonry systems are introduced and new developments to strengthen and retrofit unreinforced masonry walls are discussed. The timber design portion includes design and behavior of wood fasteners, beams, columns, and beam-columns as well as introduction to plywood and glued laminated members.

**CE 545. Rock Mechanics I. 3 credits, 3 contact hours.**
Restriction: approved undergraduate course in soil mechanics within last five years or permission of instructor. Rock mechanics including geological aspects, mechanical properties, testing, and in-situ measurements of rock properties, and a brief introduction to design of structures in rock.

**CE 552. Geometric Design of Transportation Facilities. 3 credits, 3 contact hours.**
Prerequisite: CE 350 or equivalent (see undergraduate catalog for description). Design principles and criteria related to highways and railroads resulting from requirements of safety, vehicle performance, driver behavior, topography, traffic, design speed, and levels of service. Elements of the horizontal and vertical alignments and facility cross-section, and their coordination in the design. Computer-aided design procedures including COGO, CADAM, Digital Terrain Modeling. Same as TRAN 552.

**CE 553. Design and Construction of Asphalt Pavements. 3 credits, 3 contact hours.**
Importance of designing proper asphalt pavements. Topics include the origin of crude, refining crude, types of asphalts, desired properties of asphalt cement, specification and tests for asphalt cement, aggregates for asphalt mixtures, aggregate analysis, gradation and blending, hot-mix asphalt (HMA) mix design, manufacture of HMA and HMA-paving, hot and cold recycling. Same as TRAN 553.

**CE 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: permission from the civil engineering department and the Division of Career Development Services. Cooperative education/internship providing on-the-job reinforcement of academic programs in civil engineering. Work assignments and projects are developed by the co-op office in consultation with the civil engineering department; and evaluated by civil engineering faculty co-op advisors.

**CE 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: permission from the civil engineering department and the Division of Career Development Services.

**CE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: permission from the civil engineering department and the Division of Career Development Services.

**CE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer and approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CE 602. Geographic Information System. 3 credits, 3 contact hours.**
Restriction: course or working knowledge of CADD or permission of instructor. Geographical/Land Information System (GIS/LIS) is a computerized system capable of storing, manipulating and using spatial data describing location and significant properties of the earth's surface. GIS is an interdisciplinary technology used for studying and managing land uses, land resource assessment, environmental monitoring and hazard/toxic waste control. Introduces this emerging technology and its applications. Same as MIP 652 and Tran 602.

**CE 605. Research Methods in Remote Sensing. 3 credits, 3 contact hours.**
Prerequisites: CE 601 and MATH 661. Major components of RS data acquisition systems, overview of image processing techniques with emphasis on neural network and traditional pattern recognition, principal component transformations, and data reduction. Emphasizes geometric and mapping aspects of RS/GIS techniques for linking RS images with spatial data, sources of error, and accuracy assessment techniques. Hands-on experience with existing hardware/software (ERDAS & GENESIS).

**CE 606. Geospatial Data Applications. 3 credits, 3 contact hours.**
Prerequisite: CE 602. The course focuses on geospatial data processing, information extraction and analysis tools. It provides visualization and decision support applications using desktop GIS software. Examples of the student projects include: Applications of integrated geospatial date in environmental, infrastructure, urban planning and homeland security.

**CE 610. Construction Management. 3 credits, 3 contact hours.**
Restriction: B.S. degree in CE, technology, architecture, or related field. Managerial aspects of contracting. Study of an individual firm in relation to the entire construction industry. Topics include contractor organization and management, legal aspects of construction, and financial planning.

**CE 611. Project Planning and Control. 3 credits, 3 contact hours.**
Prerequisite: CE 610. Management tools as related to construction projects are analyzed and applied to individual projects. Emphasis is on network scheduling techniques, time-cost analysis, resource allocation and leveling, cost estimating, bidding strategy, and risk analysis.

**CE 614. Underground Construction. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in soil mechanics. Various aspects of underground construction, including rock and soft ground tunneling; open cut construction; underpinning; control of water; drilling and blasting rock; instrumentation; and estimating underground construction costs. Case studies and a field trip to an underground construction site will be included.

**CE 615. Infrastructure and Facilities Remediation. 3 credits, 3 contact hours.**
Restriction: graduate standing in civil engineering and basic knowledge of structures, and material science. Examines the methodology of inspection, field testing, evaluation and remediation of existing infrastructure and facilities, which include pipelines, tunnels, bridges, roadways, dams, and buildings. Typical materials distress and failure scenarios will be covered with remediation options through the use of case studies.

**CE 616. Construction Cost Estimating. 3 credits, 3 contact hours.**
Prerequisite: CE 610. Full range of construction cost-estimating methods including final bid estimates for domestic building and heavy/highway projects; computerized takeoff and estimating techniques; international construction; financial and cost reporting; databases; indices; risk; competition; performance; and profit factors.

**CE 617. Historic Preservation. 3 credits, 3 contact hours.**
This course addresses the many aspects of structural preservation from both an engineering and aesthetic perspective. Course topics include: permits and regulations, an overview of architectural styles, designation of historic structures, past methods of construction, current methods of preservation and the availability of grants and funding. Knowledge gained from the course will be applied directly to course projects involving the evaluation and recommendations needed for the proposed preservation of an existing structure.

**CE 618. Applied Hydrogeology. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in earth science/geology, fluid mechanics, and calculus or permission of instructor. Examines ground water and contaminant movement through the subsurface environment. A basic understanding of the aquifer geology is emphasized. Hydrogeologic applications including well design, pumping tests, and computer modeling of subsurface flow, and methods to monitor and remediate contaminated groundwater are introduced.

**CE 620. Open Channel Flow. 3 credits, 3 contact hours.**
Prerequisite: undergraduate fluid mechanics. The principles developed in fluid mechanics are applied to flow in open channels. Steady and unsteady flow, channel controls, and transitions are considered. Application is made to natural rivers and estuaries.

**CE 621. Hydrology. 3 credits, 3 contact hours.**
Prerequisite: undergraduate fluid mechanics. The statistical nature of precipitation and runoff data is considered with emphasis on floods and droughts. The flow of groundwater is analyzed for various aquifers and conditions. Flood routing, watershed yield, and drainage problems are considered.

**CE 622. Coastal Engineering. 3 credits, 3 contact hours.**
Prerequisite: fluid mechanics and calculus. An introductory course covering basic wave theory, sediment transport and ocean circulation. The application of these principles to various coastal engineering problems will be discussed, including beach erosion, pollution transport in coastal waters, and the design of shore protection structures.

**CE 623. Groundwater Hydrology. 3 credits, 3 contact hours.**
Prerequisite: undergraduate fluid mechanics and computer programming, or consent of instructor. Basic principles of groundwater hydraulics; Darcian analysis of various aquifer systems; unsaturated flow into porous mediums; transport of contaminants in soil media; and mathematical models for fluid and contaminant transport.

**CE 631. Advanced Reinforced Concrete Design. 3 credits, 3 contact hours.**
Prerequisite: an undergraduate course in theory and design of reinforced concrete. A review of basic concepts of elastic and ultimate strength theories and a study of the present design codes. Topics include: design of concrete building frames, two-way slabs, flat slabs, deep beams, and other structural elements using the above two theories.

**CE 632. Prestressed Concrete Design. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in theory and design of reinforced concrete. Analysis and design of pre-tensioned and post-tensioned prestressed concrete elements for both determinate and indeterminate structures will be studied. Examples of prestressed elements used in buildings and bridges will be discussed, as well as the source and magnitude of prestress losses.

**CE 634. Structural Dynamics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in structural analysis. Dynamic analysis of beams, frames, and other types of structures. Practical methods developed are applied to problems such as the analysis of the effects of earthquakes on buildings and moving loads on bridges.

**CE 635. Fracture Mechanics of Engineering Materials. 3 credits, 3 contact hours.**
Restriction: graduate standing in civil and/or mechanical engineering and basic knowledge of structures and mechanics of materials. Basic principles of fracture mechanics to increase understanding of cracking and fracture behavior of materials and structures. Emphasis on practical applications of fracture mechanics.

**CE 636. Stability of Structures. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in theory of structural analysis. Topics include structural design concept; stability criteria; elastic and inelastic buckling; column buckling; lateral buckling of beams; stability of frames; stability of plates and shell; local buckling and post-buckling.

**CE 637. Short Span Bridge Design. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in steel design and concrete design, and some knowledge of prestressed concrete fundamentals. Design and performance of highway and railroad bridges, particularly steel and prestressed concrete structures since they are most common in the northeast; and computer applications including bridge geometry, abutment design and composite beam design.

**CE 638. Nondestructive Testing Methods in Civil Engineering. 3 credits, 3 contact hours.**
Familiarizes the civil engineering student with nondestructive testing (NDT) techniques currently employed for evaluation and condition monitoring of civil structures and construction materials. Major emphasis in the application of NDT methodologies to steel, concrete, and timber as the construction material. Covers theories, principles, and testing methodologies associated with individual technologies from specific material point of view. Discusses advantages and limitations pertaining to the application of individual NDT technologies to construction materials.

**CE 639. Applied Finite Element Methods. 3 credits, 3 contact hours.**
Prerequisites: CE 332 and CS 101. Introduction to application of finite element method to problems of structural analysis and design. Review of matrix algebra and the stiffness method of structural analysis. Applications include trusses, frames, plates, shells, and problems of plane stress/strain. Application of finite element method to design.

**CE 641. Engineering Properties of Soils. 3 credits, 3 contact hours.**
Prerequisite: approved undergraduate course in soil mechanics within last five years. An in-depth study of physical and mechanical properties of soils. Topics include clay mineralogy, shear behavior and compressibility of fine and coarse grained soil; and in-situ measuring techniques such as vane shear, core penetration and pressure meter. Laboratory work includes consolidation test and triaxial test, with emphasis on analysis, interpretation and application of data to design problems.

**CE 642. Foundation Engineering. 3 credits, 3 contact hours.**
Prerequisite: approved undergraduate courses in soil mechanics and foundation engineering. The salient aspects of shallow foundation design such as bearing capacity and settlement analyses. Topics are relevant to the deep foundation, selection of the type and the determi-nation of load bearing capacity from soil properties, load tests, and driving characteristics utilizing wave equation analyses. Earth pressure theory and retaining wall design.

**CE 643. Advanced Foundation Engineering. 3 credits, 3 contact hours.**
Prerequisite: CE 642. Lateral and earth pressure computations for the design of retaining walls, bulkheads, cellular cofferdams, and sheetpiles. Also considers the design of internal bracing systems and anchors, soil nailing and reinforced earth. Slope stability of embankments and dams.

**CE 644. Geology in Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in geology or permission of instructor. Geology has a significant influence on how we plan, design, and construct engineering works. This course examines how the geologic formations underlying a locale will ultimately determine land use, control structure design, and affect construction material availability. Included is a study of the various rock-forming processes and geologic agents that have shaped Earth's surface. The course also explores the role of geologic factors in assessing environmental impacts and natural hazards such as earthquakes, subsiding soils, and landslides. Case study applications and a field trip are included.

**CE 645. Rock Mechanics II. 3 credits, 3 contact hours.**
Prerequisite: CE 545 or equivalent, or permission of instructor. Applications of design problems in underground structures, subways, stability of rock slopes, blasting, and seismic effects. A design project is a course requirement.

**CE 647. Geotechnical Aspects of Solid Waste. 3 credits, 3 contact hours.**
Prerequisites: CE 341, CE 341A or equivalents (see undergraduate catalog for descriptions). Geotechnical aspects of solid waste such as municipal landfill, dredged materials, coal and incinerator ashes, identification and classification of waste materials, geological criteria for siting, laboratory and field testing, design for impoundment and isolation of waste, methods of stability analyses of landfill sites, techniques for stabilizing waste sites, leachate and gas collection and venting systems. Primary emphasis is on municipal wastes.

**CE 648. Flow Through Soils. 3 credits, 3 contact hours.**
Prerequisite: CE 641. Explains the fundamentals of fluid flow through saturated and unsaturated soils and the use of computer programs for the solution of boundary value fluid flow problems in soils. The first two-thirds of the course are devoted to flow through saturated soils. The topics are mathematical description of flow through soils, solutions for steady state and transient state fluid flow and geotechnical applications. The last one-third is devoted to flow through unsaturated soils. Topics include steady state of transient state fluid flow and a presentation of how these concepts are applied to geoenvironmental problems.

**CE 649. Design & Construction of Concr. 3 credits, 3 contact hours.**
Importance of designing concrete pavements to resist distress or failure. Topics include the stresses in Rigid Pavement, Traffic and Loading, Material Characterization, Drainage, Pavement Performance, Rigid Pavement Design and Overlay Design.

**CE 659. Flexible and Rigid Pavements. 3 credits, 3 contact hours.**
Prerequisite: CE 341 or equivalent (see undergraduate catalog for description). Types of rigid (Portland cement) and flexible (bituminous) pavements. Properties of materials, including mineral aggregates. Design methods as functions of traffic load and expected life. Importance and consequences of construction methods. Maintenance and rehabilitation of deteriorated pavements. Same as TRAN 659.

**CE 671. Performance and Risk Analysis of Infrastructure Systems. 3 credits, 3 contact hours.**
This course presents a comprehensive systems approach to infrastructure asset management across areas of public and private infrastructure. Topics include the framework of integrated asset management illustrated in transportation, water and wastewater systems, the economic evaluation of infrastructure options, using life cycle cost analysis (LCCA) and cost-benefit analysis (CBA). The elements of performance measurement and modeling, including condition assessment and information management, failure and impact analysis are covered. Decision and risk analysis are covered to enable students to develop a holistic economic, performance and risk analysis approach to infrastructure management illustrated in a term project.

**CE 672. Security Management of Critical Infrastructure. 3 credits, 3 contact hours.**
This course focuses on the areas of vulnerability assessment and security management of critical infrastructure systems. A review of techniques for facility and network modeling and performance simulation, leads to sector-specific approaches to vulnerability analysis and critical infrastructure protection strategies using a Model-Based Vulnerability Analysis (MBVA). Covered critical infrastructure systems include water supply/environmental, transportation, power and energy systems, SCADA systems, cyber-infrastructure and telecommunications. The course ends with a review of the combined use of multi-criteria analysis techniques, expert heuristic response to scenarios and network analysis techniques in a general framework for vulnerability and security management of infrastructure systems in its key aspects: prevention, warning/detection and event mitigation and response planning and execution.

**CE 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: student must have sufficient experience and/or graduate courses in major field to work on the project. Subject matter to be approved by the department. Permission to register must be obtained from the project advisor. Extensive investigation, analysis, or design of civil engineering problems not covered by regular graduate course work is required. A student with an exceptional project in CE 700 may, upon his/her own initiative and with the approval of his/her advisor, substitute the work of this course as the equivalent of the first 3 credits for CE 701 Master's Thesis. Students must register for 3 credits every semester until the project is completed.

**CE 700B. Civil Engr Project. 3 credits, 3 contact hours.**

**CE 701. Masters Thesis. 0 credits, 0 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester until completion and submittal of an approved document. Credit will be limited, however, to the 6 credits indicated for the thesis.

**CE 701B. Master's Thesis. 3 credits, 3 contact hours.**

**CE 701C. Master's Thesis. 6 credits, 3 contact hours.**

**CE 702. Special Topics in Civil Engineering. 3 credits, 3 contact hours.**
Restriction: advisor's approval. Topics of special current interest in civil engineering.

**CE 705. Mass Transportation Systems. 3 credits, 3 contact hours.**
Prerequisites: CE 625 and TRAN 610 or IE 610. An investigation of bus, rapid transit, commuter railroad, and airplane transportation systems. Existing equipment, economics, capacity, and terminal characteristics are discussed, as well as new systems and concepts. Long- and short-range transportation systems are compared. Same as TRAN 705.

**CE 711. Methods Improvement in Construction. 3 credits, 3 contact hours.**
Prerequisite: CE 610. Improved methods in construction; various techniques of work sampling and productivity measurement; and current innovations in the construction industry for increasing efficiency.

**CE 720. Water Resource Systems. 3 credits, 3 contact hours.**
Prerequisites: CE 620, CE 621. A system methodology is applied to the analysis of water resource development and operation. Topics include operational hydrology, water quality criteria, streamflow requirements, resource allocation, and economics. Mathematical models are developed and employed in the evaluation of a case study.

**CE 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**CE 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**CE 727. Independent Study III. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**CE 730. Plastic Analysis and Design. 3 credits, 3 contact hours.**
Prerequisite: CE 639. Theory of plasticity applied to structural design. Study of methods of predicting strength and deformation of single and multi-story steel frames in the plastic range. Comparison of plastic and prestressed concrete.

**CE 733. Design of Metal Structures. 3 credits, 3 contact hours.**
Prerequisites: CE 639 and CE 636. Methods of design of metal structural systems. Topics include combined action of unsymmetrical sections, torsion of open and closed sections, buckling of columns and plates with various end conditions, and design of curved and boxed girders.

**CE 734. Design of Tall Buildings and Space Structures. 3 credits, 3 contact hours.**
Prerequisites: CE 639 and CE 636. Design of tall buildings and space structures emphasizing framing systems, and recent developments and current research related to the design of such structures.

**CE 736. Finite Element Methods in Structural and Continuum Mechanics. 3 credits, 3 contact hours.**
Prerequisite: MECH 630 and CE 630. Restriction: a working knowledge of computer programming. Finite element approaches for analysis of plane stress problems, plates in flexure, shells, and three-dimensional solids; and choice of interpolation functions, convergence, and the capabilities of the methods.

**CE 737. Earthquake Engineering. 3 credits, 3 contact hours.**
Prerequisite: CE 634. Practical design solutions for resisting the damaging effects of earthquake ground motions and other severe dynamic excitations. Factors which control dynamic response in elastic and inelastic ranges, and the nature of severe dynamic excitations. Theories of structural analysis and dynamics, and modern design methodologies on the behavior of structures.

**CE 739. Structural Optimization. 3 credits, 3 contact hours.**
Prerequisite: CE 639. Application of methods of mathematical programming to problems of optimal structural design. Optimal criteria methods, discrete and continuous systems, and code design will be covered.

**CE 742. Geotechnology of Earthquake Engineering. 3 credits, 3 contact hours.**
Prerequisite: CE 641. Explains the fundamentals of propagation of the earthquakes through soils to supporting structures and the use of computer programs in the solution of boundary value problems in soils. The first half is devoted to synthesis of earthquakes, mathematical formulation of the problem, measurement of applicable soil parameters, use of computer programs to solve 1-D wave propagation problems in soils with structures. The second half is devoted to soil liquefaction, soil-structure interaction, and design of machine foundations.

**CE 753. Airport Design and Planning. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or EM 693 and CE 660. Planning of individual airports and statewide airport systems. Functional decision of air and landside facilities. Orientation, number and length of runways. Concepts of airport capacity. Passenger and freight terminal facility requirements. Airport access systems. FAA operating requirements. Financial, safety and security issues. Same as IE 753 and TRAN 753.

**CE 765. Multi-modal Freight Transportation Systems Analysis. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or equivalent and CE 650 or EM 602 or equivalent. Quantitative methods for the analysis and planning of freight transportation services. The supply-performance-demand paradigm for freight transportation systems. Cost and performance as determined by system design and operations. Relationship of traffic and revenue to service levels and pricing. Optimal service design and redesign for transportation enterprises and operations planning. Fleet and facility investment planning. Applications to various modes. Same as EM 765 and TRAN 765.

**CE 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Required of all candidates for the degree of Doctor of Philosophy. A minimum of 36 credits is required. Students must register for at least 6 credits of dissertation per semester until 36 credits are reached. Registration for additional credits may be permitted beyond the 6, with the approval of the advisor, to a maximum of 12 credits per semester. If the dissertation is not completed after 36 credits, registration for an additional 3 credits per semester is required thereafter. Registration for 3 credits is permitted during the summer session, hours to be arranged.

**CE 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**CE 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**CE 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**CE 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**CE 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**CE 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.**

**CE 791. Graduate Seminar. 0 credits, 1 contact hour.**
A seminar in which faculty or others present summaries of advanced topics suitable for research. Students and faculty discuss research procedures, thesis organization, and content. Students present their own research for discussion and criticism. Required of all doctoral students registered for CE 790 unless requirement is waived, in writing, by the dean of graduate studies.

**CE 792. Pre-Doctoral Dissertation. 3 credits, 3 contact hours.**

**CE 793B. Professional Project. 3 credits, 3 contact hours.**

**CHE 501. Fundamentals of Chemical Engineering I. 6 credits, 6 contact hours.**
Prerequisites: MATH 222 or equivalent, CHEM 231 or equivalent(see undergraduate catalog descriptions). An intensive course in basic chemical engineering science intended for students in the bridge program. Topics include material and energy balances, thermodynamics, kinetics and reactor design, and staged separation processes. May not be taken for degree credit in any chemical engineering program.

**CHE 502. Fundamentals of Chemical Engineering II. 4 credits, 4 contact hours.**
Prerequisites: MATH 222 or equivalent (see undergraduate catalog for description), CHE 501 or equivalent. A continuation of CHE 501. An intensive course in basic chemical engineering science intended for students in the bridge program. Topics include fluid mechanics, heat transfer and diffusion-controlled processes. May not be taken for degree credit in any chemical engineering program.

**CHE 590. Graduate Co-op Work Experience I. 3 credits, 0 contact hours.**
Restriction: permission from department and Division of Career Development Services. Cooperative education internship provides on-the-job reinforcement of the academic program by placement in major-related work situations. Work assignment developed or approved by the co-op office and evaluated by the department. Cannot be used for degree credit.

**CHE 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: permission from department and Division of Career Development Services.

**CHE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: permission from department and Division of Career Development Services.

**CHE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer and approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CHE 599. Methods for Teaching Assistants and Graduate Assistants. 3 credits, 3 contact hours.**
Restriction: graduate standing. Required for all chemical engineering teaching assistants and graduate assistants. Covers techniques of teaching, interaction with students, and safety. Does not count as degree credit.

**CHE 602. Selected Topics in Chemical Engineering I. 3 credits, 3 contact hours.**
Restriction: graduate standing. Topics of current interest in chemical engineering.

**CHE 603. Separation Process Principles. 3 credits, 3 contact hours.**
Prerequisites: CHE 342, CHE 349, CHE 363, CHE 364, CHE 367, CHE 471. The course covers the basic principles of separation with or without chemical reaction in phase equilibrium-based, external field-driven and membrane-based separation processes.

**CHE 604. Membrane Separation Processes. 3 credits, 3 contact hours.**
Prerequisites: CHE 342, CHE 349, CHE 363, CHE 364, CHE 367, CHE 471. This course covers the science, technology, engineering analysis and design of membrane separation processes, membrane reactors, membrane-based equilibrium separation processes and hybrid membrane processes.

**CHE 611. Thermodynamics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in physical chemistry and thermodynamics, or equivalent. Principles of thermodynamics developed quantitatively to include thermodynamic functions and their application to chemical engineering processes.

**CHE 612. Kinetics of Reactions and Reactor Design. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in chemical engineering kinetics, or equivalent. Elements of optimum design introduced for reactor types, series and parallel reactor systems, multiple reactions, and temperature effects. Introduction to non-ideal reactor design. Study of various models for catalytic and non-catalytic solid-fluid reactions.

**CHE 619. Nano-scale Characterization of Materials. 3 credits, 3 contact hours.**
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy; near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project.

**CHE 623. Heat Transfer. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in heat transfer. Heat transmission applied to practical problems in design. An introduction will include review of conduction, convection and radiation heat transfer modes. Related topics covered will be heat exchangers, types and design principles (including Kern & Bell?s methods), effectiveness, (NTU Design and Rating methods), Fired Heaters, Design & Rating and Cooling Towers, Design & Rating.

**CHE 624. Transport Phenomena I. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in fluid mechanics, heat transfer, and mass transfer. A unified treatment of molecular and turbulent momentum, energy, and mass transport. Emphasis is on the mathematical description of physical mechanisms in momentum and energy transport.

**CHE 625. Microlevel Modeling in Particle Technology. 3 credits, 3 contact hours.**
Presents methodologies for analyzing the macroscopic properties of particulate systems in terms of the underlying microlevel processes. Significant components are the mathematical modeling of particulate systems at the microlevel, analytical and numerical methods for predicting macroscopic properties from microlevel models, and comparison of theoretical predictions with experimental results. Demonstrates the importance of the interaction of these three components in the scientific process. The first part concerns the flow of dry particles where any interstitial fluid can be ignored. The second part considers the flow of particles suspended in an interstitial fluid. Also includes a class project involving development of simulations. Same as ME 624.

**CHE 626. Mathematical Methods in Chemical Engineering. 3 credits, 3 contact hours.**
Prerequisite: MATH 222 or equivalent undergraduate degree in Chemical Engineering. The purpose of the course is to emphasize the importance of mathematics to chemical engineering practice. Applications of ordinary differential equations, Sturm-Liouville problems arising from partial differential equations, regular Perturbation approaches to some nonlinear systems of chemical engineering interests, use of Laplace transfroms expecially the Residue Theorem for inversions and some numerical methods. It is suggested that students take this course before taking CHE 624.

**CHE 627. Introduction to Biomedical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in thermodynamics and differential equations. Introduction to the structure and composition of the body followed by an exploration of the properties of blood and its flow in the cardiovascular system; the body as a heat source and as a series of compartments involved in mass transfer of materials (such as those in the kidneys and lungs). Design of artificial kidneys and heart-lung machines is also explored. Same as BME 627.

**CHE 628. Biochemical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate degree in chemical engineering. The application of chemical engineering to biological processes, biochemical reaction systems, and their technological use. Special attention given to problems in momentum, energy, and mass transport, as well as chemical reaction kinetics in biological systems.

**CHE 634. Chemical Process Dynamics and Control. 3 credits, 3 contact hours.**
Prerequisite: undergraduate chemical engineering course in process dynamics and control. Mathematical principles of process dynamics and control; derivation and solution of differential equations describing the behavior of typical chemical engineering processing units; and mathematical analysis and design of control systems. Digital and sampled data control systems also discussed.

**CHE 650. Environ Catalysis Fund & Appl. 3 credits, 3 contact hours.**
Prerequisites:Senior Standing or Graduate Industrial Catalysis course. An introduction to catalytic processes used for environmental abatement. The course provides background information necessary to understand environmental catalytic processes. A review of mobile and stationary pollution abatement technologies are reviewed.

**CHE 654. Corrosion. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in Chemistry. Fundamental principles including thermodynamics and kinetics of corrosion; forms of corrosion (e.g. galvanic, crevice and stress); methods of corrosion measurement; high temperature corrosion; and special case histories.

**CHE 656. Industrial Catalysis: Fundamentals and Applications. 3 credits, 3 contact hours.**
The class provides an introduction to catalytic phenomena as well as catalysts. It provides the background information necessary to understand industrial catalytic processes. Examples which will be discussed are hydrogen, ammonia and methanol synthesis, inorganic and organic oxidation reactions, petrochemical processes as well as pollution abatement and other important processes. The course provides insight into the theory of catalytic phenomena and also provides practical information about these processes from an industrial perspective.

**CHE 675. Statistical Thermodynamics. 3 credits, 3 contact hours.**
Prerequisite: CHE 611 or permission of instructor. Application of equilibrium statistical mechanics to chemical engineering problems. Basic postulates and relationships of statistical thermodynamics, including the ideal gas, ideal crystal, and virial equation; statistical theories of fluid mixtures and other advanced topics.

**CHE 681. Polymerization-Principles and Practice. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in physical or organic chemistry or CHE 503 or equivalent. The course focuses on the structural and synthetic aspects of polymers and examines in detail a number of bench and industrial scale polymerization methods. In addition to kinetics and mechanisms of commercially important polymerization systems, the course examines reactive modification of synthetic and natural polymers and provides an introduction to applicable characterization methods.

**CHE 682. Polymer Structures and Properties. 3 credits, 3 contact hours.**
Prerequisite: Undergraduate physical chemistry, a materials related course or CHE 503 or equivalent. The course provides an overview of polymer structures and properties and their relationships from the molecular viewpoint to phenomenological descriptions. Topics include thermodynamics of a single molecule, dynamic theory and viscoelasticity of polymers, polymer solids and mechanical properties, rubbers, polymer blends and composites, biological polymers, and special applications. New areas and innovative applications of polymers will be introduced.

**CHE 683. Polymer Processing. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in transport phenomena, fluid flow, or heat transfer or approval of graduate advisor. The course provides a systematic approach to the physical phenomena occurring in polymer processing machinery. The synthesis of the elementary steps of polymer processing are shown in relation to the development of extrusion die flow and extrusion products and injection mold flows and molded products. Structural and residual stresses are examined.

**CHE 684. Materials and Process Selection for Polymer Product Design. 3 credits, 3 contact hours.**
Prerequisites or corequisites: CHE 681, CHE 682, CHE 683 or approval of graduate advisor. The course provides methodologies for designing polymer-based products by considering materials and processing methods. Methods for selecting homopolymers, polymer blends and composites for specific appilcations will be presented in terms of properties, processability, manufacturing methods and economics. Process/structure/property correlations are presented as well as approaches to product design including CAD, prototyping, and strength and failure criteria. Case studies from biomedical, packaging and other applications are discussed.

**CHE 700. Master's Project. 0 credits, 0 contact hours.**

**CHE 700B. Masters Project. 3 credits, 3 contact hours.**

**CHE 701B. Masters Thesis. 3 credits, 3 contact hours.**

**CHE 701C. Masters Thesis. 6 credits, 3 contact hours.**

**CHE 702. Selected Topics in Chemical Engineering II. 3 credits, 3 contact hours.**
Restriction: graduate standing. Topics of current interest in chemical engineering.

**CHE 705. Independent Study. 3 credits, 3 contact hours.**
Restriction: permission from the graduate advisor (not dissertation advisor) in chemical engineering. Students working on their PhD or MS theses cannot register for this course with their respective thesis advisors. This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHE 706. Independent Study II. 3 credits, 3 contact hours.**

**CHE 721. Combustion Reaction Engineering. 3 credits, 3 contact hours.**
Restriction: undergraduate degree in Chemical or Mechanical Engineering. Topics related to the engineering of combustion systems will be discussed. These include laminar flames, turbulent combustion, ideal reactor modeling of complex combustion systems, combustion chemistry, heterogeneous combustion and incineration.

**CHE 724. Sustainable Energy. 3 credits, 3 contact hours.**
The course is a project-based advanced graduate course which requires strong background in engineering thermodynamics and transport phenomena. The main goals of this course are to gain an understanding of the cost-benefit ratio of various alternative energy sources and to understand some of the various obstacles associated with current and conventional technologies and industrial applications. Different renewable and conventional energy technologies will be discussed in class. Course materials include biomass energy, fossil fuels, geothermal energy, nuclear power, wind power, solar energy, hydrogen fuel, hydropower, and fuel cells. Students will learn a quantitative framework to aid in evaluation and analysis of energy technology systems in the context of engineering, political, social, economic, and environmental goals.

**CHE 725. Transport Phenomena II. 3 credits, 3 contact hours.**
Prerequisite: CHE 624 or equivalent. Transport in laminar and turbulent flow: in solids, between phases, and macroscopic transport in flow systems.

**CHE 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 6 credits of dissertation per semester until 36 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**CHE 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**CHE 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**CHE 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**CHE 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**CHE 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**CHE 790F. Dissertation & Res. 15 credits, 3 contact hours.**

**CHE 790G. Doctrl Dissertatopm & Resrch. 18 credits, 0 contact hours.**

**CHE 791. Graduate Seminar. 0 credits, 1 contact hour.**
Required of all chemical engineering students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

**CHE 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Restriction: permission of Associate Chairperson for Graduate Studies. For students admitted to the Doctor of Philosophy Program in Chemical Engineering who have not yet passed the qualifying examination. Research is carried out under the supervision of designated chemical engineering faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied to the 36 credits required under ChE 790.

**CHE 792C. Pre-Doctoral Research. 6 credits, 0 contact hours.**

**CHE 794. Professional Presentations for Ph.D. Students. 0 credits, 0 contact hours.**
Intended to help students make better technical presentations. Each student is required to make a presentation on a research topic; guest lectures will occur during the semester.

**ECE 501. Linear Systems and Random Signals. 3 credits, 3 contact hours.**
This course, serving as a bridge course for non-electrical and computer engineering department graduate students, provides fundamental coverage of signal and system analysis, including probabilistic methods. Topics include signal models, system properties, Fourier Transform, introduction to probability, random variables, random processes, correlation functions, and spectral density.

**ECE 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: permission from Department of Electrical and Computer Engineering and Division of Career Development Services. Cooperative education/internship providing on-the-job reinforcement of academic programs in electrical and computer engineering. Assignments and projects are developed by the co-op office in consultation with the electrical and computer engineering department. Work assignments are related to student's major and are evaluated by faculty coordinators in the ECE department. Credits for this course may not be used to fulfill any electrical or computer engineering degree requirement.

**ECE 591. Graduate Co-op Work Experience II. 3 credits, 0 contact hours.**
Prerequisites: ECE 590 and permission from Department of Electrical and Computer Engineering and Division of Career Development Services. See ECE 590 course description. Credits for this course may not be used to fulfill any electrical or computer engineering degree requirement.

**ECE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: graduate standing and permission from Department of Electrical and Computer Engineering and Division of Career Development Services. See ECE 590 course description. Credits for this course may not be used to fulfill any electrical or computer engineering degree requirement.

**ECE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**ECE 601. Linear Systems. 3 credits, 3 contact hours.**
Methods of linear-system analysis, in both time and frequency domains, are studied. Techniques used in the study of continuous and discrete systems include state-variable representation, matrices, Fourier transforms, LaPlace transforms, inversion theorems, sampling theory, discrete and fast Fourier transforms, and Z-transforms. Computer simulation of linear systems is used, and, where feasible, computer solutions are obtained.

**ECE 605. Discrete Event Dynamic Systems. 3 credits, 3 contact hours.**
Corequisite: MATH 630 or ECE 601 or MNE 603 or equivalent. Covers the theory of discrete event dynamic systems with applications in modeling, control, analysis, validation, simulation, and performance evaluation of computer systems, flexible manufacturing systems, robotic systems, intelligent supervisory control systems, and communication networks. Emphasis on Petri net and automation based approaches.

**ECE 609. Artificial Neural Networks. 3 credits, 3 contact hours.**
Prerequisites: ECE 601 and ECE 673 or consent of instructor. Artificial Neural Networks (ANN) are networks consisting of massively parallel connected simple processing elements arranged in various topology, usually in layers. Various ANN models, learning paradigms, and applications are covered. The course evolves from a simple single-neuron structure to more complex networks.

**ECE 610. Power System Steady-State Analysis. 3 credits, 3 contact hours.**
Prerequisite: B.S. in EE or ME. Steady-state analysis of power system networks, particularly real and reactive power flows under normal conditions and current flows under faulty conditions. Symmetrical components and digital solutions are emphasized.

**ECE 611. Transients in Power Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 610. Transient performance of power systems with lumped properties, interruption of arcs, restriking voltage, re-ignition inertia effects, switching of rotational systems, magnetic saturation in stationary networks, harmonic oscillations, saturated systems, transient performance of synchronous machines.

**ECE 612. Computer Methods Applied to Power Systems. 3 credits, 3 contact hours.**
Prerequisite: undergraduate computer programming. Digital computer techniques proven successful in the solution of power system problems, particularly in the electric utility industry. Emphasis on short-circuit, load flow, and transient stability problems. Matrix sparsity is considered.

**ECE 613. Protection of Power Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 610 or equivalent Coils, condensers, and resistors as protective devices; fundamental principles of protective relaying; relay operating characteristics; power and current directional relays; differential relays; distance and wire pilot relays; heating and harmonic effects; and Computer-based protective device coordination.

**ECE 616. Power Electronics. 3 credits, 3 contact hours.**
Prerequisite: B.S. in electrical engineering. Principles of thyristor devices, dynamic characteristics of choppers, commutation, protection, voltage-fed and current-fed inverter drives, cycloconverters, pulse width modulation, phase control, and microcomputer control, with case studies.

**ECE 617. Economic Control of Interconnected Power Systems. 3 credits, 3 contact hours.**
Economic Control of Interconnected Power Systems: Advanced techniques for operating power systems in the most economic manner while meeting various network constraints; economic dispatch, penalty factors, optimal power flow, short-term electricity markets and locational marginal prices will be studied.

**ECE 618. Renewable Energy Systems. 3 credits, 3 contact hours.**
This course introduces renewable energy systems. It covers the fundamental concepts of energy and radiation with specific solar energy applications and photovoltaics, electrical energy storage systems, and thermal energy and storage. The second part covers the basic science of wind energy systems and their electrical sytem designs. The third part covers the bioenergy systems from resources to final products and conversion technologies. It finally introduces other promising energy sources.

**ECE 620. Electromagnetic Field Theory. 3 credits, 3 contact hours.**
Prerequisite: undergraduate electromagnetic field theory or equivalent. Maxwell's equations, boundary conditions and formulation of potentials. LaPlace and Poisson equations for electrostatic and magnetostatic problems and the method of images. Dielectric and magnetic materials, force and energy concepts. Quasi-static and time varying fields, plane, cylindrical and spherical waves. Green's functions, transmission lines.

**ECE 622. Wave Propagation. 3 credits, 3 contact hours.**
Prerequisite: ECE 620 or equivalent. Fundamentals of electromagnetics; radiation and scattering; Green's functions; integral equations; numerical methods; ray optics and asymptotics.

**ECE 623. Fourier Optics. 3 credits, 3 contact hours.**
Prerequisite: EE 362 (see undergraduate catalog for description) or equivalent. Theoretical background needed to analyze various optical systems: two-dimensional Fourier transforms, vector and scalar diffractions, Fresnel and Fraunhofer approximations, the properties of lenses, coherence theory, frequency analysis of optical imaging systems, spatial filtering, optical information processing, and wavefront-reconstruction imaging.

**ECE 624. Optical Engineering. 3 credits, 3 contact hours.**
This course covers basic optical concepts, emphasizing those common to many optical instruments, such as light sources and their characteristics, polarization, coherence, and interferometry. The course introduces CAD tools for lenses, optical filters, and instrument design. The course also focuses on topics concerning optical systems, such as flat panel displays and micromechanical optical systems.

**ECE 625. Fiber and Integrated Optics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate electromagnetic field theory and solid-state circuits. Planar dielectric waveguides, step and graded index fibers and dispersion in fibers. The p-n junction and heterostructures, light emitting diodes and semiconductor lasers, p-i-n and avalanche photodetectors, optical transmitter and receiver designs, optical fiber communication system design concepts.

**ECE 626. Optoelectronics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate electromagnetic field theory and solid-state circuits. Optical propagation in anisotropic materials, polarization, birefringence and periodic media. Concepts of electro-optics and acousto-optic devices, optical modulators, switches, active filters for optical communication and optical processing.

**ECE 630. Microwave Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electromagnetic field theory. Review of transmission line theory and the Smith chart; scattering matrix representation, LC and microstrip matching networks; signal flow graph analysis; micro-wave transistor amplifier design, which includes power gain, stability, noise figure circles; oscillator design.

**ECE 632. Antenna Theory. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electromagnetic field theory. Fundamentals of electromagnetic field theory; far field approximation, antenna characteristics (gain, impedance, pattern, etc.); elementary antenna types (dipoles, loops, etc.), antenna array theory, wire antennas; broadband antennas.

**ECE 635. Conduction in Plasma. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in direct power generation. Maxwellian velocity distribution function, concentration and diffusion gradients, mean free path, methods of ionization, field intensified ionization, drift velocity, plasma temperature methods of deionization, plasma oscillations and plasma sheath, spark breakdown and mechanism of arcs.

**ECE 636. Computer Networking Laboratory. 3 credits, 3 contact hours.**
Prerequisites: ECE 637 or CS 656. This course provides students with hands on training regarding the design, troubleshooting, modeling and evaluation of computer networks. In this course, students are going to experiment in a real test-bed networking environment, and learn about network design and troubleshooting topics and tools such as: network addressing, Address Resolution Protocol (ARP), basic troubleshooting tools (e.g. ping, ICMP), IP routing (e,g, RIP), route discovery (e.g. traceroute), TCP and UDP, IP fragmentation and many others. Student will also be introduced to the network modeling and simulation, and they will have the opportunity to build some simple networking models using the OPNET modeling tool and perform simulations that will help them evaluate their design approaches and expected network performance.

**ECE 637. Internet and Higher-Layer Protocols. 3 credits, 3 contact hours.**
The course introduces the protocols and standards of the TCP/IP suite that govern the functioning of the Internet. The material covered in class is a top-down approach on introduction, discussion, and analysis of protocols from the data-link layer to the application layer. Alternative protocols to the TCP/IP suite and new protocols adopted by this suite are discussed. Numerical examples related to network planning and proocol functioning are analyzed.

**ECE 638. Network Management and Security. 3 credits, 3 contact hours.**
Prerequisites: ECE 683 or CS 652, and ECE 637 or CS 656. Thorough introduction to current network management technology and techniques, and emerging network management standards. In-depth study of the existing network security technology and the various practical techniques that have been implemented for protecting data from disclosure, for guaranteeing authenticity of messages, and from protecting systems for network-based attacks. SNMP family of standards including SNMP, SNMPv2, and RMON (Remote Monitoring), OSI systems management. Various types of security attacks (such as intruders, viruses, and worms), Conventional Encryption and Public Key Cryptology. Various security services and standards (such as Kerberos, Digital Signature Standard, Pretty Good Privacy, SNMPv2 security facility). Same as CIS 696.

**ECE 639. Principles of Broadband Networks. 3 credits, 3 contact hours.**
Prerequisites: ECE 673, ECE 683 or CS 652 or equivalent. This course covers fundamental concepts of broadband networks. Topics include Broadband ISDN, Switching Techniques, ATM, SONET/SDH, Congestion Control, High-Speed Switching Architectures, Traffic Modeling of Broadband Services, Admission Control, Traffic Scheduling, IP/ATM Convergence, QoS Provisioning in IP Networks, and Optical Networks.

**ECE 640. Digital Signal Processing. 3 credits, 3 contact hours.**
Prerequisite: ECE 601 or equivalent. The theory of digital signals and basic processing techniques: Discrete Fourier Series, Discrete Fourier Transform and FFT, Linear and Circular Convolution, Digital Filter Design Techniques, Discrete Hilbert Transforms, Discrete Random Signals, Chirp-Z and other advanced transforms. Introduction to multivariate signal processing. The typical applications of signal processing tools are discussed and connected to the theoretical foundations.

**ECE 641. Laboratory for High Performance Digital Signal Processing. 3 credits, 3 contact hours.**

**ECE 642. Communication Systems I. 3 credits, 3 contact hours.**
Corequisite: ECE 673. Principles of communication theory applied to the representation and transmission of information. Topics include analysis of deterministic and random signals, amplitude modulation, angle modulation, sampling, quantization, PCM, DM, DPCM, geometric representation of signals, error probability, matched filter and correlation receivers and performance analysis of communication systems signal to noise ratio.

**ECE 643. Digital Image Processing I. 3 credits, 3 contact hours.**
Prerequisite: ECE 601. Introductory course in digital image processing. Topics include image models, digitization and quantization, image enhancement in spatial and frequency domains, image restoration, image segmentation and analysis.

**ECE 644. Wireless Communication. 3 credits, 3 contact hours.**
Prerequisites ECE 321 or MATH 333. This course is focused on the technical challenges and solutions to physical and link layer design of wireless communication systems. Course topics include characterization of the wireless channel, the cellular concept, digital modulation techniques, spread spectrum, multiple access techniques including CDMA and OFDMA, diversity techniques. Advanced techniques such as MIMO, 3G and 4G wireless technologies are introduced. Matlab is used for examples and assignments. Team projects based on advanced wireless technologies.

**ECE 645. Wireless Networks. 3 credits, 3 contact hours.**
Prerequisites: EE 321 or MATH 333, or equivalent (see undergraduate catalog for descriptions). Introduction to wireless network design, management, and planning stages. Topics include demand modeling, radio planning, network optimization, and information handling architecture with emphasis on resource allocation and mobility management aspects. Investigation of signaling load optimizations and internetworking problems.

**ECE 646. Introduction to Data Communications. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673, or equivalent. Introduces the theory and technology of data communications over voice-grade and broadband channels. Provides the analytical tools required to understand and design data communication systems. Topics include: an overview of data communication systems, channel capacity, channel coding (block codes, cyclic codes, convolutional codes), data transmission, synchronization, equalization, and an introduction to adaptive equalization.

**ECE 648. Digital Microelectronics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate semiconductor circuits. Topics include: linear wave shaping with RC circuits, clipping and clamping circuits; theory of operation of semiconductor diode, bipolar transistor (BJT), and MOSFET; BJT and MOSFET inverters, gate circuits, and regenerative logic circuits.

**ECE 649. Compression in Multimedia Engineering. 3 credits, 3 contact hours.**
Prerequisite: ECE 640 or instructor's permission. Foundations of information theory, audio/speech and video compression technologies. Detailed discussion of JPEG, image compression, H.261, MPEG-1 and MPEG-2 international video compression standard algorithms. Current status and future directions of very low bit rate MPEG-4 video compression standards activities.

**ECE 650. Electronic Circuits. 3 credits, 3 contact hours.**
Prerequisite: senior undergraduate level semiconductor circuits. Methods of analysis and design of linear and digital semiconductor circuits are studied. Topics include low and high frequency models, passive and active biasing techniques, I-C analysis and design, op-amp circuits, and active filters.

**ECE 653. Micro/Nanotechnologies for Interacing Live Cells. 3 credits, 3 contact hours.**
In this course, we will study technologies and tools available for interfacing live cells from a sub-cellular, single-cell, and multi-cellular (tissue models) approach. We will introduce key concepts of the biology of cells and tissues and will explore the technologies (micro-/nanotechnologies) and tools (sensors and actuators) available for the investigation of cell and tissue biology. Same as BME 653.

**ECE 655. Modeling of Biological Neural Systems. 3 credits, 3 contact hours.**
This course introduces biological neural networks and systems as the essential parts of the autonomous, peripheral and central nervous systems in human body to perform physiological functions and determine behavior. The difference in neural architecture and function in different nervous systems will be discussed. Approaches for modeling of neural circuits with examples of simulation of small and large neural networks in human nervous systems for pattern generation, recall and recognition are discussed and studied.

**ECE 657. Semiconductor Devices. 3 credits, 3 contact hours.**
Fundamental principles of solid state materials necessary for understanding semiconductor devices. Topics include crystal structure; energy bands; electron and hole generation, and transport phenomena; generation and recombination processes, and high field effects. P-N junction diode, metal semiconductor contact, and bipolar and metal oxide semiconductor transistors, including switching phenomena and circuit models. Introduction to: photonic devices~light emitting diodes, semiconductor lasers, photodetectors, and solar cells; microwave devices~tunnel and IMPATT diodes, transferred electron devices, and charge-coupled capacitors.

**ECE 658. VLSI Design I. 3 credits, 3 contact hours.**
Prerequisite: ECE 657 or equivalent. Analysis and design of digital integrated circuits; basic building blocks and dependence on circuit parameters of propagation delay; noise margin; fan-out; fan-in; and power dissipation for circuits of different logic families, including NMOS, CMOS and BiCMOS; subsystem designs in combinational and sequential logic; Memory Systems; HSPICE circuit simulation is used for digital characteristics evaluation. Mentor Graphics Layout design tools are used for chip design.

**ECE 659. Fabrication Principles of Electronic and Optoelectronic Devices. 3 credits, 3 contact hours.**
Prerequisite: ECE 657 or equivalent. Overview of all major processing steps in fabrication of integrated circuits such as crystal growth, epitaxy, oxidation, diffusion, ion implantation and etching. Formation of thin film structures along with techniques for defining submicron structures. Emphasizes silicon device technology but also includes processing of compound semiconductors such as gallium arsenide.

**ECE 660. Control Systems I. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course equivalent to EE 333 or ME 305 (see undergraduate catalog for descriptions) and ECE 601 or equivalent or permission from instructor. Introduction to feedback control. Review of state-space analysis. Frequency-domain methods for analysis: Routh-Hurwitz stability algorithms, Root-loci; Nyquist and Bode plots; system ?type.? Controllability and observability. The separation principle and design by pole placement. Linear observers. Optimization of quadratic performance criteria. Elements of random processes. The Kalman filter as an optimum observer. Robustness considerations.

**ECE 661. Control System Components. 3 credits, 3 contact hours.**
Prerequisite: ECE 660. The theoretical and practical requirements for analog and digital state-of-the-art control system components are covered. Actuators, amplifiers, sensors, encoders, resolvers and other electromagnetic devices are included. A complete system is designed using current vendor catalog data. Problems affecting the system performance are analyzed using measures of functionality, reliability and cost.

**ECE 664. Real-time Computer Control Systems. 3 credits, 3 contact hours.**
Prerequisite: EE 486 or equivalent (see undergraduate catalog for description). Emphasizes the practical aspects of modern computer control systems. Topics include: Architecture of digital signal processors (DSP) and microcontrollers, real-time data acquisition devices and interface, programming a DSP, review of sampling theorems and properties of discrete-time systems, introduction of control systems theory, design and implementation of parameter optimized controllers, state variable controllers, and cancellation controllers. An experimental project using a TMS320C2x DSP-based data acquisition system is an integral part of this course.

**ECE 666. Control Systems II. 3 credits, 3 contact hours.**
Prerequisites: ECE 601 and ECE 660. Properties of nonlinear systems and basic concepts of stability including small-signal linearization. State plane methods are introduced, with emphasis on controller design for systems that can be represented by second-order approximations. Concepts of equivalent gain, describing function, and dual-input describing function as applied to a large class of nonlinear systems. Representation of linear sampled-data systems in discrete state variable form, stability and performance of discrete-event systems. Full-state feedback, pole placement and observer design. Linear quadratic control and Kalman filtering.

**ECE 667. Bio-Control Systems. 3 credits, 3 contact hours.**
The course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves which govern the basic operations of all living organisms and especially higher order life forms. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Same as BME 667.

**ECE 668. Mecial Imaging Systems. 3 credits, 3 contact hours.**
This course provides a detailed introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound and optical imaging modalities are included. Same as BME 668.

**ECE 669. Engineering Physiology. 3 credits, 3 contact hours.**
To enable students to apply basic tools in engineering analysis, mathematics, computer science, general physics and chemistry courses so that they can develop models that quantitatively predict the functioning of physiological systems in the human body. To enable students to apply engineering systems analysis to systematic physiology and employ the ideas of feedback control, signal procession, mathematical modeling and numerical simulation. Same as BME 669.

**ECE 673. Random Signal Analysis I. 3 credits, 3 contact hours.**
Fundamentals of the theory of random variables. Introduction to the theory of random processes. Topics include functions of random variables, sequences of random variables, central limit theorem, properties of random processes, correlation, spectral analysis and linear systems with random inputs.

**ECE 677. Optimization Techniques. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in differential equations. Analytical and numerical methods for finding an extremum emphasizing how and when to apply them. Classical differentiation, Lagrange multipliers, the calculus of variations, penalty functions, slack variables, search techniques, and stochastic approximation are covered.

**ECE 681. High Performance Routers and Switches. 3 credits, 3 contact hours.**
The course introduces the different system comprising and Internet routing including the processors for networking function and protocol compliance, switching functions and packet classification for deep-layer inspection capable routers or network appliances. This course material describe the different functions that Internet routers perform and discusses the different approaches used for improving performance of high-end routers. The content includes a discussion on switch architectures.

**ECE 682. Introduction to Computer Network Design: Internet Perspective. 3 credits, 0 contact hours.**
Explicit emphasis on design considerations. Covers the basics of computer networking and the important current network technologies including the premier local area network and wide area network technologies and services, as well as the description of the relevant protocols. Also covers explicit related design considerations and implications. Amplifies the conclusions with discussions of relevant examples and case studies.

**ECE 683. Computer Network Design and Analysis. 3 credits, 3 contact hours.**
Corequisite: ECE 673. Queueing models and state-transition models are introduced to model, design and analyze computer networks. The OSI model, LANS (including token ring, token bus, and Ethernet), and useful network protocols. Emphasis on the physical, data link and network layers. ALOHA, Stop-and-Wait protocol, Go-Back-N protocol, window-flow-control, and shortest-path routing.

**ECE 684. Advanced Microprocessor Systems. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in computer architecture and microprocessors, and some experience in assembly language programming. Architecture of advanced microprocessors; CPU architecture, memory management and protection, interrupt and exception facilities, instruction sets, systems aspects including peripheral interfaces, communications ports, and real-time systems.

**ECE 685. Network Interface Design. 3 credits, 3 contact hours.**
Prerequisite: ECE 683 or equivalent. Provides a working knowledge of data communications networking devices, the building blocks upon which networks are constructed. Emphasizes devices and their function in data communication networks. Covers the use of devices in the design, implementation, modification, and optimization of data communications networks.

**ECE 686. Instrumentation Systems and Microprocessors. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in microprocessors. Principles of instrumentation transducers and the electronic amplifiers and filters needed to process the electrical signals generated by them; types and characteristics of A/D and D/A converters and other circuits necessary for the interfacing of instrumentation data to a computer or digital data transmission system. Emphasis placed on development of stand-alone analog instrumentation systems as well as microprocessor-based systems. Tradeoffs and alternatives for both implementations are emphasized as well as cost effectiveness of each design. Hardware and software are developed as needed.

**ECE 687. Design of Medical Instrumentation. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electronics. Principles and practice of medical instrumentation. Instrument components and medical instrument systems design. Examples taken from electrocardiography, clinical chemistry, medical imaging. Microprocessor-based systems emphasized.

**ECE 688. Microcontrollers in Instrumentation. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in microprocessors. Microcontroller as single chip computer system for diverse applications. System microcontroller real-time design concepts from architecture to interface. Assembly language programs. Real-time facilities of advanced microcontrollers are emphasized.

**ECE 689. Computer Arithmetic Algorithms. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in logic design. Data representation, integers, floating point and residue representation. Bounds on arithmetic speed, algorithms for high speed addition, multiplication, and division. Pipelined arithmetic. Hardware implementation and control issues.

**ECE 690. Computer Systems Architecture. 3 credits, 3 contact hours.**
Prerequisites: ECE 684 and COE 353 (see undergraduate catalog for description) or CS 650. Discusses advanced topics in modern computer systems architecture such as pipelined and superscalar processors, parallel computers (vector, SIMD, MIMD), multithreaded and dataflow architectures, cache and memory hierarchy, and system interconnect architectures. Also discusses relevant system software design issues such as shared memory and message-passing communication models, cache coherence and synchronization mechanisms, latency-hiding techniques, virtual memory management, program partitioning and scheduling. Examples are drawn from real systems.

**ECE 692. Embedded Computing Systems. 3 credits, 3 contact hours.**
Pre-requisites: ECE 353 (COE) or ECE 684 (EE) and CS 105 (or equivalents). Introduction of the methodology for the design and implementation of embedded computing systems, and its application to real-world problems. Topics include Embedded System Design Process, UML, ARM Instruct Set Architectures, CPU's Hardware Platforms, Software Design and Analysis, Embedded Operating Systems, Real-Time Scheduling, Hardware Accelerators, Distributed Embedded Systems, and Design Methodology and Quality Assurance.

**ECE 698. Selected Topics in Electrical and Computer Engineering. 3 credits, 3 contact hours.**
Special area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

**ECE 699. Selected Topics in Electrical and Computer Engineering II. 3 credits, 3 contact hours.**
See description for ECE 698 above.

**ECE 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry may be acceptable. Work is carried out under the supervision of a member of the department faculty. A maximum of 3 credits may be applied to the degree.

**ECE 700B. Master's Project. 3 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry may be acceptable. Work is carried out under the supervision of a member of the department faculty. A maximum of 3 credits may be applied to the degree.

**ECE 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: written approval of thesis advisor. Projects involving design, construction, experimental or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried on under the supervision of a designated member of the department faculty. Completed work in the form of a written thesis should be of a quality leading to journal publication. The completed thesis must be defended by the student in an open forum and must be approved by a committee of at least three people. A student must register for a minimum of 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

**ECE 701B. Master's Thesis. 3 credits, 3 contact hours.**
Restriction: written approval of thesis advisor. Projects involving design, construction, experimental or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried on under the supervision of a designated member of the department faculty. Completed work in the form of a written thesis should be of a quality leading to journal publication. The completed thesis must be defended by the student in an open forum and must be approved by a committee of at least three people. A student must register for a minimum of 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

**ECE 701C. Master's Thesis. 6 credits, 3 contact hours.**
Restriction: written approval of thesis advisor. Projects involving design, construction, experimental or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried on under the supervision of a designated member of the department faculty. Completed work in the form of a written thesis should be of a quality leading to journal publication. The completed thesis must be defended by the student in an open forum and must be approved by a committee of at least three people. A student must register for a minimum of 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

**ECE 711. Power System Dynamics and Stability. 3 credits, 3 contact hours.**
Prerequisites: ECE 610 and undergraduate course in electric machines. Elements of the stability problem: principal factors affecting stability, ordinary simplified methods of making stability calculations, and illustrations of the application of these methods to studies of power systems, damping, and saturation.

**ECE 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Master's degree students cannot count ECE 725 as degree credit but can count these credits to qualify for full-time status.

**ECE 726. Independent Study II. 3 credits, 3 contact hours.**
See description for ECE 725 above. This course is not available to master's students.

**ECE 730. Theory of Guided Waves. 3 credits, 3 contact hours.**
Prerequisite: ECE 620 or equivalent. Modes, rays and beam propagation in guiding structures. Non-uniform waveguides and transitions, excitation of waveguides and optical fibers. Coupled modes theory with applications to resonators and couplers. Wave propagation in anisotropic media.

**ECE 739. Laser Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 620 or permission of instructor. Optical resonators, laser radiation and oscillation. Laser characteristics: semiconductor lasers, gas and glass lasers; mode-locking, Q-switching. Quantum-well lasers, noise; modulation and detection of laser light, optical systems for communication and computation.

**ECE 740. Advanced Digital Signal Processing. 3 credits, 3 contact hours.**
Prerequisites: ECE 601, ECE 640 and ECE 673. Topics in stationary discrete time stochastic processes; modeling of discrete time processes, Yule-waker equations, aspects of discrete wiener theory; principle of orthogonality, linear predictors; Levinson-Durbin recursion and algorithm, lattice predictors, method of least squares (RLS) algorithm, systolic array implementation of QRD-Ls.

**ECE 742. Communication Systems II. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalents. Principles of digital communication. Topics include fundamentals of information theory, digital modulation techniques, optimum detector receivers for digitally modulated signals, the bandlimited gaussian channel and intersymbol interference, equalization, spread spectrum, CDMA.

**ECE 743. Image Data Hiding, Forensics. 3 credits, 3 contact hours.**
Prerequisites: ECE 643 or CS 659 or equivalent As we have entered digital world, information forensics and security have become critically important. With digital images as media, this course covers digital watermarking, reversible data hiding, steganography and steganalysis, forensics and counter-forensics, including image tampering detection, classification of double JPEG/MPEG compressions, camera classification from given images, classification of photographic images from computer graphic images, and so on.

**ECE 744. Optimization for Communication Networks. 3 credits, 3 contact hours.**
Modern communication are required to provide optimal performance in terms of quality-of-service under strict constrains on the utilization of resources, such as spectrum of power. In addition, the emerging paradigm of decentralized communication systems, such as ad hoc and sensor networks, calls for distributed, and possibly competitive, optimization techniques. This course covers the basic analytical and algorithmic tools that enable such centralized and decentralized optimization.

**ECE 746. Adaptive Array Processing and Interference Cancellation. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673. Principles of array processing, performance criteria used, and adaptive algorithms for realization of these processors; and ideas and principles of array processing in the design of contemporary radar systems.

**ECE 747. Signal Decomposition Techniques: Transforms, Sub-bands, and Wavelets. 3 credits, 3 contact hours.**
Prerequisites: ECE 640 and ECE 673. Multiresolution signal decomposition techniques, transforms, sub-bands, and wavelets. Time-frequency localization properties of multiresolution algorithms. Evaluation and critique of proposed decomposition strategies from compression and performance standpoints. Applications to speech and video compression, and localized feature extraction. These are basic signal processing tools used in diverse applications such as speech and image processing and storage, seismology, machine vision.

**ECE 755. Advanced Topics in Digital Communications. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalent. Advanced topics in digital communication systems in the presence of intersymbol interference, noise, and fading: modulation and demodulation in the presence of gaussian noise, efficient signaling with coded modulation, trellis decoding, Viterbi algorithm, digital transmission with intersymbol interference, and digital signaling over imperfect channels.

**ECE 756. Advanced Topics in Semiconductor Devices. 3 credits, 3 contact hours.**
Prerequisite: ECE 657 or permission of instructor. Builds on ECE 657. Covers photonic devices particularly semiconductor laser and photodetectors for optical systems; microwave and other high speed devices; scaled advanced MOS, FET, and bipolar transistors.

**ECE 757. Advanced Wireless Communications. 3 credits, 3 contact hours.**
Prerequisite: ECE 742 or equivalent. Introduction of digital cellular radio. In-depth analytical characterization of linear, time-variant systems as they apply to wireless channels. Thorough consideration of the principles of the CDMA multiuser system, together with methods for reducing multiple-access interference. Emphasis on general topics such as diversity interleaving.

**ECE 758. VLSI Design II. 3 credits, 3 contact hours.**
Prerequisite: ECE 658 (with ECE 657 suggested). Use of CMOS, biCMOS and bipolar semiconductor technology for VLSI design. Digital techniques are emphasized with minor coverage of analog design. Application areas for full custom, gate arrays, standard cell, and compiled designs are compared. Mentor VLSI design tools running on the HP and Sun workstations are used in the course projects for each enrollee. The course attempts to provide a design environment for projects that is similar to that encountered by VLSI designers in industry.

**ECE 759. Principles of Phase Lock and Frequency Feedback. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalents. Principles of operation and design for phase locked and frequency feedback loops, linear equivalent circuit, nonlinear effects, and optimization against noise used in a wide range of applications including low-level signal reception, tracking, phase extraction, filtering, and frequency synchronization. F.M. communication is emphasized.

**ECE 760. Solid-State Image Sensors. 3 credits, 3 contact hours.**
Prerequisites: ECE 657 and ECE 648 or ECE 658. Construction, operation, and performance evaluation of visible and infrared image sensors. Included are a review of the main approaches for photodetectors and readout structures, image sensor architectures, performance evaluation and trade-offs, noise considerations, modulation transfer function, techniques for control of blooming, interlacing, color-coding for visible imagers, HDTV imagers, photo-counting amplifiers, and radiometry and figures of merit for infrared imagers.

**ECE 766. Stability Theory of Nonlinear Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 666. Concepts of stability in dynamic systems, theory and application of Lyapunov's direct method. Use of functional analysis, and frequency response method of Popov and its extensions including their application to the investigation of stability, boundedness, and damping in a class of unforced and forced nonlinear systems.

**ECE 768. Optimal Control Theory. 3 credits, 3 contact hours.**
Prerequisite: ECE 677. Optimal control for classes of deterministic systems with various constraints using calculus of variations, dynamic programming and the maximum principle, state variable constraints, and application of theory to design problems.

**ECE 769. Stochastic Estimation and Control. 3 credits, 3 contact hours.**
Prerequisites: ECE 660 and ECE 673. Markov processes. The discrete-time Kalman filter as a minimum variance estimator. The continuous-time Kalman-Bucy filter. Relationship to the Wiener filter. Nonlinear systems: the extended Kalman filter and other generalizations. Computational difficulties and methods for avoiding them: separated-bias estimation, ?UDU? factorization. Applications in navigation and control.

**ECE 776. Information Theory. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalents. Classical theory of information developed from Shannon's theory. Information measure, Markov sources and extensions, the adjoint source, uniquely decodable and instantaneous codes and their construction, Shannon's first and second theorems, mutual information, and performance bounds on block and convolutional codes.

**ECE 777. Statistical Decision Theory in Communications. 3 credits, 3 contact hours.**
Prerequisite: ECE 642 or equivalent. Relation between detection theory and statistical hypothesis testing problem. Use of Bayes decision criteria, Neyman-Pearson, and mini-max tests; receiver operating characteristics. Representation of signals in signal space, probability of error calculations. Estimation of random and non-random signal parameters, Cramer-Rao Inequality. The general Gaussian problem and the use of covariance matrices.

**ECE 778. Algebraic Coding for Information Transmission. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673. Coding for reliable digital transmission and storage, error detection and correction codes. Decoding techniques and performance evaluation of block and convolutional codes, including BCH, Reed-Solomon code and Trellis coded modulation.

**ECE 782. Advanced Data Security and Privacy. 3 credits, 3 contact hours.**
Prerequisites: CS 608, CS 696, or instructor approval. In-depth study of the security and privacy issues associated with the massive amount of data that is collected, stored, shared and distributed in today's society. New paradigms are needed to address the security/privacy challenges when data is outsourced at untrusted servers (such as in cloud computing), when data is anonymized in order to be shared among untrusted parties, or when copyrighted data needs to be protected from unauthorized use.

**ECE 783. Computer Communication Networks. 3 credits, 3 contact hours.**
Prerequisites: ECE 673 and ECE 683. Data link control and communication channels. Delay models in data networks. Queueing analysis techniques are taught in detail. Multi-access communication techniques. Routing in computer communication networks.

**ECE 785. Parallel Processing Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 684 or equivalent. Parallel computer architectures. General purpose and specialized parallel computers. Shared-memory multiprocessors, message-passing multicomputers, and vector supercomputers. Principles of scalable performance. MPP designs. SIMD and MIMD computers. Design of parallel algorithms (merging and sorting of data, FFT, etc.) and performance evaluation. Load balancing, data decomposition, and scheduling of operations.

**ECE 788. Selected Topics in Electrical and Computer Engineering. 3 credits, 3 contact hours.**
Special-area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

**ECE 789. Selected Topics in Electrical and Computer Engineering II. 3 credits, 3 contact hours.**
See description for ECE 788.

**ECE 790. Doctrl Dissrtn & Research. 0 credits, 0 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790A. Doctrl Dissrtn & Research. 1 credit, 1 contact hour.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790B. Doctrl Dissrtn & Research. 3 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790C. Doctrl Dissertation & Resrch. 6 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790D. Doctrl Dissertation & Resrch. 9 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790E. Doct Dissrtation & Resrch. 12 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790F. Doct Dissertation & Resrch. 15 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790G. Doct Dissertation & Resrch. 18 credits, 3 contact hours.**

**ECE 791. Graduate Seminar. 0 credits, 0.5 contact hours.**
All master's and doctoral students must register for two semesters and six semesters of ECE 791 Graduate Seminar, respectively. To receive a satisfactory grade, students must attend at least five seminars during the semester, as approved by the seminar supervisor.

**ECE 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**ECE 792C. Pre-Doctoral Research. 6 credits, 3 contact hours.**

**EM 501. Industrial Management. 3 credits, 3 contact hours.**
Prerequisite: approval from the engineering management graduate advisor or program director. Operational aspects of management techniques: organization, product design and development, distribution logistics, marketing, plant location and layout, materials handling, production planning and control, inventory control, quality control, work analysis, and incentive plans.

**EM 502. Engineering Cost Analysis. 3 credits, 3 contact hours.**
Restriction: approval from the engineering management graduate advisor or program director. Financial, engineering, economic, and cost-control aspects of industrial management; the accounting cycle; cost accounting procedure; and cost-model techniques of making cost comparisons through engineering economic studies.

**EM 503. Methods and Applications of Industrial Statistics and Probability. 3 credits, 3 contact hours.**
Restriction: approval from the engineering management graduate advisor or program director, undergraduate course in calculus. An analytical approach to basic engineering probability and statistics, with applications drawn from both manufacturing and process industries. Emphasis is placed upon the utility of statistical inference derived from engineering data.

**EM 602. Management Science. 3 credits, 3 contact hours.**
Prerequisite: undergraduate calculus and probability and statistics. Linear programming: formulation, methodology, and application; the transportation problem; the assignment problem; Markov chains and their applications in decision making; queueing systems; deterministic and stochastic inventory models.

**EM 617. Environmental Risk Assessment. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in calculus and economics. Application of management technique methodology to recognize, evaluate, and make decisions regarding expenditures for the mitigation of potentially hazardous environmental risks. Basic analytical techniques applicable to social and economic risk assessment; methodology and application to current air and water resources; and rationale for cost-benefit and trade-off analysis. Technical characteristics of materials: half-life, decomposition rates, and temperature sensitivity determining environmental probabilities and expectations.

**EM 631. Legal Aspects in Environmental Engineering. 3 credits, 3 contact hours.**
Control of air, water, and solid waste pollution by federal, state, and local government statutes and international law. Preparation of environmental impact statements and the right of private citizens to bring suit under federal clean air and water pollution legislation are discussed, as well as limitations on these rights.

**EM 632. Legal Aspects in Construction. 3 credits, 3 contact hours.**
Introduction to the legal factors affecting construction activities: contract responsibilities of contractors, engineers, and owners; subcontracts and third-party liability; construction law and code compliance; and insurance and bonds.

**EM 633. Legal Aspects of Health and Safety. 3 credits, 3 contact hours.**
Review of key laws and regulations pertaining to occupational health, safety, and product liability; methods to determine which codes apply in given situations and to prepare operating procedures to be used for internal compliance.

**EM 634. Legal, Ethical and Intellectual Property Issues for Engineering Managers. 3 credits, 3 contact hours.**
Introduction to various environmental, product liability, health and safety, and intellectual property, legal, as well as ethical, issues facing engineering managers. Current New Jersey and federal laws and pending legal actions in these fields. Case studies and advanced multimedia learning tools are used.

**EM 635. Management of Engineering Research and Development. 3 credits, 3 contact hours.**
Prerequisite: principles of management and statistics, or EM 501 and EM 503. A systems approach to management of resources, and tasks needed for engineering research and development. Identification, analysis, and evaluation of the operational characteristics and structure of the research laboratory and engineering office; functions of planning, organizing, staffing, direction, control, innovation, and representation; and planning and control theories, techniques, and current practices in scientific and engineering management.

**EM 636. Project Management. 3 credits, 3 contact hours.**
Prerequisites: IE 492 (see undergraduate catalog for description), IE 603 or equivalents. Introduction to concepts of project management and techniques for planning and controlling of resources to accomplish specific project goals. While the focus is on technically oriented projects, the principles discussed are applicable to the management of any project. Topics include time, cost considerations, cash flow forecasting, financial and performance control, documentation.

**EM 637. Project Control. 3 credits, 3 contact hours.**
Prerequisite: EM 636 or equivalent. Focuses on the methodology that can be employed to plan project implementation and control progress. Topics include work breakdown construction, task and schedule development budgetary control, earned value analysis, and behavioral considerations. Project management software utilization is emphasized.

**EM 640. Distribution Logistics. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or TRAN 650 or equivalent. Distribution logistics emphasizing systems engineering techniques used to optimize corporate profit and customer service: transportation modes; inventory policies; warehousing and order processing; and the best logistics gross margin. Same as TRAN 640.

**EM 641. Engineering Procurement and Materials Management. 3 credits, 3 contact hours.**
Prerequisites: EM 602, EM 640, and EM 674 or equivalents. Study of the logistics life cycle, involving planning, analysis, design, testing, distribution and life cycle support. Make versus buy engineering design decision. Various tools and techniques for an effective life cycle support program. Bench-marking approach to survey available internal and external resources and competitor solutions. Constructing life cycle cost models for acquisitions. Build adequate specification. Application of the latest techniques in supplier chain quality management. Case studies and advanced multimedia learning tools are used.

**EM 655. Management Aspects of Information Systems. 3 credits, 3 contact hours.**
Prerequisite: computer programming experience. Information flow in an organization as an integrated system and management resource: techniques of data analysis, design, and processing; characteristics of computerized information-handling equipment; data acquisition, storage, processing, retrieval, and transmission to decision-makers; and information systems for finance, production, inventory, accounting, marketing, and distribution.

**EM 660. Financing an Industrial Enterprise. 3 credits, 3 contact hours.**
Prerequisite: undergraduate economics, accounting, and engineering economy. Principles of financial practice and management in modern business corporations emphasizing financial planning and control; capital project and working capital needs; internal and external financing; and finance as a major function of the management process.

**EM 661. Advanced Engineering Economics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate engineering economics or equivalent. Economic use of a firm's capital resources. Feasibility studies of potential major capital investments likely to be considered by an enterprise. Risk assessment, cost engineering, effect of financing sources, life cycle, and technologies forecasting models. Case studies are used.

**EM 674. Benchmarking and Quality Function Deployment. 3 credits, 3 contact hours.**
Prerequisite: IE 673 or equivalent. Continuation of IE 673. Benchmarking surveys of competition, process analysis of engineering activities, statistical process control mathematics, Taguchi methods of process and product design, current total quality management innovations, quality functional deployment. Case studies and advanced multimedia learning tools are used.

**EM 691. Cost Estimating for Capital Projects. 3 credits, 3 contact hours.**
Prerequisites: EM 502 and EM 503, or equivalent. Cost estimating techniques and procedures for budgeting used in evaluation, planning, and control of capital investments. Emphasis on updating for change, escalation, and statistical and computer methods.

**EM 693. Managerial Economics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate economics. Internal and external influences on the economic practices of business; classical and current theories of economic behavior; contemporary analytical techniques; behavior of costs, prices, and profits; demand analysis, competition and monopoly; capital expenditure planning; profit theories and business cycles; and econometric models of market strategies, competitive action, and demand behavior.

**EM 695. Public Utility Energy Management. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or equivalent. Managing loads on electric power systems. Influence of variable rate structure and description of several projects currently in progress.

**EM 696. Nuclear Power Reactor Management. 3 credits, 3 contact hours.**
Prerequisite: undergraduate economics and physics. Nuclear power reactor management and power generation alternatives: optimum performance; maximum control; minimum cost; capacity planning; cost estimating; investment requirements; plant location and safety; separation technology for fuel enrichment; transportation and storage of spent fuel; reprocessing and nuclear waste storage; and regulatory aspects of nuclear power.

**EM 700. Master's Project. 0 credits, 0 contact hours.**

**EM 700B. Master's Project. 3 credits, 3 contact hours.**

**EM 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: matriculation for the M.S. degree, adequate graduate courses in the field of the proposed thesis, and the thesis advisor's approval. Thesis must contribute to the field, and preferably aid the candidate's present or potential career. While original research may not always result, the thesis should provide a new conclusion or application. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**EM 701B. Master's Thesis. 3 credits, 3 contact hours.**
Restriction: matriculation for the M.S. degree, adequate graduate courses in the field of the proposed thesis, and the thesis advisor's approval. Thesis must contribute to the field, and preferably aid the candidate's present or potential career. While original research may not always result, the thesis should provide a new conclusion or application. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**EM 701C. Master's Thesis. 6 credits, 3 contact hours.**
Prerequisites: matriculation for the M.S. degree, adequate graduate courses in the field of the proposed thesis, and the thesis advisor's approval. Thesis must contribute to the field, and preferably aid the candidate's present or potential career. While original research may not always result, the thesis should provide a new conclusion or application. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**EM 714. Multicriteria Decision Making. 3 credits, 3 contact hours.**
Prerequisite: some background in operations research. Multiobjective programming and conflict analysis to evaluate alternatives in decision making, utility, assessment methodology, interactive and noninteractive multiple mathematical programming methods, and surrogate worth trade-off methods are covered.

**EM 715. Design of an Enterprise. 3 credits, 3 contact hours.**
Prerequisite: undergraduate economics, industrial management accounting, engineering economy, probability and statistics; 9 credits of EM courses at 600-level or above; and advisor's approval. Organization and management of an enterprise, from initial planning through production and distribution of manufactured products. Students choose the industry that they study.

**EM 716. Seminar in the Design of an Enterprise. 3 credits, 3 contact hours.**
Prerequisite: EM 715. Continuation of EM 715. Depending on the student's interest, report on design of the particular enterprise emphasizing either the management of research and development; the management of production; the management of distribution; or the management of manpower.

**EM 725. Independent Research. 3 credits, 3 contact hours.**
Restriction: permission from the ME department's industrial and management engineering division advisor. Program of study prescribed and approved by student's advisor. Special course covers areas of study in which one or more students may be interested, but is not of sufficiently broad interest to warrant regular course offering.

**EM 726. Independent Research II. 3 credits, 3 contact hours.**

**EM 740. Management of Transportation Carriers. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or equivalent and TRAN 650 or EM 602 or equivalent. Presents theory and practice of managing transportation carriers, including the concepts of costing, pricing, designing and marketing transportation service; the concepts of financial efficiency and resource productivity with application to the selected freight carriers in each mode of transportation. Selected case studies of carriers? operations management practices in various modes. Comparative studies of service characteristics, market share, cost structures both within a particular transportation mode and between the modes. Same as TRAN 740.

**EM 765. Multi-modal Freight Transportation Systems Analysis. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or equivalent and TRAN 650 or EM 602 or equivalent. Quantitative methods for the analysis and planning of freight transportation services. The supply-performance-demand paradigm for freight transportation systems. Cost and performance as determined by system design and operations. Relationship of traffic and revenue to service levels and pricing. Optimal service design and redesign for transportation enterprises and operations planning. Fleet and facility investment planning. Applications to various modes. Same as TRAN 765 and CE 765.

**EM 771. Operations Cost and Management Control. 3 credits, 3 contact hours.**
Prerequisites: 6 credits of EM courses at 600-level or above. Analysis and control of cost and other operational aspects of enterprises: manufacturing, distribution and overhead budgets; cost accounting; management information systems; relevant behavioral factors; financial and other management reports. Case studies used.

**ENE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisite: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**ENE 630. Physical Processes of Env Syst. 3 credits, 3 contact hours.**

**ENE 660. Introduction to Solid and Hazardous Waste Problems. 3 credits, 3 contact hours.**
Prerequisite: ENE 663. (May be taken concurrently.) Introduction to solid waste disposal. Industrial and urban sources of solid waste and conventional methods of waste disposal. Application of engineering principles related to these topics.

**ENE 661. Environmental Microbiology. 3 credits, 3 contact hours.**

**ENE 662. Site Remediation. 3 credits, 3 contact hours.**
Prerequisite: EM 631. Can be taken concurrently with EM 631. Examines site remediation from start to finish. Includes regulations, cleanup standards, remedial investigations, feasibility studies, risk assessment, and safety. Examines established and innovative cleanup technologies such as incineration, containment, bioremediation, vapor extraction and ground water recovery.

**ENE 663. Water Chemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate general chemistry. The ability to analyze and solve a wide range of chemical equilibrium problems in water chemistry is developed.

**ENE 664. Physical and Chemical Treatment. 3 credits, 3 contact hours.**
Prerequisite: ENE 663. Physical and chemical operations and processes employed in the treatment of water and wastewater. Topics include gas transfer, coagulation, flocculation, solid-liquid separation, filtration, and disinfection.

**ENE 665. Biological Treatment. 3 credits, 3 contact hours.**
Prerequisites: ENE 663, ENE 661. (May be taken concurrently.) Principles of evaluation and control of water pollution that describe aerobic treatment processes: oxidation ponds, trickling filters, and activated sludge. Anaerobic digestion and sludge handling and disposal as well as biodegradability study techniques for various wastes.

**ENE 666. Analysis of Receiving Waters. 3 credits, 3 contact hours.**
Prerequisites or corequisites: ENE 663 and ENE 661. Ecological responses of various types of receiving waters to municipal and industrial waste loadings. Mathematical models for water quality prediction and planning.

**ENE 667. Solid Waste Disposal Systems. 3 credits, 3 contact hours.**
Prerequisite: ENE 663. Review and evaluation of design criteria, methods, and equipment employed in handling and disposal of industrial and municipal solid wastes. Emphasis is on hazardous toxic waste, resource recovery, and regulatory constraints.

**ENE 671. Environmental Impact Analysis. 3 credits, 3 contact hours.**
Prerequisite or corequisite: ENE 663. A graduate course dealing with physical aspects of the environment. Overview of environmental problems, federal and state standards, methodology for developing impact statements, case studies based on recent experience, basis for assessment and decision making.

**ENE 672. Stormwater Management. 3 credits, 3 contact hours.**
This course provides a comprehensive study of stormwater management with emphasis on design practices. Topics include regulatory framework, an overview of structural and non-structural BMPs, groundwater recharge analysis, estimate of runoff, and design of detention basin and drainage systems.

**ENE 673. Sustainability and Life Cycle Analysis. 3 credits, 3 contact hours.**
The course provides a systematic foundation for the connection between evolving technology and human activity impacts on natural systems by emphasizing the sources of environmental degradation and energy use and strategies to reduce risk and promote sustainability. The course provides hands-on experience with life cycle assessment computer tools and approaches. The course emphasizes relationships between industrial activities and regional and global natural systems-physical, chemical and biological-focusing on the importance of sustainability goals and practices.

**ENE 700. Master'S Project. 0 credits, 0 contact hours.**
Prerequisite: student must have sufficient experience and/or graduate courses in major field to work on the project. Subject matter to be approved by the department. Permission to register must be obtained from the project advisor. Extensive investigation, analysis, or design of environmental engineering problems not covered by regular graduate course work is required. A student with an exceptional project in EnE may, upon his/her own initiative and with the approval of his/her advisor, substitute the work of this course as the equivalent of the first 3 credits for EnE 701 Master's Thesis.

**ENE 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: student must have sufficient experience and/or graduate courses in major field to work on the project. Subject matter to be approved by the department. Permission to register must be obtained from the project advisor. Extensive investigation, analysis, or design of environmental engineering problems not covered by regular graduate course work is required. A student with an exceptional project in EnE may, upon his/her own initiative and with the approval of his/her advisor, substitute the work of this course as the equivalent of the first 3 credits for EnE 701 Master's Thesis.

**ENE 701. Master'S Thesis. 0 credits, 0 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated for the thesis.

**ENE 701B. Master'S Thesis. 3 credits, 3 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated for the thesis.

**ENE 701C. Master'S Thesis. 6 credits, 3 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated for the thesis.

**ENE 702. Special Topics in Environmental Engineering. 3 credits, 3 contact hours.**
Restriction: advisor's approval. Topics of special current interest in environmental engineering.

**ENE 720. Environmental Chemodynamics. 3 credits, 3 contact hours.**
Introduction to concepts, mechanisms and models used to describe the transport of chemicals in the environment. Concepts and models are applied to air-water, sediment-water and soil-air interfaces.

**ENE 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**ENE 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**ENE 790. Doctoral Dissert & Res. 0 credits, 0 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790A. Doctoral Dissert & Res. 1 credit, 1 contact hour.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790B. Doctoral Dissert & Res. 3 credits, 3 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790C. Doctoral Dissertation. 6 credits, 0 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790D. Doctoral Dissertation. 9 credits, 9 contact hours.**

**ENE 790E. Doctoral Dissertation & Res. 12 credits, 3 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790F. Doctoral Dissertation & Res. 15 credits, 3 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 791. Graduate Seminar. 0 credits, 0 contact hours.**
Seminar in which faculty or others present summaries of advanced topics suitable for research. Students and faculty discuss research procedures, thesis organization, and content. Students present their own research for discussion and criticism. Required of all doctoral students registered for ENE790 unless requirement is waived, in writing, by the dean of graduate studies.

**ENE 792. Pre-Doctoral Dissertation. 3 credits, 3 contact hours.**

**ENE 792C. Pre-Doctoral Research. 6 credits, 3 contact hours.**

**ESC 701B. Master'S Thesis. 3 credits, 3 contact hours.**

**IE 501. Fundamentals of Industrial Engineering. 3 credits, 3 contact hours.**
Basic concepts of industrial engineering for students who lack an undergraduate degree in the discipline, including: manufacturing processes, work methods and measurement concepts, basics of human factors, quality control, facilities design, production planning, operations research tools, and simulation models.

**IE 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: permission from the industrial engineering program director and the Division of Career Development Services. Cooperative education internship providing on-the-job reinforcement of academic programs in industrial engineering. Work assignments and projects are developed by the co-op office in consultation with the industrial engineering program director. Work assignments are related to student's major and are evaluated by faculty coordinators in the IE department. Course cannot be applied toward degree credit.

**IE 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: permission from the industrial engineering program director and the Division of Career Development Services. Course cannot be applied toward degree credit.

**IE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: graduate standing and permission from the industrial engineering program director, and the Division of Career Development Services. Course cannot be applied toward degree credit.

**IE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**IE 601. Measurement Methods for Performance Analysis of Operations. 3 credits, 3 contact hours.**
Prerequisite: undergraduate mathematics for management science, or EM 602. Quantitative study of various analytical methods for designing and evaluating systems employed in the management of complex enterprises such as decision-making, efficiency measurement, and methods for obtaining optimal system performance.

**IE 603. Behavioral Science in Engineering Organization. 3 credits, 3 contact hours.**
Prerequisite: undergraduate probability and statistics, or EM 503. A study of scientific research on human behavior in organizations. Processes and problems of communication in engineering activities; line-staff and supervisor-subordinate relationships; formal and informal organizations; organization models; and technical and social structure of organizations.

**IE 604. Advanced Engineering Statistics. 3 credits, 3 contact hours.**
Prerequisite: IE 331 (see undergraduate catalog for description) or equivalent. The foundations of modern quality improvement, scientific basis of quality engineering, probability, statistical inference, statistical experimental design issues such as randomized blocks, factorial design at different levels, application to factorial design, building models, and implementation and critique of Taguchi's contributions. Statistical software is used in the data analysis.

**IE 605. Engineering Reliability. 3 credits, 3 contact hours.**
Prerequisite: statistics. Concepts of modern reliability applied to practical industrial problems: statistical concepts, reliability through design, reliability through testing, analysis of reliability data, and the organization and management of a reliability program. Offered alternate years.

**IE 606. Maintainability Engineering. 3 credits, 3 contact hours.**
Prerequisite: statistics. Factors affecting maintainability design applied to military and industrial problems: statistical concepts; maintainability prediction, allocation, and demonstration; availability, system and costeffectiveness; provisioning; optimal maintenance policies; and management of a maintainability program.

**IE 608. Product Liability Control. 3 credits, 3 contact hours.**
Product liability and the effect of legal doctrines on minimizing hazards of design and manufacture. Use of actuarial techniques and legal precedents applicable to design, manufacturing, advertising, and marketing problems: warranties, notices, disclaimers, definition of liability, use of expert witnesses, reliability prediction and analysis methods, safety engineering concepts, and design review. A review of government regulations for safety and protection, as well as mandatory and voluntary standards will also be included.

**IE 609. Advanced Analytical Engineering Statistics. 3 credits, 3 contact hours.**
Prerequisite: IE 604. An extension of the techniques of engineering statistical analysis to industrial applications. Emphasis is placed on the design of experiments and analysis of tests for multivariate level problems.

**IE 610. Transportion Economics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in economics. Principles of engineering economy. Costs of highway and public transportation facilities. Economic comparisons and evaluations. Financing approaches, tax allocation theory. Programming highway and public transit improvements. Same as TRAN 610.

**IE 614. Safety Engineering Methods. 3 credits, 3 contact hours.**
Prerequisites: introductory course in statistics and industrial or construction management. Application of selected safety engineering methods to detect, correct, and prevent unsafe conditions and procedures in future practice. Methods selected are from safety management and programs; loss prevention; fire protection; systems safety; the design of buildings and other facilities; and the design of products, machinery, and equipment. Engineering problems in designing and constructing a hazard-free environment.

**IE 615. Industrial Hygiene and Occupational Health. 3 credits, 3 contact hours.**
Prerequisites: one year of college physics and one semester of college chemistry or biology. Introduction to industrial hygiene. Recognition, evaluation and control of human exposure to noise, heat, bio-hazards, chemicals, radiation, and improper lighting. Government standards, field measurements, work practices, engineering designs, and the effects of excessive exposure on worker health and productivity.

**IE 618. Engineering Cost and Production Economics. 3 credits, 3 contact hours.**
Prerequisite: IE 502 or equivalent. Cost management of operational activities. Focuses on capital investment decision making and efficient resource utilization to achieve cost-effective operations. Topics include alternative investment evaluation, budgeting activity based costing, quality costs, life cycle management and relevant behavioral science. These are considered in the context of manufacturing and service industry application.

**IE 621. Systems Analysis and Simulation. 3 credits, 3 contact hours.**
Prerequisites: IE 331, IE 466 (see undergraduate catalog for descriptions), or equivalent or department approval. The application of well-integrated systems approach, systems and systems engineering in the system life cycle, system design process, mathematical tools and techniques applied to systems analysis, design for operational feasibility, systems engineering management, modeling techniques including simulation, application of discrete simulation techniques to model industrial systems, design of simulation experiments using software, output data analysis.

**IE 622. Simulation and Risk Analysis in Operations Management. 3 credits, 3 contact hours.**
Prerequsites: IE 331 (see undergraduate catalog for description) or equivalent. Introduction to the concepts, methodologies and applictions of simulation in operations management. Foundations of simulation, Monte Carlo approaches, simulation models using spreadsheets, generating probabilistic outcomes using random number generation techniques, applying risk analysis software to spreadsheets for various decisions making. Variety of applications in operations management, finance and marketing. Software to develop models of practical operations management applications, is provided.

**IE 623. Linear Programming. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or introductory course in operations research. Principles, methodology, and practical applications of linear programming to complex problems in production and marketing, simplex techniques, duality theory, parametric analysis, Wolfe and Dantzig's decomposition methods, ellipsoid method, and Karmakar's method.

**IE 624. Heuristic Methods. 3 credits, 3 contact hours.**
Prerequisites: EM 503 or equivalent. Techniques and concepts used to develop intelligent decision support systems. Application of rules called heuristics and models of reasoning to solve problems in engineering design and manufacturing. Topics include set theory, fuzzy subset theory, decision theory, logic, inference expert systems and single and multi-fault diagnostics.

**IE 641. Operations Analysis. 3 credits, 3 contact hours.**
Prerequisites: EM 602 and computer programming experience. Management systems and business behavior using industrial models. Special attention is given to the interaction of individual elements that make up the total system.

**IE 642. Network Flows and Applications. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or equivalent. Theories, algorithms, computation complexity, and application of networks, shortest path, network flow, and minimum cost flow problems. Models of industrial service systems as network problems.

**IE 643. Transportation Finance. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in economics. Balance sheets and income statements. Asset and liability management, sources and costs of debt and equity financing. Financial performance measures in the private sector (airlines, railroads, trucking and bus companies). Financing issues associated with the public sector (highways and mass transit). Equity and efficiency in pricing. Subsidy allocation formulae. Innovative financing schemes in the public sector. Same as TRAN 643.

**IE 644. Application of Stochastic Modeling in Systems Control. 3 credits, 3 contact hours.**
Stochastic processes applied to control of various types of systems: Markov chains, queueing theory, storage theory applications to measure performance of flexible manufacturing systems, telecommunication and distributions networks and similar service systems. Knowledge of probability theory and linear algebra is essential.

**IE 650. Advanced Topics in Operations Research. 3 credits, 3 contact hours.**
Prerequisite: introductory course in operations research or equivalent. Current topics in deterministic models of operations research: linear programming, large scale decomposition, integer programming, dynamic programming, and nonlinear programming. Emphasis on optimization techniques for solving mathematical programming problems.

**IE 651. Industrial Simulation. 3 credits, 3 contact hours.**
Prerequisite: introductory course in statistics/simulation or instructor's permission. Statistical design and analysis of Monte Carlo simulation experiments from an engineering view. Examples are provided with emphasis on industrial and manufacturing applications of simulation modeling. Markovian processes simulation, random number generation, mathematical programming, heuristics and decision theory.

**IE 652. Facilities Location and Plant Layout. 3 credits, 3 contact hours.**
Prerequisite: introductory course in operations research or instructor's approval. Basic con-cepts of facilities location and plant layout. Quantitative and qualitative tools needed in industrial engineering, including single and multiple facilities location problems, site selections and allocation models, use of Duality theory in location and plant layout problem, and computerized layout planning.

**IE 653. Facility Maintenance. 3 credits, 3 contact hours.**
Prerequisite: EM 501 or equivalent. Intended for those individuals who manage the functioning and maintenance of physical facilities. Emphasis on planning and control of facilities use, maintenance, utility management, managerial control, budgets and costs, personnel administration, legal and safety, flexibility measurement, and design.

**IE 655. Concurrent Engineering. 3 credits, 3 contact hours.**

**IE 659. Supply Chain Engineering. 3 credits, 3 contact hours.**
Coordination of product manufacturing and logistic activities across the global supply chain is studied. Focus is on supply chain design, implementation, and control. Topics include transportation and distribution networks, inventory control, demand planning, materials handling and warehousing, supply chain contracts, manufacturing flexibility, product design for responsiveness, and ERP systems. Supply chain analytics concepts and relevant case studies are introduced.

**IE 661. Man-Machine Systems. 3 credits, 3 contact hours.**
Prerequisite: human factors engineering. Analysis of integrated man-machine systems: physical and psychological effects of systems of deterministic and conditional responses of individuals and groups, and the resulting interaction between individuals, groups, and machine systems; also current research and development pertaining to man-machine systems.

**IE 662. Cognitive Engineering. 3 credits, 3 contact hours.**
Prerequisite: IE 355 or equivalent. The purpose of this course will be to introduce the application of human factors and cognitive psychology principles to the user interface design of information technology, including computer systems, groupware and communications, handheld devices and Internet applications, and automatic speech recognition interfaces. The course will provide grounding in the engineering design processes used to enhance the usability of products and services, and usability testing methods used by user interface designers. Secondly, major areas and design problems in human-computer interaction and Information Technology will be covered, with real world examples. The course would be appropriate for advanced undergraduates in engineering, computer science, and psychology.

**IE 664. Advanced Ergonomics. 3 credits, 3 contact hours.**
Prerequisite: IE 355 or equivalent. The course covers important topics for ergonomics, including functional anatomy of the human body, work physiology and body energy expenditure, and biomechanics for people at work. Commonly used analytical tools for ergonomics will be introduced in the course.

**IE 665. Applied Industrial Ergonomics. 3 credits, 3 contact hours.**
Prerequisites: IE 355 (see undergraduate catalog for description) or IE 699. Introduces the fundamentals and applications of industrial ergonomics for improving equipment, tool, workplace, and job design. Engineers, as well as safety and health professionals, will benefit from the course by understanding the design principles for human operators and current issues in industrial ergonomics, and a variety of evaluating methodologies for the design.

**IE 669. Human Design Factors in Engineering. 3 credits, 3 contact hours.**
Prerequisite: engineering statistics. Human factors research related to workplace and equipment design and development. Capabilities and limitations of the human sensory-motor system. Design of displays and resulting interaction between individuals, groups, environments and machine systems. Current research in engineering pertaining to the man-machine interface. Not for IE students who have had an undergraduate course in human factors.

**IE 670. Industrial Work Physiology. 3 credits, 3 contact hours.**
Prerequisite: IE 669 or equivalent. A study of human physiological responses to industrial environmental factors emphasizing knowledge of human anatomy and physiological tolerances: skeletal, muscle, and neuromuscular systems, evaluation of physical work capacity and performance, changes in circulation and respiration during work. Semester project under the instructor's supervision is also required.

**IE 672. Industrial Quality Control. 3 credits, 3 contact hours.**
Prerequisite: engineering statistics. The management of quality assurance: operational and statistical principles of acceptance sampling and process control; quality problems in production lines, and introduction to total quality management concepts.

**IE 673. Total Quality Management. 3 credits, 3 contact hours.**
Introduces the concept of total quality management as applicable to industrial systems. Presents methods for product quality improvement. Emphasis is on prevention through quality engineering and design, and goes beyond traditional statistical process quality control. Presentation of recent methods in supplier management, quality assurance, process control, and competitor analysis. Includes Taguchi methods and quality function deployment. Description of ISO 9000 and Baldridge Award.

**IE 674. Quality Maintenance and Support Systems. 3 credits, 3 contact hours.**
Prerequisites: probability and statistics, IE 331 (see undergraduate catalog for description) or equivalent. Consideration of factors necessary for cost effective maintenance and support of technical operating systems. Topics discussed include service organization and management, spare parts and logistics, quality assurance, ISO9003 training. Examples from automation, computer systems, clinical engineering, power, and transportation will be used to illustrate application areas.

**IE 675. Safety in Facility and Product Design. 3 credits, 3 contact hours.**
Prerequisite: IE 614 or equivalent. Application of safety principles to minimize the health and safety hazards in the design and manufacture of various products. Practical techniques for, and economic ramifications of, conformance with the many statutes enacted to assure safe workplaces and products.

**IE 677. Applied Statistics and Epidemiology for Hazard Analysis. 3 credits, 3 contact hours.**
Prerequisite: IE 604 or equivalent. Application of statistical concepts to the field of hazard analysis including: investigation of root causes of accidents, their patterns and trends; rules for systematic data analysis; determination of commonality factors; availability and use of customized computer software.

**IE 681. Interdisciplinary Seminar in Occupational Safety and Health. 1 credit, 1 contact hour.**
Restriction: OSHE students, or permission of instructor. This is a required course for students who receive the trainee scholarship from the Occupational Safety and Health Engineering Program sponsored by the National Institute for Occupational Safety and Health (NIOSH). Other graduate students are also welcome and encouraged to take the interdisciplinary seminar course. Students and residents in the ERC programs will be able to participate in an interdisciplinary course with students in industrial hygiene, occupational medicine and occupational safety.

**IE 682. Industrial Safety and Health Evaluation. 3 credits, 3 contact hours.**
Restriction: OSHE students, or permission of instructor. This is a required course for students who receive the trainee scholarship from the Occupational Safety and Health Engineering Program sponsored by the National Institute for Occupational Safety and Health (NIOSH). Other graduate students are also welcome and encouraged to take this site visit course. Upon completion of this course, students will be able to plan and conduct a walk-through evaluation of health and safety hazards in a workplace. Students will also understand the role of occupational health and safety disciplines in the recognition and prevention of occupational injury and illness.

**IE 685. Systems Safety. 3 credits, 3 contact hours.**
Prerequisites: applied probability/statistics and introductory safety. Safety decision making and systems engineering applications to safety, including planning, managing and conducting system safety programs.

**IE 686. Intro to Healthcare Systems. 3 credits, 3 contact hours.**
This course provides a systems analysis view of healthcare services, combining economic, quality, enterprise data and activity costing perspectives. Operations, processes and activities that characterize the US Healthcare system are introduced. System costs, reimbursement methods and financial aspects in the healthcare. Focus on the application of information technologies and system engineering tools to effectively create and deliver value in the care process. Analytical tools for identifying opportunities for systems efficiency and effectiveness.

**IE 687. Healthcare Enterprise Systems. 3 credits, 3 contact hours.**
Prerequisites: IE 686. Provide a thorough understanding of the role of Healthcare Enterprise Systems in healthcare organizations. A detailed study of electronic health records, computerized physician order entry, and meaningful use standards. Design and implementation of enterprise level healthcare information systems, advanced desicion support tools, and process mapping methods for optimal delivery of cost effective care. Analytical and quantitative methods that can be used to evaluate healthcare business processes, determine data requirements, and plan operating procrdures.

**IE 688. Healthcare Sys Perfor Modeling. 3 credits, 3 contact hours.**
Prerequisites: IE 686. Presents advanced techniques and methods for modeling and evaluating the performance of healthcare systems, including operations research, and productivity analysis, and statistical analysis methods. Introduces the performance dynamics of healthcare systems, identifies key decision variables and formulates their effect on systems performance. Develop and optimize healthcare staffing models. Application of operations research methods to a wide range of healthcare scheduling, facility design and patient flow problems.

**IE 699. Special Topics in Industrial Engineering. 3 credits, 3 contact hours.**
Restriction: approval from the industrial engineering graduate advisor. Special course given when interest in a subject area develops. Advanced notice of topics will be given before registration.

**IE 700. Master'S Project. 0 credits, 0 contact hours.**

**IE 700B. Master'S Project. 3 credits, 3 contact hours.**

**IE 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: matriculation for the master of science degree, thesis advisor's approval, and adequate graduate courses in the field of the proposed thesis. Candidates for the degree who choose this option must submit an acceptable thesis on an approved subject that contributes to the literature of the field, and preferably aids the candidate's present or potential, career. While original research may not always result, the thesis should provide a new conclusion or application. Approval to register for the thesis must be obtained from the thesis advisor. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**IE 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisites: matriculation for the master of science degree, thesis advisor's approval, and adequate graduate courses in the field of the proposed thesis. Candidates for the degree who choose this option must submit an acceptable thesis on an approved subject that contributes to the literature of the field, and preferably aids the candidate's present or potential, career. While original research may not always result, the thesis should provide a new conclusion or application. Approval to register for the thesis must be obtained from the thesis advisor. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**IE 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisites: matriculation for the master of science degree, thesis advisor's approval, and adequate graduate courses in the field of the proposed thesis. Candidates for the degree who choose this option must submit an acceptable thesis on an approved subject that contributes to the literature of the field, and preferably aids the candidate's present or potential, career. While original research may not always result, the thesis should provide a new conclusion or application. Approval to register for the thesis must be obtained from the thesis advisor. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**IE 704. Sequencing and Scheduling. 3 credits, 3 contact hours.**
Prerequisite: IE 650 or equivalent. Advanced sequencing and scheduling for job shops, flow lines, and other general manufacturing and production systems are discussed in this course. Both deterministic and stochastic scheduling models are covered in detail. Heuristics and worst case analysis for unsolvable hard scheduling problems (NP-C problem) are introduced.

**IE 705. Mathematical Programming in Management Science. 3 credits, 3 contact hours.**
Prerequisites: IE 623 and IE 650. An advanced study of various mathematical programming techniques such as linear and non-linear, parametric, integer, stochastic and dynamic programming. Readings and discussions emphasize mathematical advances and applications in operations research.

**IE 706. A Queueing Approach to Performance Analysis. 3 credits, 3 contact hours.**
Prerequisite: IE 644 or equivalent. Newly developed techniques in the area of queueing networks that play a critical role in studying several aspects of discrete event stochastic systems such as FMS, computer-aided communication systems, transportation systems and service systems.

**IE 725. Independent Research. 3 credits, 3 contact hours.**
Prerequisite: approval from the industrial engineering program director. Program of study prescribed and approved by student's advisor. This special course covers areas in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course.

**IE 726. Independent Research II. 3 credits, 3 contact hours.**

**IE 753. Airport Design and Planning. 3 credits, 3 contact hours.**
Prerequisite or corequisite: TRAN 610 or EM 693. Planning of individual airports and statewide airport systems. Functional decision of air and landside facilities. Orientation, number and length of runways. Concepts of airport capacity. Passenger and freight terminal facility requirements. Airport access systems. FAA operating requirements. Financial, safety and security issues. Same as CE 753 and TRAN 753.

**IE 754. Port Design and Planning. 3 credits, 3 contact hours.**
Prerequisite: TRAN 610 or EM 693. Functional design of the water and landsides for general cargo, liquid and dry bulk, and container operations. Yard and storage systems. Port capacity in an intermodal network. Economic, regulatory, and environmental issues. Same as CE 754 and TRAN 754.

**IE 760. Quantitative Methods in Human Factors. 3 credits, 3 contact hours.**
Prerequisite: IE 661. More advanced human factors engineering concepts analyzed quantitatively: systems modeling, control theory, human error, and decision making. Discussion of human factors, research design and data analysis. Operator/computer interaction is also emphasized.

**IE 761. Advanced Studies in Human Factors. 3 credits, 3 contact hours.**
Prerequisite: one year of graduate work in human factors or the equivalent. The course integrates various areas of graduate studies in human factors such as: work physiology, occupational safety, environment and human-machine systems. Detailed discussion of selected current papers covering theoretical review, experimental design, results, applications, and future research. Completion of semester project under instructor's guidance is mandatory.

**IE 762. Psychophysical Methods in Human Factors. 3 credits, 3 contact hours.**
Prerequisite: one year of graduate work in human factors or instructor's approval. This course considers various classical and modern psychophysical methods, signal detection theory, information theory, and human information processing applicable to advanced human factors/occupational safety research measurement and normative modeling.

**IE 790. Doctoral Dissertation. 0 credits, 0 contact hours.**

**IE 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**

**IE 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**

**IE 790C. Doc Dissertation & Res. 6 credits, 3 contact hours.**

**IE 790D. Doc Dissertation & Res. 9 credits, 3 contact hours.**

**IE 790E. Doc Dissertation & Res. 12 credits, 3 contact hours.**

**IE 790F. Doct Dissertation & Res. 15 credits, 0 contact hours.**

**IE 790G. Doctoral Dissertation. 18 credits, 0 contact hours.**

**IE 791. Graduate Seminar. 0 credits, 0 contact hours.**
A seminar in which faculty or others present summaries of advanced topics suitable for research. Discussion of research procedures, thesis organization, and content. Students engaged in research will present their own research for discussion and criticism.

**ME 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Cooperative education internship providing on-the-job reinforcement of academic programs in mechanical engineering. Work assignments and projects are developed by the co-op office in consultation with the mechanical engineering department. Work assignments are related to student's major and are evaluated by faculty coordinators in mechanical engineering. Course cannot be used for mechanical engineering degree credit.

**ME 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Course cannot be used for mechanical engineering degree credit.

**ME 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Course cannot be used for mechanical engineering degree credit.

**ME 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**ME 607. Advanced Thermodynamics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate thermodynamics. Basic laws of thermodynamics are applied to various thermodynamic systems. Topics include: availability, stability requirements, equation of state, property relations, properties of homogeneous mixtures, optimization applied to power generation and refrigeration cycles, and thermodynamic design of system components.

**ME 608. Non-Equilibrium Thermodynamics. 3 credits, 3 contact hours.**
Prerequisites: undergraduate thermodynamics and heat transfer, and ME 616. (May be taken concurrently.) Principles and mathematical techniques of non-equilibrium thermodynamics applied to mechanical engineering problems. Topics include field theory, energy and entropy balances, variational principles, and applications to fluid flow, heat exchangers and combustion.

**ME 609. Dynamics of Compressible Fluids. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, fluid mechanics, and thermodynamics. One-dimensional reversible and irreversible compressible fluid flow, including effects of variable area, friction, mass addition, heat addition, and normal shock; two-dimensional reversible subsonic and supersonic flows, and an introduction to the method of characteristics and two-dimensional oblique shock.

**ME 610. Applied Heat Transfer. 3 credits, 3 contact hours.**
Prerequisites: undegraduate fluid mechanics, thermodynamics, heat transfer and differential equations. Fundamentals of conduction, convection and radiation heat transfer. Practical engineering applications of heat exchangers including the design approaches by Mean Temperature Difference and Effectiveness-NTU methods, fins, convection fouling factors, and variable property analysis.

**ME 611. Dynamics of Incompressible Fluids. 3 credits, 3 contact hours.**
Prerequisites: undergraduate fluid mechanics and ME 616. (May be taken concurrently.) An introduction to the hydrodynamics of ideal fluids; two-dimensional potential flow and stream functions; conformal mapping; and differential equations of viscous flow. Boundary layer theory and dimensional analysis are introduced.

**ME 612. Gas Dynamics. 3 credits, 3 contact hours.**
Prerequisite: ME 616. (May be taken concurrently.) Physical phenomena of gas dynamics and mathematical methods and techniques needed for analysis. Dynamic and thermodynamic relations for common flow situations are described through vector calculus. The nonlinearity of resulting equations and solutions such as numerical analysis, linearization or small perturbation theory, transformation of variables, and successive approximations are discussed. The method of characteristics is reviewed in detail for shock flows.

**ME 613. Radiation Heat Transfer. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, thermodynamics, heat transfer and ME 616. (May be taken concurrently.) Heat radiation of solid bodies, gases and flames; angle factors; radiative properties of electrical conductors and non-conductors; application of radiative networks to multi-body problems; diffuse specular reflectors: artificial satellites and space vehicles; analogy between heat transfer by radiation and electrical networks; and combined conduction and radiation problems.

**ME 614. Continuum Mechanics. 3 credits, 3 contact hours.**
Prerequisites: Undergraduate courses in mechanics, fluid mechanics, solid mechanics, and mathematics (linear algebra, differential equations, and vector calculus) or approval of the instructor. Fundamentals of the mechanics of continuous media. Specific topics include vector and tensor analysis; kinematics associated with finite deformation; the stress tensor; and the conservation laws of mass, linear momentum, angular momentum, and energy. Constitutive equations for linear and non-linear elastic solids and for inviscid and Newtonian fluids are discussed. The role of material invariance under superimposed rigid body motion and material symmetry in the formulation of appropriate constitutive equations are emphasized.

**ME 615. Advanced Mechanical Vibrations. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and system dynamics. One-, Two- and Multiple degree of freedom systems, Lagrange's equation of motion, Runge-Kutta computation, Finite Element Method and classical methods for normal mode analysis, matrix notation and iteration procedure, and Fourier series representation for the solution of vibration problems.

**ME 616. Matrix Methods in Mechanical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate differential equations. Applications of matrix algebra and matrix calculus to engineering analysis; matrix methods in solid and fluid mechanics; vibration, elasticity, viscous fluids, and heat transfer. Matrix theory is used to show the basic unity in engineering analysis.

**ME 618. Selected Topics in Mechanical Engineering. 3 credits, 3 contact hours.**
Prerequisite: departmental approval. Given when interest develops. Topics may include analysis and/or design of energy or mechanical systems of current interest to mechanical engineers.

**ME 619. Nano-scale Characterization of Materials. 3 credits, 3 contact hours.**
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy, near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project.

**ME 620. Stress Methods in Mechanical Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and strength of materials. Governing equations and solutions for analysis and design of structural and machine elements; appropriate boundary conditions to investigate pipes and rods subjected to shrink and force fits; rotating disks of uniform and variable thickness; beam and plate elements; and thermal stresses and stress concentrations in mechanical design.

**ME 621. Energy Methods in Mechanical Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and strength of materials. Use of energy methods to design structural and machine elements. Includes approximate solutions for problems using conservation of energy and several variational approaches; the role of energy in failure criteria; combined loads; and the relationship of variational methods to the development of finite element solutions.

**ME 622. Finite Element Methods in Mechanical Engineering. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and strength of materials. Using variational formulation and Ritz approximation, element equations for bar, beam, potential flow, heat transfer, torsion of a solid bar and plane elasticity problems are derived and solved with computer programs.

**ME 624. Microlevel Modeling in Particle Technology. 3 credits, 3 contact hours.**
Presents methodologies for analyzing the macroscopic properties of particulate systems in terms of the underlying microlevel processes. Significant components are the mathematical modeling of particulate systems at the microlevel, analytical and numerical methods for predicting macroscopic properties from microlevel models, and comparison of theoretical predictions with experimental results. Demonstrates the importance of the interaction of these three components in the scientific process. The first part concerns the flow of dry particles where any interstitial fluid can be ignored. The second part considers the flow of particles suspended in an interstitial fluid. Also includes a class project involving development of simulations. Same as CHE 625.

**ME 625. Introduction to Robotics. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, kinematics and demonstrated competence in computer programming and ME 616. (May be taken concurrently.) Introduction to robotics, and computer-controlled programmable robotic manipulators; robot geometries; kinematics of manipulators; differential motion; work space planning and trajectory control; dynamics; robot sensing, and robot programming.

**ME 628. Machine Vision Principles and Applications. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and demonstrated competence in computer programming. Fundamentals of machine vision as applied to inspection, recognition, and guidance in mechanical and manufacturing processes. Emphasis on real-time machine vision algorithms for machine parts inspection and identification. Topics include lighting and optics, camera selection and calibration, image segmentation, edge detection, feature extraction, and pattern classification.

**ME 630. Analytical Methods in Machine Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, machine design, and ME 616. (May be taken concurrently.) Theory and analytical methods used in machine design. Comparisons are made between approximate and exact engineering methods for evaluation of the range of applicability of solutions. Topics include advanced analysis of threaded members; keyed, splined, and shrink fits when subjected to torque; preloaded bearings; surging, presetting and buckling of coiled springs; and accurate analysis of impact stresses and stresses beyond the yield point.

**ME 631. Bearings and Bearing Lubrication. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, machine design and ME 616. (May be taken concurrently.) The theoretical and physical aspects of lubrication: hydrostatic and hydrodynamic problems. Reynold's differential equation for pressure distribution applied to slider bearing and journal bearing problems with and without end leakage.

**ME 632. Mechanical Engineering Measurements. 3 credits, 3 contact hours.**
This course offers extensive mechanical engineering lab experience, including measurement fundamentals, hands-on experiments, uncertainty analysis, technique comparison, and professional engineering reports. It also focuses on the fundamental principles behind each methodology and relevant applications. The topics cover measurement in major mechanical engineering areas including thermodynamics, thermofluids, and control. Specialized experiments include fluidization, CAD/CAM, and NC machining. Comparisons of experimental results against theoretical or computational results are also required.

**ME 633. Dynamics of Machinery. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and matrix analysis. Consideration of kinematics, constraints and Jacobians, linear and angular momentum and potential energy and conservative forces of mechanical systems. Application of principle of virtual work, D?Alembert's principle, method of virtual power and Lagrange's equation to systems of particles and systems of rigid bodies.

**ME 635. Computer-Aided Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate linear algebra (matrices operation) and differential equations. Adaptation of computer for solving engineering design problems; design morphology; simulation and modeling; algorithms; problem-oriented languages; use of available software; computer graphics, and automated design.

**ME 636. Mechanism Design: Analysis and Synthesis. 3 credits, 3 contact hours.**
Prerequisites: undergraduate kinematics, dynamics and demonstrated competence in computer programming and ME 616. (May be taken concurrently.) Kinematic principles combined with computer-assisted methods for designing mechanisms; complex polar notation; and dynamic and kinetostatic analysis of mechanisms. Kinematic synthesis of planar mechanisms; graphical Burmester theory for plane linkage synthesis; and planar linkage synthesis for function and path generation.

**ME 637. Kinematics of Spatial Mechanisms. 3 credits, 3 contact hours.**
Prerequisites: undergraduate kinematics, dynamics, knowledge of matrices and ME 616. (May be taken concurrently.) Advanced techniques for the dual-number coordinate-transformation matrix modeling to perform the displacement, velocity, static and dynamic force analysis of spatial mechanisms. Applications considered will include shaft couplings, skew four-bars, wobble plates, generalized slider-cranks and robotic manipulators.

**ME 638. Computer-Aided Machining. 3 credits, 3 contact hours.**
Prerequisites: demonstrated competence in computer programming, ME 305, ME 616 and ME 635 or equivalent. Introduction of computer applications to understand integrated computer-aided machining process. Included in the course are the fundamentals of motion control and NC/CNC/DNC machining, part programming and post-processors, and advances in CAM. Student projects are carried out using appropriate manufacturing software.

**ME 641. Refrigeration and Air Conditioning. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, fluid mechanics and thermodynamics. Refrigeration and air conditioning cycles; comfort analysis, psychometric chart analysis, heat and mass transfer steady and transient processes, heating and cooling design loads, energy loads and standards requirements.

**ME 643. Combustion. 3 credits, 3 contact hours.**
Prerequisites: Undergraduate thermodynamics & fluid mechanics. Chemical & physical process of combustion: ideal combustion, actual combustion, mass balance, energy of reaction, maximum adiabatic combustion temperature, chemical equilibrium, heating values of fuels, combustion in furnaces, internal combustion engines & other heat engines, with emphasis on the analysis & control of the products of combustion in light of environmental considerations.

**ME 644. Building Environmental Control Principles. 3 credits, 3 contact hours.**
Prerequisites: undergraduate thermodynamics, fluid mechanics, heat transfer and differential equations. Control systems for buildings including control of temperature, moisture and air quality. Optimization of systems for control of building energy use. Modern microprocessor-based control systems, including direct digital control, proportional and integral controllers, predictive control, adaptive control, optimum start controllers and optimal control.

**ME 653. Control of Electro-Mechanical Networks. 3 credits, 3 contact hours.**
Prerequisites: undergraduate electrical circuits and mechanical vibrations or equivalent. Electro-mechanical systems; control loops; use of mechanical networks in dynamic systems; and stability and response to various inputs in electro-mechanical networks.

**ME 655. Introduction to Modern Control Methods. 3 credits, 3 contact hours.**
Prerequisites: undergraduate system dynamics and automatic controls. Introduction to modern control methods applied to mechanical and manufacturing systems. Topics include state variable feedback, observer theory, nonlinear control, optimal control, and adaptive control for both continuous and discrete systems.

**ME 660. Noise Control. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and physics. Engineering methods for reducing noise pollution; reduction of intensity at the source; limitation of transmission paths and absorption; application to structures, machinery, ground transportation, aircraft, and noise measurement.

**ME 670. Introduction to Biomechanical Engineering. 3 credits, 3 contact hours.**
Prerequisites: undergraduate thermodynamics, statics, and dynamics. Introduction to biomechanical engineering of physiological systems; fluid flow, structural, motion, transport, and material aspects; energy balance of the body, and the overall interaction of the body with the environment.

**ME 671. Biomechanics of Human Structure and Motion. 3 credits, 3 contact hours.**
Prerequisites: undergraduate statics, kinematics, and dynamics. Principles of engineering mechanics and materials science applied to human structural and kinematic systems and to the design of prosthetic devices. Topics include anatomy; human force systems; human motion; bioengineering materials; and design of implants, supports, braces, and replacements limbs.

**ME 675. Mechanics of Fiber Composites. 3 credits, 3 contact hours.**
Prerequisites: ME 315 (see undergraduate catalog for course description) and demonstrated competence in computer programming. Introduces various design problems using fiber composites. Analysis of general fiber composite laminate and short fiber composites, fracture mechanics, fatigue, creep and viscoelasticity, thermal stresses, special layups and associated optimization problems.

**ME 676. Applied Plasticity. 3 credits, 3 contact hours.**
Prerequisite: ME 620 or equivalent. Fundamentals of plasticity applied to mechanical and manufacturing engineering problems. Topics include elastic-plastic analysis for beams, rings and plates. Plastic instability and slip-line fields are considered.

**ME 678. Engineering Design of Plastic Products. 3 credits, 3 contact hours.**
Prerequisite: Knowledge of Pro/Engineer (or IDEAS). Structure and properties of plastics including stress-strain behavior and the effect of fillers and reinforcements. Designing for impact, flexure, shear, friction, puncture, creep and fatigue. Case studies of structural, electrical, and optical applications.

**ME 679. Polymer Processing Techniques. 3 credits, 3 contact hours.**
Prerequisites: undergraduate courses in fluid dynamics and heat transfer. Techniques for processing of plastics: extrusion, injection molding, compression molding, thermoforming, casting.

**ME 680. Polymer Processing Equipment. 3 credits, 3 contact hours.**
Prerequisites: CHE 645 or equivalent and undergraduate heat transfer. Application of heat transfer, fluid mechanics, and thermodynamics to the design and control of polymer processing equipment. Detailed consideration of extrusion, collandering, rotational molding, stamping, and injection molding.

**ME 700. Master'S Project. 0 credits, 0 contact hours.**
Prerequisite: department approval. An extensive paper involving design, construction, and analysis, or theoretical investigation. Further information may be obtained from the graduate advisor.

**ME 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: department approval. An extensive paper involving design, construction, and analysis, or theoretical investigation. Further information may be obtained from the graduate advisor.

**ME 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: department approval. Projects involving design, construction, experimental, or theoretical investigation carried out under the supervision of a designated member of the mechanical engineering faculty. The completed written thesis must be defended in a publicly announced oral defense. A student must register for a minimum of 3 credits per semester until completion, although degree credit will be limited to the 6 credits indicated for the thesis.

**ME 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: department approval. Projects involving design, construction, experimental, or theoretical investigation carried out under the supervision of a designated member of the mechanical engineering faculty. The completed written thesis must be defended in a publicly announced oral defense. A student must register for a minimum of 3 credits per semester until completion, although degree credit will be limited to the 6 credits indicated for the thesis.

**ME 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: department approval. Projects involving design, construction, experimental, or theoretical investigation carried out under the supervision of a designated member of the mechanical engineering faculty. The completed written thesis must be defended in a publicly announced oral defense. A student must register for a minimum of 3 credits per semester until completion, although degree credit will be limited to the 6 credits indicated for the thesis.

**ME 710. Conduction Heat Transfer. 3 credits, 3 contact hours.**
Prerequisite: ME 610 and ME 616 or equivalent. Heat transfer by conduction: differential and integral forms of the energy equation for isotropic and anisotropic material. Analytical and numerical studies of transient and steady one-, two-, and three-dimensional heat transfer problems for a variety of boundary conditions including phase change. In addition, variational and boundary element methods are applied to heat conduction problems.

**ME 711. Convection Heat Transfer. 3 credits, 3 contact hours.**
Prerequisites: ME 610 and ME 616 or equivalent. Development of convective heat transfer theory: currently available methods, analytical and numerical, for predicting heat rates in forced, natural, and mixed convection in laminar and turbulent flow regimes are thoroughly studied. Studied techniques are applied to the thermal design of complex systems.

**ME 712. Mechanics of Viscous Fluids. 3 credits, 3 contact hours.**
Prerequisite: ME 611 and ME 616. (May be taken concurrently.) Properties and behavior of real fluids in laminar and turbulent motion. Review of tensor analysis; current mathematical and empirical laws and methods; flows in ducts; exact solutions of Navier-Stokes equations; boundary layers over surfaces and flow past bodies.

**ME 713. Non-Newtonian Fluid Dynamics. 3 credits, 3 contact hours.**
Prerequisite: ME 611, ME616. Review of Newtonian fluid mechanics. Time dependent response and transport properties of non-Newtonian fluids in simple shear and extensional flows. Experimental techniques for measuring dynamic response and transport properties. Continuum and micromechanical constitutive models; solutions of constitutive equations.

**ME 714. Principles of Particulate Multiphase Flows. 3 credits, 3 contact hours.**
Prerequisite: Courses in fluid mechanics or approval of the instructor. This course provides an introduction to the fundamental principles of mass, momentum and heat transfer in particulate multiphase flows. Theories and governing equations for distinctive responses and motions of each phase and the dynamic interactions among phases are formulated. Typical industrial applications will be illustrated.

**ME 717. Selected Topics in Mechanical Engineering I. 3 credits, 3 contact hours.**
Prerequisite: department approval. Given when interest develops. Topics may include advanced mechanisms, aerodynamics, analysis of ME systems, design optimization, and case studies in design.

**ME 718. ST:. 3 credits, 3 contact hours.**

**ME 721. Thermal Stresses. 3 credits, 3 contact hours.**
Prerequisites: vector analysis or ME 616 or equivalent and theory of elasticity or ME 785. Thermoelasticity; reduction of thermoelastic problems to constant temperature equivalents; fundamentals of heat transfer; and elastic and inelastic stress analysis.

**ME 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisites: written permission from department chairperson plus prerequisite courses prescribed by a supervising faculty member. Areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering. A maximum of two independent studies courses may be applied to a degree.

**ME 726. Independent Study II. 3 credits, 3 contact hours.**
Prerequisites: written permission from department chairperson plus prerequisite courses prescribed by a supervising faculty member. Areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering. A maximum of two independent studies courses may be applied to a degree.

**ME 727. Independent Study III. 3 credits, 3 contact hours.**
Prerequisites: written permission from department chairperson plus prerequisite courses prescribed by a supervising faculty member. Areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering. A maximum of two independent studies courses may be applied to a degree.

**ME 735. Advanced Topics in Robotics. 3 credits, 3 contact hours.**
Prerequisite: ME 625. Introduction to advanced topics and techniques in robotics. Subjects covered include differential kinematics, calibration and accuracy, trajectory control, and compliant motion control as well as an in-depth treatment of topics discussed in ME 625.

**ME 736. Advanced Mechanism Design. 3 credits, 3 contact hours.**
Prerequisite: ME 636 and ME 616. Advanced methods for the synthesis of mechanisms. Topics include synthesis of planar mechanisms for three, four and five positions, multiloop linages, change of branch and order problems, and optimal synthesis of mechanisms. Synthesis of linkages for special types of motion including straight line motion, cusp points on coupler curves and adjustable mechanisms.

**ME 738. Computer Aided Engineering. 3 credits, 3 contact hours.**
Prerequisites: ME 635. This course covers advanced CAD and CAE tools for visual computing simulation and analysis. Topics include modeling, assembly, CAD data exchange by exporting and importing various CAD model formats, computer simulation and analysis of structure, thermal, fluid and animation of the results of analysis. Multi-physics analyses such as thermal-structure, electric-thermal-structure in MEMS and fluid-structure interactions are studied. The laboratory component involves use of most current commercial CAD/CAE software packages.

**ME 752. Design of Plates and Shells. 3 credits, 3 contact hours.**
Prerequisites: ME 616 or equivalent and ME 620. A study of plates and shells. Mechanical engineering design solutions for typical loading and boundary conditions through analytical and numerical methods. Plate and shell interfaces and vibration are also considered.

**ME 754. Pressure Vessel Design. 3 credits, 3 contact hours.**
Prerequisites: ME 616 or equivalent and ME 620. Theories in designing pressure vessels; analysis of circular plates; cylindrical and spherical shells; pressure vessel heads; pipe bends; and attachments. Consideration is also given to pressure vessel materials in fatigue and creep designs.

**ME 755. Adaptive Control Systems. 3 credits, 3 contact hours.**
Prerequisite: ME 655. Theory and application of self-tuning and model reference adaptive control for continuous and discrete-time deterministic systems. Topics include model-based methods for estimation and control, stability of nonlinear systems and adaptive laws. Applications of adaptive control in mechanical systems and manufacturing processes.

**ME 785. Theory of Deformable Solids in Mechanical Engineering I. 3 credits, 3 contact hours.**
Prerequisites: ME 616 or equivalent and ME 620. Measure of strain; strain tensor; stress tensor; equilibrium equations; constitutive relations; compatibility conditions; conditions for and formulation of three-dimensional problems; and the relationship of engineering theories for beams, plates, and shells to the equations of elasticity.

**ME 786. Theory of Deformable Solids in Mechanical Engineering II. 3 credits, 3 contact hours.**
Prerequisite: ME 785. Solutions for problems formulated in ME 785 eigenfunction solutions; operational methods; complex variables theory; three-dimensional problems; contact problems; wave propagation; and non-linear problems.

**ME 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Required of all students working toward the Doctor of Philosophy in Mechanical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached and for 3 credits each semester thereafter.

**ME 790A. Doc Dissertation & Res. 1 credit, 1 contact hour.**

**ME 790B. Doc Dissertation & Res. 3 credits, 3 contact hours.**

**ME 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**ME 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**ME 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**ME 790F. Doctoral Diss & Research. 15 credits, 3 contact hours.**

**ME 790G. Doctoral Dissertation. 18 credits, 3 contact hours.**

**ME 791. Graduate Seminar and Professional Presentations. 0 credits, 0 contact hours.**
Regular attendance required of all students in the Mechanical Engineering PhD program. Each PhD student is required to make a 15 minute presentation on a topic related to the student's research with an additional 10 minutes to address audience questions. The seminar participants eveluate each speaker.

**ME 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**ME 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.**

**ME 792D. Pre Doctoral Research. 9 credits, 3 contact hours.**

**ME 794. Mechanical Engineering Colloquium. 0 credits, 1 contact hour.**
Prerequisite: graduate standing and major in mechanical engineering. National and international experts in mechanical engineering discuss their recent research. Required of all students enrolled in mechanical engineering graduate degree programs. Students must register in this course for at least two semesters and attend at least four lectures in each semester. All doctoral students and students with assistantships must register in this course each semester and attend regularly.

**MECH 630. Theory of Elasticity. 3 credits, 3 contact hours.**
Prerequisite: differential equations. Theory of elasticity as basis for both advanced stress analysis and for a critical examination of elementary stress analysis.

**MNE 601. Computerized Manufacturing Systems. 3 credits, 3 contact hours.**
Development of automated manufacturing systems with applications including Industrial Robotics, Programmable Logic Controller, Lean Manufacturing and other artificial intelligence technologies. Laboratory experimentation using hardware and software necessary for various industrial robots & PLC systems in the automotive assemble; pharmaceutical and chemical industries are included.

**MNE 602. Flexible and Computer Integrated Manufacturing. 3 credits, 3 contact hours.**
Prerequisites: MNE 601. Flexible manufacturing systems are developed including Robotic applications, PLC & CNC programming as automated inspection and transportation systems. Laboratory experience with hardware and software needed for various industrial robots & other automated systems are included.

**MNE 654. Design for Manufacturability. 3 credits, 3 contact hours.**
Prerequisite: MNE 601 or instructor's approval. Methodologies used in the synthesis and analysis of product design to optimize manufacturability. The relationship of design to production processes, product material, material handling, quality costs, and CAD/CAM are presented. Emphasis is on both formed products and assembled products. Simulation and other design analysis tools are employed.

**MNE 655. Concurrent Engineering. 3 credits, 3 contact hours.**
Concurrent/simultaneous engineering methods and tools such as system analysis, system modelling and system integration, market oriented, integrated design for manufacturing, assembly, quality and maintenance, product design analysis, integrated product design and manufacturing innovation methods, QFD (Quality Function Deployment) ? applied to concurrent engineering, FMEA (Failure Mode and Effect Analysis), POKA-YOKE, KANZEI, waste reduction, quality circles, rapid prototyping of designed objects and various other advanced processing methods.

**MNE 700. Master'S Project. 0 credits, 0 contact hours.**
An interdisciplinary team project performed in collaboration with industry. The project must reflect proficiency in the student's selected area of specialization.

**MNE 701. Master'S Thesis. 0 credits, 0 contact hours.**
In special cases, a thesis based on an important industrial problem will be substituted for the master's project. Research for the thesis should be performed with industrial sponsorship and collaboration.

**MNE 725. Independent Study. 3 credits, 3 contact hours.**
Prerequisites: written permission from the director of manufacturing systems engineering programs, and courses prescribed by the supervising faculty member. Areas of study in manufacturing computer systems analysis and design in which one or more students may be interested, but that are not of sufficiently broad interest to warrant a regular course offering.

**MNE 791. Seminar In Manufact Engr. 1 credit, 1 contact hour.**
A series of invited speakers, primarily from industry, will discuss current manufacturing problems and methods. Attendance at these seminars is required for all students enrolled in the manufacturing systems engineering program.

**PHB 505. Principles of Pharm. Microbiology and Biochemistry. 3 credits, 3 contact hours.**
Prerequisites: Graduate standing. This course covers major concepts of cell biology including cell physiology and structure, molecular biology, and genetics. Cellular chemistry, life cycles, and regulation are discussed as well as the fundamentals of biochemistry related to physical organic chemistry, including buffers, blood proteins, enzymes, carbohydrates, fats, and nucleic acids. This is a required course for PHB students with no or limited knowledge of biology.

**PHB 590. Graduate Co-op Work Experience I. 3 credits, 0 contact hours.**
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Cooperative education internship provides on-the-job reinforcement of the academic program by placement in major-related work situations at pharmaceutical companies or companies serving the pharmaceutical industry. Work assignment developed or approved by the co-op office and evaluated by the department. Cannot be used for degree credit.

**PHB 591. Graduate Co-op Work Experience II. 3 credits, 0 contact hours.**
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Same range of activities as in PHB 590. Cannot be used for degree credit.

**PHB 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Same range of activities as in PHB 590 and PHB 591. Cannot be used for degree credit.

**PHB 593. Graduate Co-op Work Experience IV. 0 credits, 3 contact hours.**
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Same range of activities as in PHB 590, PHB 591 and PHB 592. Cannot be used for degree credit.

**PHB 610. Biotechnology-Biopharmaceutical, Processes and Products. 3 credits, 3 contact hours.**
Prerequisites: PHB 505, if required and PHEN 601. This course covers biological processes used in the pharmaceutical and biotechnology industry to obtain pharmaceutical products, including biochemical processes for antibiotic production and peptide extraction, and biopharmaceutical process to obtain recombinant proteins, monoclonal antibodies, cytokines, hormone and blood products, therapeutic enzymes, antibodies, vaccines, and nucleic acid therapeutics.

**PHB 615. Bioseparation Processes. 3 credits, 3 contact hours.**
Prerequisites: If required, PHEN 500, PHEN 501, PHEN 502 and PHB 505 and PHEN 601. This course covers the principles, methods and unit operations for the separation and recovery of biologically obtained molecules and especially proteins. Also studied here is the relationship between the chemistry of biological molecules and efficient separation and preservation of biological activity, with special emphasis on separation of biomolecules.

**PHB 630. Pharmaceutical Bioprocess Engineering. 3 credits, 3 contact hours.**
Prerequisites: If required, PHEN 500, PHEN 501, PHEN 502 and PHB 505; PHEN 601. This course covers the principles and methods to develop and operate bioprocess engineering systems, with emphasis on pharmaceutical bioprocessing and the use of chemical engineering principles to obtain products of therapeutic values. Topics include cell line selection, cell growth kinetics, substrate utilization, product formation, transport phenomena in biosystems, and bioreactors.

**PHB 698. Special Topics in Pharmaceutical Bioprocessing I. 3 credits, 3 contact hours.**
Prerequisites: Graduate standing and permission of the instructor. Topics of current interest in Pharmaceutical Bioprocessing.

**PHB 699. Special Topics in Pharmaceutical Bioprocessing II. 3 credits, 3 contact hours.**
Prerequisites: Graduate standing and permission of the instructor. Topics of current interest in Pharmaceutical Bioprocessing.

**PHB 701. Master's Thesis. 0 credits, 0 contact hours.**

**PHB 701B. Master's Thesis. 3 credits, 3 contact hours.**
Prerequisites: Matriculation in the MS program in PHB and approval of PHB Program Advisor. Original research under the guidance of a Thesis Advisor. A written thesis must be approved by a three-member Thesis Committee including the primary advisor and at least one member of the CBPE faculty. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHB 701C. Master's Thesis. 6 credits, 0 contact hours.**
Prerequisites: Matriculation in the MS program in PHB and approval of PHB Program Advisor. Original research under the guidance of a Thesis Advisor. A written thesis must be approved by a three-member Thesis Committee including the primary advisor and at least one member of the CBPE faculty. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHB 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisites: Permission from the Program Advisor in PhB (not the Thesis Advisor), as well as completion of courses prescribed by a supervising faculty member (who cannot be the student's Thesis Advisor). This special course covers areas of study in which one or more students may be interested, but which is not of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**PHB 726. Independent Study II. 3 credits, 3 contact hours.**
Prerequisites: Permission from the Program Advisor in PhB (not the Thesis Advisor), as well as completion of courses prescribed by a supervising faculty member (who cannot be the student's Thesis Advisor). This special course covers areas of study in which one or more students may be interested, but which is not of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**PHB 791. Graduate Seminar. 0 credits, 0 contact hours.**
Prerequisites: Graduate standing. Required, when offered, of all PHB graduate students receiving departmental or research-based awards. The student must register each semester until completion of the degree, if the Graduate Seminar is offered. Outside speakers and department members present their research for general discussion.

**PHEN 500. Pharmaceutical Engineering Fundamentals I. 3 credits, 3 contact hours.**
Prerequisite: undergraduate calculus. This is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree. This course is not counted toward degree credit related to the Pharmaceutical Engineering MS program. The course covers the fundamentals of calculus, differential equations, probability and statistics, and finance business mathematics applied to pharmaceutical engineering problems and illustrated through pharmaceutical engineering examples.

**PHEN 501. Pharmaceutical Engineering Fundamentals II. 3 credits, 3 contact hours.**
Prerequisite: If needed, PHEN 500 (which can also be taken concurrently with this course), as well as an undergraduate course in physical chemistry. This course is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree or with an engineering background that did not include the topics covered in this course. The course is not counted toward degree credit related to the Pharmaceutical Engineering MS program. The course covers the fundamentals of pharmaceutical engineering calculations related to material and energy balances applied to pharmaceutical facilities and systems; estimation of thermophysical properties, phase and reaction equilibrium; and chemical kinetics and basic reactor design.

**PHEN 502. Pharmaceutical Engineering Fundamentals III. 3 credits, 3 contact hours.**
Prerequisite:If needed, PHEN 500 and PHEN 501, as well as undergraduate course in physical chemistry. This is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree or with an engineering background that did not include the topics covered in this course. The course is not counted toward degree credit related to the Pharmaceutical Engineering MS program. The course covers the fundamentals of fluid mechanics, heat transfer, mass transfer and the design of unit operations involving these principles.

**PHEN 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisite: permission from Pharmaceutical Engineering Program Advisor and Division of Career Development Services. Cooperative education internship provides on-the-job reinforcement of the academic program by placement in major-related work situations at pharmaceutical companies or companies serving the pharmaceutical industry. Work assignment developed or approved by the co-op office and evaluated by the department. Cannot be used for degree credit.

**PHEN 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisite: permission from Pharmaceutical Engineering Program Advisor and Division of Career Development Services. Same range of activities as in PHEN 590.

**PHEN 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisite: permission from Pharmaceutical Engineering Program Advisor and Division of Career Development Services. Same range of activities as in PHEN 590 and PHEN 591.

**PHEN 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**PHEN 601. Principles of Pharmaceutical Engineering. 3 credits, 3 contact hours.**
This course provides an overview of the pharmaceutical industry, including basic information about drug discovery and development, FDA requirements and approval processes, drug dosage forms, and the role of key operational units in drug manufacturing processes. This course enables the students to: understand the role of the pharmaceutical industry in the global market and its implications; learn the fundamentals of the drug development cycle and the investment required to bring a drug to market; learn the most important drug manufacturing processes and the key elements of dosage formulation.

**PHEN 602. Pharmaceutical Facility Design. 3 credits, 3 contact hours.**
Prerequisite: PHEN 601, PHEN 603; undergraduate courses in differential equations and fluid flow or completion of bridge program for students who are required to take it. This course provides instruction in design of state-of-the art pharmaceutical facilities for both manufacturing and R&D, by identifying key functional requirements and design concepts necessary to pharmaceutical processes. Interdisciplinary training will be provided in appropriate areas of facility design.

**PHEN 603. Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems. 3 credits, 3 contact hours.**
This course examines methodologies, both applied and fundamental, to analyze and scale up manufacturing pharmaceutical processes involving liquid and dispersed-phase systems, such as liquid and multiphase mixing, sterilization and sanitation, lyophilization, filtration, centrifugation and others. The emphasis is primarily on the engineering aspects of the parmaceutical processes examined in the course.

**PHEN 604. Validation and Regulatory Issues in the Pharmaceutical Industry. 3 credits, 3 contact hours.**
This course is focused on the development of a working knowledge of the Federal Code of Regulations and its impact on the pharmaceutical and allied industries. The history of the Federal Government's regulation of the pharmaceutical industry is studied. Also covered is the industry's response and the methodologies it uses to comply with these regulations.

**PHEN 605. Pharmaceutical Packaging Technology. 3 credits, 3 contact hours.**
Prerequisite: PHEN 601, PHEN 603, and completion of the bridge program for students who are required to take it. This course focuses on developing a working knowledge of the machinery and unit operations used in transferring a drug substance in the bulk final form to a finished product ready for sale to the consuming public. Packaging of both liquid and solid forms in various types of delivery containers such as vials/ampoules, blister packs, individual packets, bottles, pouches and syringes is examined. The cleaning, sterilization and scaling/capping required for each dosage form is discussed, as well as freeze-drying, tableting capsule filling, and form/fill/seal, and proper labeling of final drug forms.

**PHEN 606. Pharmaceutical Unit Operations: Solids Processing. 3 credits, 3 contact hours.**
This course examines methodologies, both applied and fundamental, to analyze and scale up manufacturing pharmaceutical processes involving solids processing, such as solids characterization, blending, milling, granulation, tableting, coating, and others. The emphasis is primarily on the engineering aspects of the pharmaceutical processes examined in the course.

**PHEN 612. Pharmaceutical Reaction Engineering. 3 credits, 3 contact hours.**
Prerequisite: PHEN 601, PHEN 603; undergraduate courses in differential equations and chemical engineering kinetics, or completion of bridge program for students who are required to take it. This course examines a variety of reactions and reactors typically encountered in the pharmaceutical industry, including single/multiphase systems (e.g., crystallization), chemical synthesis, enzymatic, bio-reactions (fermentation), and others. The course then focuses on quantitative pharmaceutical reactor design and scale-up issues.

**PHEN 614. Pharmaceutical Separation Processes. 3 credits, 3 contact hours.**
This course covers separation processes in general and pharmaceutical separations in particular. Specific processes to be studied include distillation, extraction, crystallization, adsorption, ion exchange, chromatography, moving bed processes, electrophoresis, freeze drying, microfiltration/ultrafiltration, reverse osmosis, and pervaporation.

**PHEN 618. Principles of Pharmacokinetics and Drug Delivery. 3 credits, 3 contact hours.**
The course covers the basic principles of pharmacokinetics, including drug transport, parenteral and enteral routes of drug administration, and factors affecting drug absorption, distribution, metabolism, and excretion. Mathematical pharmacokinetic models and drug delivery processes are also presented and quantitatively studied.

**PHEN 698. Special Topics in Pharmaceutical Engineering I. 3 credits, 3 contact hours.**
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

**PHEN 699. Special Topics in Pharmaceutical Engineering II. 3 credits, 3 contact hours.**
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

**PHEN 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the Master's degree in pharmaceutical engineering. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the pharmaceutical engineering faculty, and one other faculty member. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHEN 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: matriculation for the Master's degree in pharmaceutical engineering. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the pharmaceutical engineering faculty, and one other faculty member. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHEN 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: matriculation for the Master's degree in pharmaceutical engineering. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the pharmaceutical engineering faculty, and one other faculty member. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHEN 702. Selected Topics in Pharmaceutical Engineering. 3 credits, 3 contact hours.**
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

**PHEN 725. Independent Study. 3 credits, 3 contact hours.**
Prerequisites: permission from the graduate advisor (not the thesis advisor) in pharmaceutical engineering, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which is not of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**PHEN 791. Graduate Seminar. 0 credits, 0 contact hours.**
Required, when offered, of all pharmaceutical engineering graduate students receiving departmental or research-based awards. The student must register each semester until completion of the degree, if the Graduate Seminar is offered. Outside speakers and department members present their research for general discussion.

**TRAN 552. Geometric Design of Transportation Facilities. 3 credits, 3 contact hours.**
Prerequisite: CE 350 or equivalent. Design principles and criteria related to highways and railroads resulting from requirements of safety, vehicle performance, driver behavior, topography, traffic, design, speed, and levels of service. Elements of the horizontal and vertical alignments and facility cross-section, and their coordination in the design. Computer-aided design procedures including COGO, CADAM, Digital Terrain Modeling. Same as CE 552.

**TRAN 553. Design and Construction of Asphalt Pavements. 3 credits, 3 contact hours.**
Importance of designing asphalt pavements. Topics include the origin of crude, refining crude, types of asphalts, desired properties of asphalt cement, specification and tests for asphalt cement, aggregates for asphalt mixtures, aggregate analysis, gradation and blending, hot-mix asphalt (HMA) mix design, manufacture of HMA and HMA-paving, hot and cold recycling. Same as CE 553.

**TRAN 592. Graduate Co-op Work Experience. 3 credits, 3 contact hours.**
Prerequisites: permission from Transportation Program and Division of Career Development Services. Work assignments and projects are developed by the co-op office in consultation with the transportation program. Work assignments are related to student's major and are evaluated by Transportation Program faculty coordinators. Credits for this course may not be used to fulfill any transportation degree requirements.

**TRAN 602. Geographic Information Systems. 3 credits, 3 contact hours.**
Prerequisite: course or working knowledge of CADD or permission of instructor. Geographical/Land Information System (GIS/LIS) is a computerized system capable of storing, manipulating and using spatial data describing location and significant properties of the earth's surface. GIS is an interdisciplinary technology used for studying and managing land uses, land resource assessment, environmental monitoring and hazard/toxic waste control, etc. Introduces emerging technology and its applications. Same as CE 602.

**TRAN 603. Introduction to Urban Transportation Planning. 3 credits, 3 contact hours.**
Urban travel patterns and trends; community and land activity related to transportation study techniques including survey methods, network analysis, assignment and distribution techniques. Case studies of statewide and urban areas are examined. Same as CE 603.

**TRAN 608. Behavioral Issues in Transportation Studies. 3 credits, 3 contact hours.**
Behavioral science concepts and principles such as perception, learning, motivation, and information processing as they relate to: transportation, consumer use of mass transit, automobiles, ridesharing and intelligent transportation systems. Same as HRM 608.

**TRAN 610. Transportation Economics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in economics. Principles of engineering economy. Cost of highway and public transportation facilities. Economic comparisons and evaluations. Financing approaches, tax allocation theory. Programming highway and public transit improvements. Same as IE 610.

**TRAN 615. Traffic Studies and Capacity. 3 credits, 3 contact hours.**
Prerequisite: elementary probability and statistics. Presentation of the characteristics of the traffic stream, road users, and of vehicles, and a review of traffic flow relationships. Students are exposed to the principal methodologies followed by transportation practices to perform volume, speed, travel time, delay, accident, parking, pedestrian, transit and goods movement studies. Presentation of the principal methodologies used to perform transportation facility capacity analyses for: basic freeway sections, weaving areas, ramps and ramp junctions, multi-lane and two lane roadways, signalized and unsignalized intersections. Students get hands on experience using highway capacity software (HCS) and SIDRA. Same as CE 660.

**TRAN 625. Public Transportation Operations and Technology. 3 credits, 3 contact hours.**
Prerequisite: graduate standing in civil or industrial engineering or instructor approval. Presentation of the technological and engineering aspects of public transportation systems. Historical development of public transportation technologies. Vehicle and right-of-way characteristics, capacity and operating strategies. Public transportation system performance. Advanced public transportation systems. Same as CE 625.

**TRAN 640. Distribution Logistics. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or TRAN 650 or equivalent. Distribution logistics emphasizing systems engineering techniques used to optimize corporate profit and customer service: transportation modes; inventory policies; warehousing and order processing; and the best logistics gross margin. Same as EM 640.

**TRAN 643. Transportation Finance. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in economics. Balance sheets and income statements. Asset and liability management, sources and costs of debt and equity financing. Financial performance measures in the private sector (airlines, railroads, trucking and bus companies). Financing issues associated with the public sector (highways and mass transit). Equity and efficiency in pricing. Subsidy allocation formulae. Innovative financing schemes in the public sector. Same as IE 643.

**TRAN 650. Urban Systems Engineering. 3 credits, 3 contact hours.**
Prerequisite: computer programming background. Identifies the various urban problems subject to engineering analysis, and modern techniques for their solution, including inductive and deductive mathematical methods, mathematical modeling and simulation, and decision making under uncertainty. Same as CE 650.

**TRAN 653. Traffic Safety. 3 credits, 3 contact hours.**
Prerequisite: TRAN 615 or equivalent. System behavioral principles are applied to safety aspects of highway operation and design, and improvements of existing facilities. Solutions are evaluated on the basis of cost effectiveness. Same as CE 653.

**TRAN 655. Land Use Planning. 3 credits, 3 contact hours.**
Spatial relations of human behavior patterns to land use; methods of employment and population studies are evaluated; location and spatial requirements as related to land use plans; and concepts of urban renewal and recreational planning are investigated by case studies. Same as CE 655 and MIP 655.

**TRAN 659. Flexible and Rigid Pavements. 3 credits, 3 contact hours.**
Prerequisite: CE 341 or equivalent. Types of rigid (Portland cement) and flexible (bituminous pavements). Properties of materials, including mineral aggregates. Design methods as functions of traffic load and expected life. Importance and consequences of construction methods. Maintenance and rehabilitation of deteriorated pavements. Same as CE 659.

**TRAN 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: written approval of project advisor. An independent project demonstrating the student's professional competence in an area of specialization. Oral examination and written report required.

**TRAN 700B. Master'S Project. 3 credits, 3 contact hours.**

**TRAN 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: written approval of thesis advisor. A comprehensive project, usually in the form of substantial study and analysis, a functional design project or control-operations systems study.

**TRAN 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: written approval of thesis advisor. A comprehensive project, usually in the form of substantial study and analysis, a functional design project or control-operations systems study.

**TRAN 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: written approval of thesis advisor. A comprehensive project, usually in the form of substantial study and analysis, a functional design project or control-operations systems study.

**TRAN 702. Selected Topics in Transportation. 3 credits, 3 contact hours.**
Prerequisite: advisor's approval. Topics of special or current interest.

**TRAN 705. Mass Transportation Systems. 3 credits, 3 contact hours.**
Prerequisite: TRAN 610 or IE 610. Investigation of bus, rapid transit, commuter railroad, and airplane transportation systems. Existing equipment, economics, capacity, and terminal characteristics are discussed, as well as new systems and concepts. Long- and short-range transportation systems are compared. Same as CE 705.

**TRAN 720. Discrete Choice Modeling for Travel Demand Forecasting. 3 credits, 3 contact hours.**
Prerequisite: TRAN 610 or equivalent. Discrete choice modeling describes a class of theoretical and analytical models essential for most advanced planning and forecasting efforts in transportation analysis. Includes logit, multi-nominal, and probit models. Develops theoretical and analytical skills needed to design, estimate and apply both revealed and stated preference models to appropriate travel demand forecasting problems.

**TRAN 725. Independent Study. 3 credits, 3 contact hours.**

**TRAN 726. Independent Study II. 3 credits, 3 contact hours.**

**TRAN 752. Traffic Control. 3 credits, 3 contact hours.**
Traffic laws and ordinances; regulatory measures; traffic control devices; markings, signs and signals; timing of isolated signals; timing and coordination of arterial signal systems; operational controls; flow, speed, parking; principles of transportation system management/ administration; highway lighting; and state-of-the-art surveillance and detection devices and techniques. Hands-on experience with TRAF/NETSIM and FREESIM. Same as CE 752.

**TRAN 753. Airport Design and Planning. 3 credits, 3 contact hours.**
Prerequisites or corequisites: TRAN 610 or EM 693 and TRAN 615. Planning of individual airports and statewide airport systems. Functional design of air and landside facilities. Orientation, number and length of runways. Concepts of airport capacity. Passenger and freight terminal facility requirements. Airport access systems. FAA operating requirements. Financial, safety and security issues. Same as CE 753 and IE 753.

**TRAN 754. Port Design and Planning. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or EM 693 and TRAN 615. Functional design of the water and landsides for general cargo, liquid and dry bulk, and container operations. Yard and storage systems. Port capacity in an intermodal network. Economic, regulatory, and environmental issues. Same as CE 754 and IE 754.

**TRAN 755. Intelligent Transportation Systems. 3 credits, 3 contact hours.**
Prerequisite: TRAN 752. Techniques used to improve the safety, efficiency and control of surface transportation systems. Emphasis on technological and operational issues of these systems and using them for incident detection and for traffic management through route and mode diversion.

**TRAN 760. Urban Trans Networks. 3 credits, 3 contact hours.**
Prerequisites: elementary probability and statistics and TRAN 650 or equivalent. Provides analytical techniques for the analysis of transportation problems in an urban environment. Principal components include applications of models for the analysis of transportation problems, advanced static, dynamic, and stochastic traffic assignment procedures and transportation network design exact and heuristic solution algorithms. Offers hands-on experience with existing software in traffic assignment and transportation network design.

**TRAN 765. Multi-modal Freight Transportation Systems Analysis. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or equivalent and TRAN 650 or EM 602 or equivalent. Quantitative methods for the analysis and planning of freight transportation services. The supply-performance-demand paradigm for freight transportation systems. Cost and performance as determined by system design and operations. Relationship of traffic and revenue to service levels and pricing. Optimal service design and redesign for transportation enterprises and operations planning. Fleet and facility investment planning. Applications to various modes. Same as EM 765 and CE 765.

**TRAN 790. Doctoral Dissertation. 0 credits, 0 contact hours.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester thereafter.

**TRAN 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester.

**TRAN 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester.

**TRAN 790C. Doctoral Dissertation. 6 credits, 3 contact hours.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester.

**TRAN 790D. Doctoral Dissertation. 9 credits, 3 contact hours.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester.

**TRAN 790E. Doctoral Dissertation. 12 credits, 3 contact hours.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester.

**TRAN 790F. Doctoral Dissertation. 15 credits, 3 contact hours.**
Corequisite: TRAN 791. Required of all candidates for the Doctor of Philosophy in Transportation. A minimum of 36 credits is required. Students may register for 6 to 15 credits of dissertation per semester. If 36 credits are achieved prior to completion of the doctoral dissertation and research, students must register for 3 credits per semester.

**TRAN 791. Doctoral Seminar. 0 credits, 1 contact hour.**
Corequisite: TRAN 790. A seminar in which faculty, students, and invited speakers will present summaries of advanced topics in transportation. Students and faculty will discuss research procedures, dissertation organization, and content. Students engaged in research will present their own problems and research progress for discussion and criticism.

**TRAN 792. Pre-Doctoral Research. 0 credits, 0 contact hours.**
Prerequisite: Permission of program director. For students admitted to the Doctor of Philosophy Program in Transportation who have not yet passed the qualifying examination. Research is carried out under the supervision of a faculty member in the program. Up to 6 credits may be applied toward the required dissertation credits for the program.

**TRAN 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**TRAN 792C. Pre-Doctoral Research. 6 credits, 3 contact hours.**

# Biomedical Engineering

Biomedical engineering is currently the fastest growing field of engineering in the U. S. and requires an education that draws from advanced engineering and computing as well as the biological and medical sciences. NJIT offers an extremely flexible Masters program that encourages students to contribute to an individualized plan of study that builds upon the strengths of their B.S. and develop expertise in an area of concentration leading to careers in research and/or product development, or to prepare for further study in medicine, dentistry, law, and management, or for a Ph.D. in biomedical engineering. Major areas in which NJIT offers courses and conducts research are bioinstrumentation, biomaterials and tissue engineering, biomechanics, neural engineering and rehabilitation engineering.

Over the past several years, the M.S. in Biomedical Engineering program at NJIT currently has graduated the largest number of M.S. degrees in BME in the nation. The department offers a comprehensive set of courses specifically in biomedical engineering (usually 14-16 per semester), which are augmented by related engineering and life science courses taught in other departments. NJIT's location, in the middle of the nation's largest concentration of biomedical industries, provides access to expert instructors who offer specialized courses, which add to the richness of the academic environment. These industries also support graduate internships and thesis work, and often provide employment after graduation. The NJIT campus is within walking distance of both the University of Medicine and Dentistry of New Jersey flagship campus and Rutgers University-Newark. Graduate education at the three institutions is enhanced by collaboration agreements that allow cross-registration for courses, use of libraries, and opportunities for independent research. This benefits biomedical engineering by opening the possibilities for M.S. students to take advanced biological and medical science courses in addition to engineering courses.

The NJIT Department of Biomedical Engineering has a very active research program that is accessible to Masters students and provides opportunities for thesis or other independent study, which integrates engineering and the medical sciences. Research is conducted cooperatively between NJIT and the medical and dental schools of RBHS, the Kessler Institute for Rehabilitation, St. Barnabas Medical Center, Veteran's Administration Medical Center in East Orange, the Children's Specialized Hospital, the Public Health Research Institute, the Rutgers Center for Biological and Molecular Neuroscience and other institutions in the New Jersey-New York metropolitan area. In addition, cooperative research opportunities exist with a number of biomedical device and pharmaceutical companies within a short commuting distance from NJIT.

The Doctor of Philosophy in Biomedical Engineering is jointly offered by NJIT and Rutgers Biomedical and Health Sciences (RBHS). It offers advanced graduate education providing students with the skills necessary for careers in basic and applied research, as well as the intellectual foundation to provide leadership in academia and industry. This program emphasizes an integration of engineering and the life sciences to address complex problems. Students are admitted to either institutions and receive the same degree with a joint diploma. Course requirements are the same regardless of admission. The RBHS description of this program can be found at http://njms.rutgers.edu/gsbs/prospective_students/info/phd/bio_engineering/index.htm

The recent National Research Council Ph.D. rankings placed it 26th out of 74 U.S. BME Ph.D. programs.

## Aim of the M.S. Program

This program provides the opportunity for individuals with degrees in biomedical engineering to focus on a specialized area to a much greater degree than could be done in their undergraduate studies. Similarly, it also allows those with engineering and science backgrounds in other fields to acquire knowledge and skill that will allow them to join this growing field. Unlike many other graduate programs, the NJIT BME M.S has no core requirements. Each student develops an individualized plan of study with his or her advisor that is based on prior study, past work experience and career goals. The intentional flexibility in the selection of courses reflects the expected maturity of the graduate students as they assume significant responsibility for planning their concentrations. This flexibility also encourages students to exhibit some curiosity about unfamiliar areas of biomedical engineering and allows them to take two courses that may be peripheral to their academic focus.

The opportunity to pursue a thesis has the benefit of allowing students to choose a topic in which they will demonstrate the ability to integrate what they have learned, execute a 2-semester technical project, and communicate their results. Students not electing to pursue a thesis may choose three additional courses (replacing the 6-credit thesis) that increase their depth in engineering and breadth in the life sciences.

## Eligibility for the Program

Students who have a B. S. degree in science or engineering are eligible. In general, those with a B.S. in biomedical, mechanical, electrical, computer or chemical engineering will be well prepared to enter the program. Exceptional students with undergraduate degree in the life sciences with sufficient background in mathematics will also be considered for admission.

All applicants must have had courses in scientific computer programming, differential equations, statistics, and physiology. Students who are missing one or more of these can be conditionally admitted with a requirement to take undergraduate bridge courses, which are in addition to the 30-credit graduation requirement. Certain graduate courses or concentrations may require additional background, such as, statics and/or dynamics, thermodynamics, and electronics. Students who do not have these prerequisites may be asked to take additional courses or acquire the necessary material through tutoring and independent study. Prospective students may contact the M.S. Program Director for advice regarding their specific needs.

Students selected for admission should have earned a minimum undergraduate G.P.A. of 3.0, and have GRE Math and Verbal scores higher than 670 and 400, respectively. GRE scores are required for all international applicants, and are optional for graduates of U.S. universities and colleges.

## Course Offerings

The courses offered through this program allow students to choose concentrations that genuinely reflect their needs and interests. The sample course concentrations listed below reflect a curriculum that is rich in cutting edge engineering and science, and deep in its content. This critical mass of courses at NJIT, RBHS and Rutgers allows students to acquire a level of expertise that is uncommon among most biomedical engineering programs. The students in this program are nearly evenly split between those continuing their education immediately following their B.S. and those who are returning to study after a number of years of employment. The same is true for the educational backgrounds of the students, with approximately half having studied biomedical engineering and the other half coming from different fields. Most candidates for the Masters degree enroll as full-time students. However, the degree can be completed on a part-time basis for those who wish to study while continuing to work. Most courses are offered in the late afternoon and in the evening.

The BME graduate courses listed in this catalog are each offered at least once per academic year. This listing is frequently updated to avoid the potential of including courses that are no longer offered. Potential applicants are encouraged to view the current academic year's course schedule and course enrollments at http://www.njit.edu/registrar/schedules/index.php.

Course are taught by faculty who have considerable expertise. BME faculty and lecturers from nearby medical institutions offer graduate courses that are related to their ongoing research areas, while lecturers from industry bring experience from a corporate sector.

Approximately 30% of BME M.S. students complete a thesis, which is a mentored two-semester research/development experience. Many students (particularly those with experience in industry) may already have experienced the equivalent of an in-depth, year-long project, and can be better served by taking additional courses. Students considering a thesis are directed to the NJIT Library's website where most recent theses are available online.

Those who have questions about the scope and content of biomedical engineering theses should review several that fall within their areas of interest. These can be found at http://archives.njit.edu/vhlib/etd/list-programs.php#Biomedical-Engineering.

The department's Graduate Seminar is a weekly opportunity for students to be exposed to current topics in biomedical engineering and develop an appreciation for the breadth of this exciting field. These lectures are given by visiting scholars and industry experts. The department website offers a current listing of seminar speakers and topics. Please visit http://biomedical.njit.edu/.

In addition to the department seminar, the Graduate Biomedical Engineering Society (GBMES) operates its own lecture series that focuses on BME in industry (http://www.njit.edu/gbmes/index.php). Monthly speakers discuss product development and applied research. Many speakers are NJIT BME alumni with whom current students can network.

## Co-op Opportunities and Internships

Students have the opportunity to participate in the co-op and internship programs at neighboring medical institutions or at biomedical engineering firms to gain practical experience. NJIT is situated in an area that contains many major biomedical engineering and pharmaceutical companies. The biomedical engineering department has a part-time advisor for co-op and internship experiences.

## Prospects for Employment

Considerable opportunity exists in the field of biomedical engineering. This takes the form of basic and applied research and product development. Employment may be found in medical institutes, government agencies, corporations and hospitals, all of which are involved in the design, manufacture and utilization of equipment and procedures intimately involved in health care improvement. Many students go on to obtain professional degrees in medicine, dentistry, law or administration for which an engineering background is becoming ever more important.

## Admission Requirements

Prospective students seeking admission to the Program must have an undergraduate degree in engineering, science or mathematics and satisfy the admission and academic requirements of the Graduate School.

1. General Guidelines. Each program of study must satisfy the Graduate School academic requirements (see the latest graduate catalog at www.njit.edu (http://www.njit.edu)).
2. Prerequisite Courses. Minimum Undergraduate Requirements for the Program:
    - B.S. in Biomedical, Chemical, Electrical, Computer, or Mechanical Engineering.
    - Applicants with a B.S. in Computer Science are expected to have had Calculus through differential equations, one full year of Physics, one full year of Chemistry, and a course in Physiology.
    - Applicants with strong life science or medical education, including the equivalent of one full year of Physics as well as Calculus through differential equations, will be considered on a case-by-case basis.
    - Conditional admission may be granted to applicants lacking full preparation with a requirement to take undergraduate bridge courses that will not carry graduate credit.

Admitted students who have not previously taken an upper level physiology course will be required to take BME 669 Engineering Physiology or an equivalent course as one of their graduate courses.

Applicants with a background in life science or other related degrees, such as biology, biochemistry, physical therapists, etc. may be conditionally admitted to the program. Admitted students will be required to register for bridge courses in their first semester prior to taking graduate level BME courses as a condition of admission. In general, the following courses will be required, pending review of transcripts by the graduate advisor:

Calculus 1,2, and 3
Differential Equations
Introduction to Computer Programming
BME 301 Electrical Fundamentals of Biomedical Engineering or equivalent
BME 302 Mechanical Fundamentals of Biomedical Engineering or equivalent

Students must complete BME 301 and BME 302 with a minimum grade of B. Failure to receive a B grade in bridge courses may preclude students from enrolling in regular graduate BME courses. Equivalent courses may be accepted with prior approval from graduate advisor.

## Aims of the Ph.D. Program

This joint program builds upon the synergistic relationship between NJIT and RBHS. The physical proximity of the two institutions facilities access to courses, laboratories, libraries, and seminars, as well as blending scientific and clinical opportunities in education and research. In addition, the location of NJIT and RBHS in Newark promotes interaction with New Jersey's pharmaceutical and medical device industries and medical facilities. As the preparation for the Ph.D. involves an extensive research apprenticeship in the form of dissertation, the program is closely linked to the areas of biomedical engineering research at NJIT and RBHS. This research is clustered in the following areas.

- Biomaterials and Biocompatibility

- Tissue Engineering and Regenerative Medicine
- Cellular and Orthopedic Biomechanics
- Biomedical Signal Processing, Imaging and Instrumentation
- Neural and Neuromuscular Engineering

The program requires a minimum of 78 credits beyond the B.S. or 60 credits beyond an M.S. degree in biomedical engineering or closely related field. For the post M.S. student, 24 credits must be in advanced graduate level courses with 12 credits in biomedical engineering and 12 credits in life sciences. The post B.S. student must take an additional 18 credits in approved courses.

The remaining 36 credits are comprised of mentored dissertation research, in which the student demonstrate aptitude for independent research of publishable nature. Individuals completing this degree are well-prepared for employment in academia, industry and government laboratories, or for post-doctoral study.

## Eligibility for the Program

Prospective students seeking admission to the joint Ph.D. Program should have an undergraduate degree in engineering, basic science or mathematics, and satisfy the admission and academic requirements of the NJIT Graduate School and the RBHS Graduate School of Biomedical Sciences. In general, applicants are expected to have had Calculus through differential equations equations, one full year of physics, one full year of chemistry, and a course in physiology as part of their prior engineering studies. Non-engineering applicants with strong life science or medical education, with the same physics, chemistry, math and physiology background, but who do not have experience in essential engineering sciences, will be considered on a case-by-case basis. These applicants may be asked to pursue and M.S. in BME prior to admission to the Ph.D. program. Alternatively, conditional admission may be granted to applicants lacking full preparation, the a requirement to take undergraduate bridge courses that will not carry graduate credit. Admitted students who have not previously taken an upper level physiology course will be required to take BME 669 Engineering Physiology or an equivalent course as one of their graduate courses.

Applicants are expect to have a minimum G.P.A of 3.5 in their most recent degree (B.S. or M.S.) and minimum GRE Math and Verbal scores of 750 and 500. The GRE is required for all applicants, and TOEFL is required for all international students.

The program has a joint admission committee, which reviews all application, thus allowing students to apply to either institution. The host institution for a student may be changed depending upon the eventual research advisor and/or the institutional source of the research funding. The only significant institutional difference in the application process is that RBHS only admits students in the spring for the upcoming fall semester. NJIT can admit students who are beginning in either the fall or spring semesters. In general, however, spring admissions are rare.

As the Ph.D. program is significantly based on faculty research, admission depends upon available opportunities and funding in individual laboratories, in addition to prior academic performance. A very limited number of teaching assistantships and university fellowships are available for begging students, with subsequent years of research supported by faculty grants.

Laboratory and funding opportunities vary considerably from year to year. Serious potential applicants are encouraged to contact the Ph.D. program director at either NJIT or RBHS to discuss the current factors influencing admission.

## NJIT Faculty

### A

Adamovich, Sergei, Associate Professor

Alvarez, Tara L., Professor

Arinzeh, Treena L., Professor

### B

Biswal, Bharat, Professor

### C

Chandra, Namas, Professor

Chaudhry, Hans, Research Professor

Cho, Cheul, Assistant Research Professor

### D

Di, Xin, Assistant Research Professor

## F

Foulds, Richard A., Associate Professor

## G

Georges Deveau, Penelope, University Lecturer

## H

Haorah, James, Associate Professor

Hunter, William C., Professor

## I

Ihlefeld, Antje, Assistant Professor

## J

Jaffe, Michael, Research Professor

## L

Lee, Eun Jung, Assistant Professor

Li, Xiaobo, Associate Professor

## M

Mantilla, Bruno Antonio, University Lecturer

## O

Ophir, Zohar, Research Professor

## P

Perez-Castillejos, Raquel, Assistant Professor

Peringady, M. A. Muneer, Assistant Research Professor

Pfister, Bryan J., Chair

## R

Reisman, Stanley, Professor Emeritus

## S

Sahin, Mesut, Professor

Schesser, Joel, Senior University Lecturer

Skotak, Maciej, Assistant Research Professor

## V

Van Buskirk, William C., Distinguished Professor Emeritus

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Biomedical Device Development

# Biomedical Engineering Courses

**BME 590. Graduate Co-Op Work Exper I. 3 credits, 3 contact hours.**

**BME 592. Graduate Co-Op Work Exper III. 3 credits, 3 contact hours.**

**BME 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer and approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**BME 601. Seminar. 1 credit, 1 contact hour.**
Required every semester of all master's students in biomedical engineering who receive departmental or research-based support and all doctoral students. To receive a satisfactory grade, students must attend at least five seminars per semester, as approved by the seminar supervisor.

**BME 611. Engineering Aspect of Molecular and Cellular Bio I. 1 credit, 1 contact hour.**
Molecular and cellular biology is a foundation of the understanding of the biological sciences and is vital to the study of advanced biomedical engineering. This course is to be taken simultaneously with UMDNJ N551 to enrich the crossover between engieering and life sciences. Course topics parallel those covered in N551 and both add engineering relevance, and provide engineering students with a stronger understanding of molecular and cellular biology. For students in joint BME PhD program.

**BME 612. Engineering Aspects of Molecular and Cellular Bio 2. 1 credit, 1 contact hour.**
Molecular and cellular biology is a foundation of the understanding of the biological sciences and is vital to the study of advanced biomedical engineering. This course is to be taken simultaneously with UMDNJ N552 to enrich the crossover between engineering and life sciences. Course topics parallel those covered in N552 and both add engineering relevance, and provide engineering students with a stronger understanding of molecular and cellular biology. For students in joint BME PhD program.

**BME 651. Principles of Tissue Engineering. 3 credits, 3 contact hours.**
Tissue Engineering is a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated using living cells combined with a scaffolding material to guide tissue development. Such scaffolds can be synthetic, natural, or a combination of both. This course will cover the advances in the fields of cell biology, molecular biology, and materials science towards developing novel "tissue engineered" materials.

**BME 652. Cellular and Molecular Tissue Engineering. 3 credits, 3 contact hours.**
This course explores molecular, cellular and tissue level interactions that are an important component of all tissue engineering strategies. Topics include how a cell moves, reacts and maintains viability and function based on its surroundings. We will discuss how to engineer our materials, tissue grafts and implants to integrate with the body. We will also liearn about bodily reactions and the biocompatibility of tissue engineered devices such as immunoreactivity and blood coagulation.

**BME 653. Micro/Nanotechnologies for Interfacing Live Cells. 3 credits, 3 contact hours.**
In this course, we will study technologies and tools available for interfacing live cells from a sub-cellular, single-cell, and multi-cellular (tissue models) approach. We will introduce key concepts of the biology of cells and tissues and will explore the technologies (micro-/nanotechnologies) and tools (sensors and actuators) available for the investigation of cell and tissue biology. Same as ECE 653.

**BME 654. Cardiovascular Mechanic. 3 credits, 3 contact hours.**
Fundamental biomechanical mechanisms at work in the cardiovascular system. Topics include the fundamental molecular structure of heart muscle, the biomechanical principles that transform the contraction of heart muscle into stress-strain functions of muscle fibers, pressure-volume flow relations in the vasculature when it is considered as a hemodynamic (blood hydraulic) system, growth and disease of the cardiovascular system, resistance, compliance, inertance, and catheter-tip transducers.

**BME 655. Advanced Characterization of Biomaterials. 3 credits, 3 contact hours.**
Methods used to discover the structures of proteins, enzymes, DNA, and carbohydrates at the molecular level, as well as complex structures such as collagen, the chromosome, and the cell. Topics will include protein and DNA sequencing, separation methods, and spectroscopies such as 2 and 3D NMR, x-ray diffraction, SEM, AFM and microscopic imaging techniques.

**BME 656. Research Skills in Stem Cell. 3 credits, 3 contact hours.**
Stem cells have emerged as new therapeutic potential and offer great opportunities for regenerative medicine, biotechnology and the pharmaceutical industry. This course is intended for graduate students interested in stem cell bioengineering and tissue engineering. The course will cover stem cell biology and biomedical engineering applications for cell-based regeneration therapies. It will discuss techniques for engineering of stem cells and the current literature in this rapidly evolving field.

**BME 661. Neural Engineering. 3 credits, 3 contact hours.**
Neural Engineering focuses on understanding how the brain functions using engineering principles. The course discusses different instrumentation and signal processing algorithms to study how the brain functions, how to detect different pathologies and new applications for research. Topics include; basic overview of neurology, vector populations, neural networks, vision research, functional MRI, functional electrical stimulation, neural prosthetics, and other advanced research topics studying neurology.

**BME 667. Bio-Control Systems. 3 credits, 3 contact hours.**
The course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves which govern the basic operations of all living organisms and especially higher order life forms. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Same as ECE 667.

**BME 668. Medical Imaging Systems. 3 credits, 3 contact hours.**
This course provides a detailed introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound and optical imaging modalities are included. Same as ECE 668.

**BME 669. Engineering Physiology. 3 credits, 3 contact hours.**
To enable students to apply basic tools in engineering analysis, mathematics, computer science, general physics and chemistry courses so that they can develop models that quantitatively predict the functioning of physiological systems in the human body. To enable students to apply engineering systems analysis to systematic physiology and employ the ideas of feedback control, signal procession, mathematical modeling and numerical simulation. Same as ECE 669.

**BME 670. Introduction to Biomechanical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate thermodynamics, statics, and dynamics. Introduction to biomechanical engineering of physiological systems; fluid flow, structural, motion, transport, and material aspects; energy balance of the body, and the overall interaction of the body with the environment. Same as ME 670.

**BME 671. Biomechanics of Human Structure and Motion. 3 credits, 0 contact hours.**
Prerequisite: undergraduate statics, kinematics, and dynamics. Principles of engineering mechanics and materials science applied to human structural and kinematic systems and to the design of prosthetic devices. Topics include anatomy; human force systems; human motion; bioengineering materials; and design of implants, supports, braces, and replacements limbs.

**BME 672. Biomaterials. 3 credits, 3 contact hours.**
Prerequisite: MECH 320 (see undergraduate catalog for description) or the equivalent. Materials and processes used to develop devices that are implanted in the human body; clinical aspects of biomechanical engineering; federal government requirements for design and testing of human implant devices; biocompatibility, metal implant devices, material design parameters, plastic and ceramic devices, sterilization techniques, and their effect on biocompatibility.

**BME 673. Biorobotics. 3 credits, 3 contact hours.**
Basics of control of a robot and telemanipulation are studied. Computer simulations, MATLAB are used to explore biomimetic autonomous robots. This is a studio-based course with hands-on exercises with small robots and actuators. Topics include understanding how biological robots (humans and animals) differ from designed robots, as well as sensors (touch, stereo and position), actuators (muscles, smart materials), and intelligent (neural and computer controlled systems.

**BME 674. Principles of Neuromuscular Engineering. 3 credits, 3 contact hours.**
Neurophysiology, motor control and robotics are used to study the human motor system. Sensorimotor learning and acquisition of new motor skills are emphasized. Topics include the central nervous system, muscle properties, spinal motor circuitry and dynamics of limb motion. The relation of motor control problems to neurophysiology of the motor system and how motor disorders affect movement control are studied. MATLAB and Simulink are used in simulations and movement date analysis.

**BME 675. Computer Methods in Biomedical Engineering. 3 credits, 3 contact hours.**
This course uses MATLAB to concentrate on methods that allow students to produce original software that can be used to acquire, process, analyze and present data. Topics include advanced graphics and animation, graphical user interfaces, interfacing to and data acquisition from laboratory instrumentation, filtering and processing of acquired data, and interfacing to user interfaces (e.g. joysticks). Applications in speech, bioelectrical signals, images and virtual reality will be included.

**BME 676. Computational Biomechanics. 3 credits, 3 contact hours.**
Prerequisites: BME 670 or equivalent. The use of commercially available software to solve complex engineering problems has become standard practice to reduce time and cost and results in a better product. This is an intro course on computational methods and the use of commercial software such as ANSYS, Fluent, and MATLAB to solve problems related to the BME device industry. Suitable for students interested in Computer Aided Design and Engineering (CAD/CAE).

**BME 677. CAD for Biomechanics and Biomaterials. 3 credits, 3 contact hours.**
Introduction to Computer Aided Design theory and application using software. Topics include datum planes, extrude, cut, sweep, swept cuts, and parallel, rotational, and general blends. Assemblies and generating, dimensioning, editing, and modifying drawing views and creation of balloons, imaging and scanning techniques of anatomical structures such as bone and arteries and 3D printing are also covered.

**BME 678. Design of Orthopedic Implants. 3 credits, 3 contact hours.**
Prerequisites: BME 677. First of a two part course on design of orthopedic implants using ProEngineer. Additional topics include machanical properties of implant materials, material selection and introduction to FEA. Methods for prototype development with the use of 3D printing will also be discussed. A critical objective of this course is the preparetion of design reports and project presentations.

**BME 679. Advanced Design of Orthopedic Implants. 3 credits, 3 contact hours.**
Prerequisites: BME 677, BME 678 or equivalent. Advanced modeling techniques for the design of hip, knee, and spine implants. Mechanical properties of materials, including wear and failure modes associated with typical implants. Kinematics and surgical protocols of implants will be discussed. Course will cover assemblies and FEA analysis of implants. Additional topics include large deformations, fatigue, optimization, review and analysis of results.

**BME 680. BioMEMS Design and Applications. 3 credits, 3 contact hours.**
The advance of bioMEMS (Micro Electrical Mechanical Systems) technology is a key component in making the next generation medical diagnostic tools possible. We will learn how bioMEMS devices are fabricated and combine engineering analysis with knowledge of known biological responses and biomolecule interactions to understand how bioMEMS are designed and function. Topics will include biological, mechanical, electrical, and chemical biosensors, and microfluidics as applied to biotechnology.

**BME 682. System Mgmt for Medical Device. 3 credits, 3 contact hours.**
This course will provide a detailed overview of Project Management techniques and methods applied to medical devices and show the integration of medical device Design Controls from 21 CFR820.30. General knowledge from the field of Project Management will be conveyed from the perspective of engineering or science personnel in the industrial medical field, particularlywith regard to FDA Quality System Regulations (QSR), ISO 13485 guidelines, and Good Clinical Practices (GCP's) for running clinical trials. Students will also take part in practical problem solving simulations based on real-world examples of medical device project anomalies. The combination of specialized project management knowledge for a heavily regulated area and realistic classroom simulation will provide a basis for those interested in commercial medical device development.

**BME 684. Medical Device Development. 3 credits, 3 contact hours.**
This course will provide a detailed overview of medical device development from a realistic industrial and academic perspective. The processes used in corporations and academic laboratories to conceive and develop devices will be explored from a research, regulatory, clinical, QA/QC, marketing, engineering, and legal perpective under the umbrella of project management techniques. Material will be presented as an aide to students who wish to decide on careers in either industry or academia.

**BME 686. Intro. to Instrumentation for Physiomeasurements. 3 credits, 3 contact hours.**
Introduction to instrumentation for students without instrumentation background only. This course teaches the hardware and instrumentation needed to measure variables from different physiological systems. Electrodes, sensors and transducers, bioelectric amplifiers safety and digital acquisition will be discussed. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system, clinical laboratory instruments, electrical safety and computers in biomedical instrumentation.

**BME 687. Design of Medical Instrumentation. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electronics. Principles and practice of medical instrumentation. Instrument components and medical instrument systems design. Examples taken from electrocardiography, clinical chemistry, medical imaging. Microprocessor-based systems emphasized.

**BME 688. Virtual Biomedical Instrument. 3 credits, 3 contact hours.**
Introductory course to the programming language, LabVIEWTM. Topics include loops, arrays, clusters, data acquisition, and file input/output. Students will learn how to apply these basic concepts into the development of algorithms. Examples relevant to the biomedical industry will be given how to debug and solve complex programming problems. By the completion of the course, students will be able to develop programs to automate processes and experimental designs.

**BME 698. Selected Topics. 3 credits, 3 contact hours.**
Selected topics for Biomedical Engineering.

**BME 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 700B. Master's Project. 3 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 701. Master's Thesis. 6 credits, 0 contact hours.**
Prerequisite: written permission from thesis advisor. Projects include design, construction, experimental or theoretical investigation of the engineering applications to the diagnosis and/or treatment of disease. Research may be in cooperation with industry or medical institutions. Completed work should be of sufficient quality to be acceptable for publication. Oral presentations are required.

**BME 701B. Master's Thesis. 3 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 701C. Master's Thesis. 6 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried out under the supervision of a member of the department faculty.

**BME 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Master's degree students cannot count BME 725 as degree credit but can count these credits to qualify for full-time status.

**BME 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Master's degree students cannot count BME 725 as degree credit but can count these credits to qualify for full-time status. This course is not available to master's students.

**BME 760. Modeling in Func Brain Imaging. 3 credits, 3 contact hours.**
Prerequisites: Although no prerequisites are required, BME 310, ECE640 or other undergraduate and graduate courses covering knowledge on signals and systems in discrete time domain are suggested to prepare for this course. This course will focus on introducing biomedical computing techniques needed for functional MRI data pre-processing, and individual-level and group-level analyses. Several projects will be assigned for hands-on training in implementing the introduced knowledge.

**BME 772. Adv Biomats for Lab and Clinic. 3 credits, 3 contact hours.**
Prerequisite: BME 672 or equivalent. Background in Materials Science is encouraged. Advanced course on the design, characterization and clinical/ research performance of biomaterials that have or may receive acceptance in medicine or as a biomedical research tool. The course requires the student to integrate background in chemistry, physics, cell and molecular biology, tissue engineering and materials science to review and summarize the scientific rationale for materials that have gained acceptance as medical devices, cell culture or diagnostic tools.

**BME 774. Principles of Neurorehabilitation. 3 credits, 3 contact hours.**
This is a research-focused course providing in-depth review of current studies in the following fields: Pathophysiology of disability; Advanced therapeutic interventions; Emerging neurorehabilitation technologies that are intended to encourage neural reorganization and relearning; Novel interfaces through chronic implementation in the brain, spinal cord and muscles used in deep brain stimulation, brain-machine interfaces, and functional electrical stimulation and Methods of assessing outcomes.

**BME 788. Selected Topics. 3 credits, 3 contact hours.**
Selected topics for Biomedical Engineering.

**BME 790. Doctoral Dissertation. 0 credits, 0 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790C. Doctoral Dissertation. 6 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790D. Doctoral Dissertation. 9 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790E. Doctoral Dissertation. 12 credits, 12 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 790F. Doct Dissertation & Research. 15 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Biomedical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**BME 791. Graduate Seminar. 0 credits, 0 contact hours.**

**BME 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Restriction: Permission of the department. For students admitted to the program leading to the Ph.D. in Computer Engineering or Electrical Engineering. Research carried on under the supervision of a designated member of the department faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied toward the 36 credits required under BME 790 after the student fulfills requirements of doctoral candidacy.

# M.S. in Biomedical Engineering

## Program Requirements

### Thesis Option

| | | |
|---|---|---|
| Five courses selected from list of BME mandatory courses (see below for complete list) | | 15 |
| One graduate course in physiology or equivalent | | 3 |
| One graduate course in experimental design, statistics, or clinical studies | | 3 |
| BME 701 Master's Thesis | | 6 |
| Any approved elective | | 3 |
| BME 791 | Graduate Seminar (required for two semesters) | 0 |
| Total Credits | | 30 |

### Non-Thesis Option

| | | |
|---|---|---|
| Five courses selected from list of BME mandatory courses (see below for complete list) | | 15 |
| One graduate course in physiology or equivalent | | 3 |
| One graduate course in experimental design, statistics or clinical studies | | 3 |
| Three approved electives | | 9 |
| BME 791 | Graduate Seminar (required for two semesters) | 0 |
| **Total Credits** | | **30** |

### MS Curriculum Mandatory Courses

1. Admitted students who have not previously taken an upper level physiology course will be required to take BME 669 Engineering Physiology or an equivalent course as one of their required graduate courses.

2. In addition, students must meet a statistics requirement. They may choose one course from the following preapproved statistics courses: MATH 660 Introduction to statistical Computing with SAS and R, MATH 661 Applied Statistics, MATH 663 Introduction to Biostatistics, IE 604 Advanced Engineering Statistics.

All graduate students must additionally **select five** courses from the following list:

| | | |
|---|---|---|
| BME 651 | Principles of Tissue Engineering | 3 |
| BME 652 | Cellular and Molecular Tissue Engineering | 3 |
| BME 653 | Micro/Nanotechnologies for Interfacing Live Cells | 3 |
| BME 654 | Cardiovascular Mechanic | 3 |
| BME 661 | Neural Engineering | 3 |
| BME 668 | Medical Imaging Systems | 3 |
| BME 670 | Introduction to Biomechanical Engineering | 3 |
| BME 671 | Biomechanics of Human Structure and Motion | 3 |
| BME 672 | Biomaterials | 3 |
| BME 673 | Biorobotics | 3 |
| BME 674 | Principles of Neuromuscular Engineering | 3 |
| BME 675 | Computer Methods in Biomedical Engineering | 3 |
| BME 676 | Computational Biomechanics | 3 |
| BME 678 | Design of Orthopedic Implants | 3 |
| BME 679 | Advanced Design of Orthopedic Implants | 3 |
| BME 680 | BioMEMS Design and Applications | 3 |
| BME 687 | Design of Medical Instrumentation | 3 |

| | | |
|---|---|---|
| BME 688 | Virtual Biomedical Instrument | 3 |

## Elective Courses

The remaining three courses can be selected from any of the BME courses offered. For students taking the MS Thesis Option, two semesters of thesis count as two elective courses.

## Other Notes

Students may take up to two courses outside the department, including the statistics course.

## Seminars

M.S. students are required to register for the 0 credit graduate seminar in each of a minimum of two semesters. This is a non-additive credit (i. e. it does not count toward the 30 required credits), however participation in the seminar is required for graduation. Graduate seminars are offered weekly during the semesters and include guest speakers as well as NJIT graduate students. The Department also maintains lists of seminars in other departments and in neighboring institutions that are of interest to biomedical engineering. Part-time graduate students may request a waiver of this requirement.

## Thesis Requirement

The Thesis Option **requires** a six (6) credit thesis. Because biomedical engineering exists at the intersection of several traditional engineering and computing fields, and the biological and medical sciences, the thesis demonstrates the student's ability to define a problem, plan two semesters of independent work in an interdisciplinary environment, and execute a research and/or design that meets NJIT's standards for a Masters Thesis. The thesis document conforms to the format of the Office of Graduate Studies and is evaluated by a committee of three members, two of whom must be from the NJIT biomedical faculty. External members from industry, medicine or other universities are encouraged. An oral defense before the committee and the departmental community is also required. All NJIT theses are archived in the University Library and are available via the Library's web site.

Thesis topics are selected by the student in consultation with faculty and other potential advisors. Thesis content can include a research study, the development/design of new technology including software, or the design, execution and evaluation of an experiment. A thesis may be conducted in an NJIT laboratory or in another institutional or industrial facility. The individual nature of the work must be clearly identifiable, as should its novelty and importance to biomedical engineering.

In cases where the intellectual property of an industrial sponsor may be in conflict with the public presentation of the thesis or its availability through the NJIT Library, special arrangements can be made by the M.S. Program Director to protect the firm's property.

# Ph.D. in Biomedical Engineering

## Specifics of the Ph.D. in Biomedical Engineering

Prior to the first semester of study, the student meets with the Ph.D. Program Committee and develops an individualized learning contract. This document maps the student's plan of study to math career goals with the Ph.D. curriculum. The development of the learning contract involves reviewing the student's prior courses, assessing future course needs, planning for qualifying exams and lab rotations, and initiating discussion of research interests. If a student enters the program with a research and mentor identified, that mentor is also included in the planning.

This learning contract is revised during each semester's advising period and it is updated as necessary. The academic Progress Committee, comprised of NJIT and RBHS faculty, monitors the progress of students in the completion of their degrees.

## Graduate Courses

### Ph.D. in Biomedical Engineering (with M.S in BME.)

| | | |
|---|---|---|
| Advanced BME courses in field of specialization [1] | | 12 |
| GSND 5135Q: Research Design and Statistics (2 credits), GSND 5006Q Grantsmanship Skills II (2 credits) and an Advanced life science course reinforcing field of specialization (2-3 credits) | | 6-7 |
| RBHS 5200 Introduction to Biomedical Sciences [2] | | 5 |
| BME 611 | Engineering Aspect of Molecular and Cellular Bio I | 1 |
| Laboratory rotation at NJIT | | 0 |
| Laboratory rotation at RBHS | | 0 |
| Dissertation research | | 36 |
| **Total Credits** | | **60-61** |

1 Generally, these courses will come from those offered at NJIT. Courses from other engineering departments are considered on a case basis.

2 The "core" course and is required of all Ph.D. students in the Graduate School of Biomedical Sciences.

Ph.D students are required to attend Graduate Seminar (BME 791 Graduate Seminar) starting the semester after successfully completing the qualifying exam and every semester thereafter until completion of the degree. Students must register for BME 791 Graduate Seminar, 0 credit, and attend 50% of seminars in BME at NJIT. Students will receive a pass/fail grade.

## Ph.D. in Biomedical Engineering (with B.S. in BME)

| | | |
|---|---|---|
| BME and life science courses [1] | | 18 |
| Advanced BME courses in field of specialization [2] | | 12 |
| GSND 5135Q: Research Design and Statistics (2 credits), GSND 5006Q Grantsmanship Skills II (2 credits) and an Advanced life science course reinforcing field of specialization (2-3 credits) | | 6-7 |
| RBHS 5200 Introduction to Biomedical Sciences [3] | | 5 |
| BME 611 | Engineering Aspect of Molecular and Cellular Bio I | 1 |
| RBHS 5001 Ethics in Science, Research and Scholarship | | 0 |
| Laboratory rotation at NJIT | | 0 |
| Laboratory rotation at RBHS | | 0 |
| Dissertation research | | 36 |
| **Total Credits** | | **78-79** |

1 Work with advisor to select courses to serve as foundation (similar to an M.S.) for the advanced courses and dissertation research.
2 Generally, these courses will come from those offered at NJIT. Courses from other engineering departments are considered on a case basis.
3 The "core" course and is required of all Ph.D. students in the Graduate School of Biomedical Sciences.

Ph.D students are required to attend Graduate Seminar (BME 791 Graduate Seminar) starting the semester after successfully completing the qualifying exam and every semester thereafter until completion of the degree. Students must register for BME 791 Graduate Seminar, 0 credit, and attend 50% of seminars in BME at NJIT. Students will receive a pass/fail grade.

## Qualifying Courses

**RBHS-GSBS life science courses** can be found at: http://njms.rutgers.edu/gsbs/current_students/course_information.php

While most students take GSBS. life science courses, students may propose alternative courses taken at **Rutgers University-Center for Molecular and Behavioral Neuroscience:** http://www.ncas.rutgers.edu/cmbn

**NJIT/Rutgers Federated Department of Biology:** http://newarkbioweb.rutgers.edu/biology

**RBHS in the School of Health-Related Professions:** (http://shrp.rutgers.edu)http://shrp.rutgers.edu/

## Qualifying Examinations

Before becoming a doctoral candidate, a student must demonstrate his/her ability to integrate the knowledge acquired studies in the Qualifying Examination. This examination is offered each June and included a day-long written portion consisting of integrative questions. Shortly after the date of the written exam, students are examined orally by the Academic Progress Committee on the same questions. Students discuss and expand upon their written answers, and demonstrate their ability to engage in scholarly discussions.

## Dissertation

The dissertation represents original research, and reflects a student's ability to critically understand the significance of a problem and conduct novel, high quality, and independent research, which advances the state of the art.

Before beginning the dissertation the student will select a dissertation committee, to be chaired by the student's primary advisor, and prepare a dissertation proposal. The proposal is organized using the format of an NIH Fellowship application, identifying a unique scholarly problem, providing a critical review of related literature, proposing an appropriate hypothesis, and presenting a methodology to address the problem. The proposal is defended before the dissertation committee.

Doctoral study concludes with a written dissertation and an oral defense.

# Chemical, Biological, and Pharmaceutical Engineering

The graduate programs in Chemical Engineering offer opportunities for students to enhance their knowledge in the core areas of the discipline, learn about advanced topics in various established as well as emerging technologies through specialized courses, and engage in original research. Courses are taught by full-time faculty members that are also involved in cutting-edge research, and adjunct faculty with extensive industrial experience.
The department enjoys close ties to the pharmaceutical and petrochemical industries, and plastics manufacturers through the Polymer Processing Institute (PPI). In addition to independent research, faculty members are associated with various research centers including the Center for Membrane Technology, the Particle Technology Center, and PPI. There are opportunities for interdisciplinary collaborative research with the Federated Department

of Biological Sciences, the Department of Biomedical Engineering, the Department of Chemistry and Environmental Science, and the University of Medicine and Dentistry of New Jersey.

# Master of Science in Chemical Engineering

This program is intended for those interested in advancing their understanding of chemical engineering. It may be taken on a part-time or full-time basis. There are two options, one of which includes a master's thesis.

## Admission Requirements

An undergraduate degree in chemical engineering is usually required. Students who do not have a degree in chemical engineering may be considered for admission through the bridge program. The bridge program is comprised of a sequence of two courses,PHEN 501, Pharmaceutical Engineering Fundamentals11 and PHEN 502,Pharmaceutical Engineering Fundamentals 111 and , that needs to be completed before beginning the graduate program. Bridge courses are not counted toward degree credit. The bridge program is primarily for individuals who have a degree in either chemistry or an engineering discipline other than chemical engineering.

A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent, is typically required for admission. All full-time applicants pursuing a degree in the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering also require a GRE. International students must achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based).

# Doctor of Philosophy in Chemical Engineering

This is a research-oriented degree intended primarily for full-time students. Although courses may be taken on a part-time basis, a minimum of one year of full-time residency is typically required for completion of the doctoral dissertation.

## Admission Requirements

A master's degree in chemical engineering and a GPA of at least 3.5 on a 4.0 scale, or equivalent, are usually required. All applicants must submit GRE scores. International students must also achieve a minimum TOEFL score of 213 (computer-based) or 550 (non-computer-based). Exceptional students with undergraduate degrees in chemical engineering may also apply directly for admission to the doctoral program. In addition to the GRE and TOEFL requirements mentioned above, a minimum undergraduate GPA of 3.5 on a 4.0 scale, or equivalent, is normally required. Students admitted to the program without a master's degree in chemical engineering must complete an additional 18 credits of course work as specified below. Admission of full-time doctoral students is on a competitive basis as the department admits only as many students as it can support through departmental and research-based funds.

# Biopharmaceutical Engineering Program Objective

The Master of Science Program in Biopharmaceutical Engineering is a program developed and administered by the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering at NJIT. The primary objective of the program is to educate professionals by providing them with the skills required to work in the bioprocessing and biomanufacturing, biopharmaceutical production, and biological/biochemical development.

New Jersey is considered a "hot bed" for pharmaceutical, health care, and bioscience companies, and examples of large and small companies having major facilities in New Jersey abound. The use of microbial/biological systems and the manipulation of biological systems for the production of pharmaceutical products and therapeutic agents are becoming increasingly important for these companies and for the health care industry as a whole. The Biopharmaceutical Engineering program is designed to address the engineering component of the educational needs in this area: students are trained in areas such as microbial and cell growth operations, bioreactor and bioprocess design, fermentation and cell culture processing, recovery and bioseparation processes, and validation and regulatory issues for biological production. Since this program is strongly tied to the pharmaceutical engineering and chemical engineering programs, Biopharmaceutical Engineering students are able to benefit from the use of basic chemical/pharmaceutical engineering approaches, such as transport phenomena, (bio)reaction engineering and unit-operations principles, to understand and design bioprocesses for new biotherapeutics.

NJIT'd M.S. program in Biopharmaceutical Engineering provides the intellectual climate and the necessary tools needed to prepare students for positions and career advancement within the industry, based on the rigorous technological requirements of this highly regulated work environment.

# Master of Science in Biopharmaceutical Engineering

## Admission Requirements

An undergraduate degree in chemical engineering or, in most cases, mechanical engineering, with a cumulative grade point average (GPA) of at least 3.0 on a 4.0 scale is usually required. Applicants with:

1. a science degree,
2. engineering degree in a discipline other than chemical engineering, or
3. a GPA below 3.0 but at least 2.8,

may be conditionally admitted to the program. Conditions may involve completion of a bridge program designed on a case-by-case basis, and typically requiring taking extra bridge courses, as further explained bellow. Depending on the background of the student, admission conditions may additionally require taking undergraduate course (e.g., chemistry) or graduate courses. Bridge courses and undergraduate courses do not count toward degree credit; graduate-level courses do.

Submission of Graduate Record Examination (GRE) score is encouraged in all cases, but it is required of those seeking financial support and those whose last prior degree is from an institution outside United States. International students must also submit scores from the Test of English as a Foreign Language (TOEFL). According to University policy, a minimum score of 79 (internet-based TOEFL) or 213 (computer_based TOEFL) is required for all international applicants.

## Bridge Program

The Biopharmaceutical Engineeringprogram has been designed so that applicants with different backgrounds can be admitted. Nevertheless, the program is strongly oriented toward the engineering and processing components of "Biopharmaceutical Engineering". In addition, since the biopharmaceutical industry is a chemistry/biology-based industry a chemical or biochemical engineering background is the most appropriate to enter the program. This implies that students who have science background (e.g., a chemistry or pharmacy B.S. degree) or an engineering degree in a discipline other than chemical, biochemical or, possibly, mechanical engineering, may be required to take a bridge program.

# Pharmaceutical Engineering Program Program Objective

The Master of Science Program in Pharmaceutical Engineering is a program developed and administered by the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering at NJIT. The primary objective of the program is to educate professionals and provide them with the skills required to work in the pharmaceutical field, with particular emphasis on the engineering aspects of drug manufacturing, pharmaceutical production, pharmaceutical development, and pharmaceutical operations.

The pharmaceutical/medical technology industry is the largest manufacturing industry in New Jersey. New Jersey is home to the headquarters of more global pharmaceutical and medical technology companies than any other state in the country, or any single country throughout the world. NJIT's M.S. program in Pharmaceutical Engineering provides the intellectual climate and the necessary tools needed to prepare students for positions and career advancement within the industry, based on the rigorous technological requirements of this highly regulated work environment.

The program is designed to provide opportunities for specialization in such areas as pharmaceutical processing and manufacturing, validation and regulatory issues in the pharmaceutical industry, pharmaceutical facility design, pharmaceutical packaging technology, reaction engineering for pharmaceutical production, pharmaceutical separation processes, pharmacokinetics and drug delivery, molecular modeling for drug discovery, pharmaceutical synthesis, fluid mixing in the pharmaceutical industry, instrumental analysis, and industrial quality control.

# Master of Science in Pharmaceutical Engineering

## Admission Requirements

An undergraduate degree in chemical engineering or, in most cases, mechanical engineering, with a cumulative grade point average (GPA) of at least 3.0 on a 4.0 scale is usually required. Applicants with:

1. a science degree,
2. an engineering degree in a discipline other than chemical or mechanical engineering, or
3. a GPA below 3.0 but at least 2.8, may be conditionally admitted to the program.

Conditions may involve completion of a bridge program designed on a case-by-case basis, and typically requiring taking extra bridge courses, as further explained below. Depending on the background of the student, admission conditions may additionally require taking undergraduate courses (e.g., chemistry) or graduate courses. Bridge and undergraduate courses do not count toward degree credit; graduate-level courses do.

Submission of Graduate Record Examination (GRE) scores is encouraged in all cases, and required of those seeking financial support and those whose last prior degree is from an institution outside the United States. International students must also submit scores from the Test of English as a Foreign Language (TOEFL). According to university policy, a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based) is required.

The admission requirements described above can be partially relaxed for applicants with significant industrial experience in the pharmaceutical industry (5+ years). The admission requirements for such candidates will be established on a case-by-case basis, and will be determined through an interview with the prospective student and the submission of letters of support attesting the level of experience attained.

## Bridge Program

The Pharmaceutical Engineering program has been designed so that applicants with different backgrounds can be admitted. Nevertheless, the program is strongly oriented toward the engineering component of "Pharmaceutical Engineering". In addition, since the pharmaceutical industry is a chemistry-based industry a chemical engineering background is the most appropriate to enter the program (mechanical engineers are also generally well prepared to enter the program). This implies that students who have a science background (e.g., a chemistry or pharmacy B.S. degree) or an engineering degree in a discipline other than chemical or, possibly, mechanical engineering, may be required to take a bridge program.

# NJIT Faculty

## A

Armenante, Piero M., Distinguished Professor

## B

Baltzis, Basil C., Professor

Barat, Robert B., Professor

Bilgili, Ecevit A., Assistant Professor

## D

Dave, Rajesh N., Distinguished Professor

Dreyzin, Edward L., Professor

## E

Engler, Peter, Associate Professor Emeritus

## G

Gogos, Costas G., Distinguished Research Professor

## H

Hanesian, Deran, Professor

Huang, Ching-Rong, Professor Emeritus

## K

Khusid, Boris, Professor

Kristol, David, Professor Emeritus

## L

Loney, Norman, Professor

## P

Perlmutter, Howard D., Professor Emeritus

Perna, Angelo, Professor

Pfeffer, Robert, Distinguished Professor Emeritus

## R

Roche, Edward C., Professor Emeritus

Rosty, Roberta, Senior University Lecturer

## S

Schoenitz, Mirko, Associate Research Profess

Sebastian, Donald H., Professor

Shilman, Avner, Professor Emeritus

Simon, Laurent, Associate Professor

Sirkar, Kamalesh K., Distinguished Professor

Sofer, Samir, Professor Emeritus

### T

Tomkins, Reginald P.T., Professor

### V

Voronov, Roman S., Assistant Professor

### W

Wang, Xianqin, Associate Professor

### X

Xu, Xiaoyang, Assistant Professor

## Programs

- Biopharmaceutical Engineering - M.S. (p. 875)
- Chemical Engineering - M.S. (p. 879)
- Pharmaceutical Engineering - M.S. (p. 880)

## Programs

- Chemical Engineering - Ph.D. (p. 886)

Pharmaceutical Technology

Pharmaceutical Management

## Chemical, Biological, and Pharmaceutical Engineering Courses

**CHE 501. Fundamentals of Chemical Engineering I. 6 credits, 6 contact hours.**
Prerequisites: MATH 222 or equivalent, CHEM 231 or equivalent(see undergraduate catalog descriptions). An intensive course in basic chemical engineering science intended for students in the bridge program. Topics include material and energy balances, thermodynamics, kinetics and reactor design, and staged separation processes. May not be taken for degree credit in any chemical engineering program.

**CHE 502. Fundamentals of Chemical Engineering II. 4 credits, 4 contact hours.**
Prerequisites: MATH 222 or equivalent (see undergraduate catalog for description), CHE 501 or equivalent. A continuation of CHE 501. An intensive course in basic chemical engineering science intended for students in the bridge program. Topics include fluid mechanics, heat transfer and diffusion-controlled processes. May not be taken for degree credit in any chemical engineering program.

**CHE 590. Graduate Co-op Work Experience I. 3 credits, 0 contact hours.**
Restriction: permission from department and Division of Career Development Services. Cooperative education internship provides on-the-job reinforcement of the academic program by placement in major-related work situations. Work assignment developed or approved by the co-op office and evaluated by the department. Cannot be used for degree credit.

**CHE 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: permission from department and Division of Career Development Services.

**CHE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: permission from department and Division of Career Development Services.

**CHE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer and approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CHE 599. Methods for Teaching Assistants and Graduate Assistants. 3 credits, 3 contact hours.**
Restriction: graduate standing. Required for all chemical engineering teaching assistants and graduate assistants. Covers techniques of teaching, interaction with students, and safety. Does not count as degree credit.

**CHE 602. Selected Topics in Chemical Engineering I. 3 credits, 3 contact hours.**
Restriction: graduate standing. Topics of current interest in chemical engineering.

**CHE 603. Separation Process Principles. 3 credits, 3 contact hours.**
Prerequisites: CHE 342, CHE 349, CHE 363, CHE 364, CHE 367, CHE 471. The course covers the basic principles of separation with or without chemical reaction in phase equilibrium-based, external field-driven and membrane-based separation processes.

**CHE 604. Membrane Separation Processes. 3 credits, 3 contact hours.**
Prerequisites: CHE 342, CHE 349, CHE 363, CHE 364, CHE 367, CHE 471. This course covers the science, technology, engineering analysis and design of membrane separation processes, membrane reactors, membrane-based equilibrium separation processes and hybrid membrane processes.

**CHE 611. Thermodynamics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in physical chemistry and thermodynamics, or equivalent. Principles of thermodynamics developed quantitatively to include thermodynamic functions and their application to chemical engineering processes.

**CHE 612. Kinetics of Reactions and Reactor Design. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in chemical engineering kinetics, or equivalent. Elements of optimum design introduced for reactor types, series and parallel reactor systems, multiple reactions, and temperature effects. Introduction to non-ideal reactor design. Study of various models for catalytic and non-catalytic solid-fluid reactions.

**CHE 619. Nano-scale Characterization of Materials. 3 credits, 3 contact hours.**
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy; near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project.

**CHE 623. Heat Transfer. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in heat transfer. Heat transmission applied to practical problems in design. An introduction will include review of conduction, convection and radiation heat transfer modes. Related topics covered will be heat exchangers, types and design principles (including Kern & Bell?s methods), effectiveness, (NTU Design and Rating methods), Fired Heaters, Design & Rating and Cooling Towers, Design & Rating.

**CHE 624. Transport Phenomena I. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in fluid mechanics, heat transfer, and mass transfer. A unified treatment of molecular and turbulent momentum, energy, and mass transport. Emphasis is on the mathematical description of physical mechanisms in momentum and energy transport.

**CHE 625. Microlevel Modeling in Particle Technology. 3 credits, 3 contact hours.**
Presents methodologies for analyzing the macroscopic properties of particulate systems in terms of the underlying microlevel processes. Significant components are the mathematical modeling of particulate systems at the microlevel, analytical and numerical methods for predicting macroscopic properties from microlevel models, and comparison of theoretical predictions with experimental results. Demonstrates the importance of the interaction of these three components in the scientific process. The first part concerns the flow of dry particles where any interstitial fluid can be ignored. The second part considers the flow of particles suspended in an interstitial fluid. Also includes a class project involving development of simulations. Same as ME 624.

**CHE 626. Mathematical Methods in Chemical Engineering. 3 credits, 3 contact hours.**
Prerequisite: MATH 222 or equivalent undergraduate degree in Chemical Engineering. The purpose of the course is to emphasize the importance of mathematics to chemical engineering practice. Applications of ordinary differential equations, Sturm-Liouville problems arising from partial differential equations, regular Perturbation approaches to some nonlinear systems of chemical engineering interests, use of Laplace transfroms expecially the Residue Theorem for inversions and some numerical methods. It is suggested that students take this course before taking CHE 624.

**CHE 627. Introduction to Biomedical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in thermodynamics and differential equations. Introduction to the structure and composition of the body followed by an exploration of the properties of blood and its flow in the cardiovascular system; the body as a heat source and as a series of compartments involved in mass transfer of materials (such as those in the kidneys and lungs). Design of artificial kidneys and heart-lung machines is also explored. Same as BME 627.

**CHE 628. Biochemical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate degree in chemical engineering. The application of chemical engineering to biological processes, biochemical reaction systems, and their technological use. Special attention given to problems in momentum, energy, and mass transport, as well as chemical reaction kinetics in biological systems.

**CHE 634. Chemical Process Dynamics and Control. 3 credits, 3 contact hours.**
Prerequisite: undergraduate chemical engineering course in process dynamics and control. Mathematical principles of process dynamics and control; derivation and solution of differential equations describing the behavior of typical chemical engineering processing units; and mathematical analysis and design of control systems. Digital and sampled data control systems also discussed.

**CHE 650. Environ Catalysis Fund & Appl. 3 credits, 3 contact hours.**
Prerequisites:Senior Standing or Graduate Industrial Catalysis course. An introduction to catalytic processes used for environmental abatement.
The course provides background information necessary to understand environmental catalytic processes. A review of mobile and stationary pollution abatement technologies are reviewed.

**CHE 654. Corrosion. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in Chemistry. Fundamental principles including thermodynamics and kinetics of corrosion; forms of corrosion (e.g. galvanic, crevice and stress); methods of corrosion measurement; high temperature corrosion; and special case histories.

**CHE 656. Industrial Catalysis: Fundamentals and Applications. 3 credits, 3 contact hours.**
The class provides an introduction to catalytic phenomena as well as catalysts. It provides the background information necessary to understand industrial catalytic processes. Examples which will be discussed are hydrogen, ammonia and methanol synthesis, inorganic and organic oxidation reactions, petrochemical processes as well as pollution abatement and other important processes. The course provides insight into the theory of catalytic phenomena and also provides practical information about these processes from an industrial perspective.

**CHE 675. Statistical Thermodynamics. 3 credits, 3 contact hours.**
Prerequisite: CHE 611 or permission of instructor. Application of equilibrium statistical mechanics to chemical engineering problems. Basic postulates and relationships of statistical thermodynamics, including the ideal gas, ideal crystal, and virial equation; statistical theories of fluid mixtures and other advanced topics.

**CHE 681. Polymerization-Principles and Practice. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in physical or organic chemistry or CHE 503 or equivalent. The course focuses on the structural and synthetic aspects of polymers and examines in detail a number of bench and industrial scale polymerization methods. In addition to kinetics and mechanisms of commercially important polymerization systems, the course examines reactive modification of synthetic and natural polymers and provides an introduction to applicable characterization methods.

**CHE 682. Polymer Structures and Properties. 3 credits, 3 contact hours.**
Prerequisite: Undergraduate physical chemistry, a materials related course or CHE 503 or equivalent. The course provides an overview of polymer structures and properties and their relationships from the molecular viewpoint to phenomenological descriptions. Topics include thermodynamics of a single molecule, dynamic theory and viscoelasticity of polymers, polymer solids and mechanical properties, rubbers, polymer blends and composites, biological polymers, and special applications. New areas and innovative applications of polymers will be introduced.

**CHE 683. Polymer Processing. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in transport phenomena, fluid flow, or heat transfer or approval of graduate advisor. The course provides a systematic approach to the physical phenomena occurring in polymer processing machinery. The synthesis of the elementary steps of polymer processing are shown in relation to the development of extrusion die flow and extrusion products and injection mold flows and molded products. Structural and residual stresses are examined.

**CHE 684. Materials and Process Selection for Polymer Product Design. 3 credits, 3 contact hours.**
Prerequisites or corequisites: CHE 681, CHE 682, CHE 683 or approval of graduate advisor. The course provides methodologies for designing polymer-based products by considering materials and processing methods. Methods for selecting homopolymers, polymer blends and composites for specific appilcations will be presented in terms of properties, processability, manufacturing methods and economics. Process/structure/property correlations are presented as well as approaches to product design including CAD, prototyping, and strength and failure criteria. Case studies from biomedical, packaging and other applications are discussed.

**CHE 700. Master's Project. 0 credits, 0 contact hours.**

**CHE 700B. Masters Project. 3 credits, 3 contact hours.**

**CHE 701B. Masters Thesis. 3 credits, 3 contact hours.**

**CHE 701C. Masters Thesis. 6 credits, 3 contact hours.**

**CHE 702. Selected Topics in Chemical Engineering II. 3 credits, 3 contact hours.**
Restriction: graduate standing. Topics of current interest in chemical engineering.

**CHE 705. Independent Study. 3 credits, 3 contact hours.**
Restriction: permission from the graduate advisor (not dissertation advisor) in chemical engineering. Students working on their PhD or MS theses cannot register for this course with their respective thesis advisors. This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**CHE 706. Independent Study II. 3 credits, 3 contact hours.**

**CHE 721. Combustion Reaction Engineering. 3 credits, 3 contact hours.**
Restriction: undergraduate degree in Chemical or Mechanical Engineering. Topics related to the engineering of combustion systems will be discussed. These include laminar flames, turbulent combustion, ideal reactor modeling of complex combustion systems, combustion chemistry, heterogeneous combustion and incineration.

**CHE 724. Sustainable Energy. 3 credits, 3 contact hours.**
The course is a project-based advanced graduate course which requires strong background in engineering thermodynamics and transport phenomena. The main goals of this course are to gain an understanding of the cost-benefit ratio of various alternative energy sources and to understand some of the various obstacles associated with current and conventional technologies and industrial applications. Different renewable and conventional energy technologies will be discussed in class. Course materials include biomass energy, fossil fuels, geothermal energy, nuclear power, wind power, solar energy, hydrogen fuel, hydropower, and fuel cells. Students will learn a quantitative framework to aid in evaluation and analysis of energy technology systems in the context of engineering, political, social, economic, and environmental goals.

**CHE 725. Transport Phenomena II. 3 credits, 3 contact hours.**
Prerequisite: CHE 624 or equivalent. Transport in laminar and turbulent flow: in solids, between phases, and macroscopic transport in flow systems.

**CHE 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Required of all students for the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 6 credits of dissertation per semester until 36 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved.

**CHE 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**CHE 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**CHE 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**CHE 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**CHE 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**CHE 790F. Dissertation & Res. 15 credits, 3 contact hours.**

**CHE 790G. Doctrl Dissertatopm & Resrch. 18 credits, 0 contact hours.**

**CHE 791. Graduate Seminar. 0 credits, 1 contact hour.**
Required of all chemical engineering students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

**CHE 792. Pre-Doctoral Research. 3 credits, 3 contact hours.**
Restriction: permission of Associate Chairperson for Graduate Studies. For students admitted to the Doctor of Philosophy Program in Chemical Engineering who have not yet passed the qualifying examination. Research is carried out under the supervision of designated chemical engineering faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied to the 36 credits required under ChE 790.

**CHE 792C. Pre-Doctoral Research. 6 credits, 0 contact hours.**

**CHE 794. Professional Presentations for Ph.D. Students. 0 credits, 0 contact hours.**
Intended to help students make better technical presentations. Each student is required to make a presentation on a research topic; guest lectures will occur during the semester.

**PHEN 500. Pharmaceutical Engineering Fundamentals I. 3 credits, 3 contact hours.**
Prerequisite: undergraduate calculus. This is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree. This course is not counted toward degree credit related to the Pharmaceutical Engineering MS program. The course covers the fundamentals of calculus, differential equations, probability and statistics, and finance business mathematics applied to pharmaceutical engineering problems and illustrated through pharmaceutical engineering examples.

**PHEN 501. Pharmaceutical Engineering Fundamentals II. 3 credits, 3 contact hours.**
Prerequisite: If needed, PHEN 500 (which can also be taken concurrently with this course), as well as an undergraduate course in physical chemistry. This course is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree or with an engineering background that did not include the topics covered in this course. The course is not counted toward degree credit related to the Pharmaceutical Engineering MS program. The course covers the fundamentals of pharmaceutical engineering calculations related to material and energy balances applied to pharmaceutical facilities and systems; estimation of thermophysical properties, phase and reaction equilibrium; and chemical kinetics and basic reactor design.

**PHEN 502. Pharmaceutical Engineering Fundamentals III. 3 credits, 3 contact hours.**
Prerequisite:If needed, PHEN 500 and PHEN 501, as well as undergraduate course in physical chemistry. This is a required bridge course for those students who are admitted to the Pharmaceutical Engineering MS program without an undergraduate engineering degree or with an engineering background that did not include the topics covered in this course. The course is not counted toward degree credit related to the Pharmaceutical Engineering MS program. The course covers the fundamentals of fluid mechanics, heat transfer, mass transfer and the design of unit operations involving these principles.

**PHEN 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisite: permission from Pharmaceutical Engineering Program Advisor and Division of Career Development Services. Cooperative education internship provides on-the-job reinforcement of the academic program by placement in major-related work situations at pharmaceutical companies or companies serving the pharmaceutical industry. Work assignment developed or approved by the co-op office and evaluated by the department. Cannot be used for degree credit.

**PHEN 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisite: permission from Pharmaceutical Engineering Program Advisor and Division of Career Development Services. Same range of activities as in PHEN 590.

**PHEN 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisite: permission from Pharmaceutical Engineering Program Advisor and Division of Career Development Services. Same range of activities as in PHEN 590 and PHEN 591.

**PHEN 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**PHEN 601. Principles of Pharmaceutical Engineering. 3 credits, 3 contact hours.**
This course provides an overview of the pharmaceutical industry, including basic information about drug discovery and development, FDA requirements and approval processes, drug dosage forms, and the role of key operational units in drug manufacturing processes. This course enables the students to: understand the role of the pharmaceutical industry in the global market and its implications; learn the fundamentals of the drug development cycle and the investment required to bring a drug to market; learn the most important drug manufacturing processes and the key elements of dosage formulation.

**PHEN 602. Pharmaceutical Facility Design. 3 credits, 3 contact hours.**
Prerequisite: PHEN 601, PHEN 603; undergraduate courses in differential equations and fluid flow or completion of bridge program for students who are required to take it. This course provides instruction in design of state-of-the art pharmaceutical facilities for both manufacturing and R&D, by identifying key functional requirements and design concepts necessary to pharmaceutical processes. Interdisciplinary training will be provided in appropriate areas of facility design.

**PHEN 603. Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems. 3 credits, 3 contact hours.**
This course examines methodologies, both applied and fundamental, to analyze and scale up manufacturing pharmaceutical processes involving liquid and dispersed-phase systems, such as liquid and multiphase mixing, sterilization and sanitation, lyophilization, filtration, centrifugation and others. The emphasis is primarily on the engineering aspects of the parmaceutical processes examined in the course.

**PHEN 604. Validation and Regulatory Issues in the Pharmaceutical Industry. 3 credits, 3 contact hours.**
This course is focused on the development of a working knowledge of the Federal Code of Regulations and its impact on the pharmaceutical and allied industries. The history of the Federal Government's regulation of the pharmaceutical industry is studied. Also covered is the industry's response and the methodologies it uses to comply with these regulations.

**PHEN 605. Pharmaceutical Packaging Technology. 3 credits, 3 contact hours.**
Prerequisite: PHEN 601, PHEN 603, and completion of the bridge program for students who are required to take it. This course focuses on developing a working knowledge of the machinery and unit operations used in transferring a drug substance in the bulk final form to a finished product ready for sale to the consuming public. Packaging of both liquid and solid forms in various types of delivery containers such as vials/ampoules, blister packs, individual packets, bottles, pouches and syringes is examined. The cleaning, sterilization and scaling/capping required for each dosage form is discussed, as well as freeze-drying, tableting capsule filling, and form/fill/seal, and proper labeling of final drug forms.

**PHEN 606. Pharmaceutical Unit Operations: Solids Processing. 3 credits, 3 contact hours.**
This course examines methodologies, both applied and fundamental, to analyze and scale up manufacturing pharmaceutical processes involving solids processing, such as solids characterization, blending, milling, granulation, tableting, coating, and others. The emphasis is primarily on the engineering aspects of the pharmaceutical processes examined in the course.

**PHEN 612. Pharmaceutical Reaction Engineering. 3 credits, 3 contact hours.**
Prerequisite: PHEN 601, PHEN 603; undergraduate courses in differential equations and chemical engineering kinetics, or completion of bridge program for students who are required to take it. This course examines a variety of reactions and reactors typically encountered in the pharmaceutical industry, including single/multiphase systems (e.g., crystallization), chemical synthesis, enzymatic, bio-reactions (fermentation), and others. The course then focuses on quantitative pharmaceutical reactor design and scale-up issues.

**PHEN 614. Pharmaceutical Separation Processes. 3 credits, 3 contact hours.**
This course covers separation processes in general and pharmaceutical separations in particular. Specific processes to be studied include distillation, extraction, crystallization, adsorption, ion exchange, chromatography, moving bed processes, electrophoresis, freeze drying, microfiltration/ultrafiltration, reverse osmosis, and pervaporation.

**PHEN 618. Principles of Pharmacokinetics and Drug Delivery. 3 credits, 3 contact hours.**
The course covers the basic principles of pharmacokinetics, including drug transport, parenteral and enteral routes of drug administration, and factors affecting drug absorption, distribution, metabolism, and excretion. Mathematical pharmacokinetic models and drug delivery processes are also presented and quantitatively studied.

**PHEN 698. Special Topics in Pharmaceutical Engineering I. 3 credits, 3 contact hours.**
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

**PHEN 699. Special Topics in Pharmaceutical Engineering II. 3 credits, 3 contact hours.**
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

**PHEN 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: matriculation for the Master's degree in pharmaceutical engineering. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the pharmaceutical engineering faculty, and one other faculty member. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHEN 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: matriculation for the Master's degree in pharmaceutical engineering. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the pharmaceutical engineering faculty, and one other faculty member. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHEN 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: matriculation for the Master's degree in pharmaceutical engineering. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the pharmaceutical engineering faculty, and one other faculty member. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

**PHEN 702. Selected Topics in Pharmaceutical Engineering. 3 credits, 3 contact hours.**
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

**PHEN 725. Independent Study. 3 credits, 3 contact hours.**
Prerequisites: permission from the graduate advisor (not the thesis advisor) in pharmaceutical engineering, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which is not of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

**PHEN 791. Graduate Seminar. 0 credits, 0 contact hours.**
Required, when offered, of all pharmaceutical engineering graduate students receiving departmental or research-based awards. The student must register each semester until completion of the degree, if the Graduate Seminar is offered. Outside speakers and department members present their research for general discussion.

# M.S. in Biopharmaceutical Engineering

## Bridge Program

Depending on the background of the applicant, the bridge program may consist of up to (but generally speaking less than, at least for students with engineering degrees) three 3-credit courses specifically designed to provide non-chemical engineers with the necessary prerequisites to enter the program.

A grade point average of at least 3.0 must be achieved in the bridge courses. Students should pay special attention to the successful completion of the bridge courses, since failure to do so may preclude them from enrolling in regular PhEn courses. Students must take the bridge courses before taking any other PhEn courses, with the exception of PHEN 601 Principles of Pharmaceutical Engineering and PHEN 604 Validation and Regulatory Issues in the Pharmaceutical Industry, which can be taken concurrently with the bridge courses. As mentioned, admission conditions may also include taking undergraduate or graduate courses, if needed.

## Degree Requirements

The Master of Science in Biopharmaceutical Engineering is a 30-credit program, including 21 credits worth of core courses. Students have the option of fulfilling six (6) of the nine (9) credit of electives by doing a Master's Thesis. The thesis option is primarily, but not exclusively, meant for full time students. Full-time students receiving support (full or partial) must complete a Master's Thesis. Part-time students working in the Pharmaceutical industry are encouraged to pursue a Master's Thesis, possibly conducted at their and in collaboration with their supervisor.

Students must maintain an overall cumulative grade point average of at least 3.0 throughout their academic career.

Students are certified for graduation only if they:

- Achieve an overall cumulative grade point average of at least 3.0; and
- Achieve a grade point average of at least 3.0 in the required core courses; and
- Achieve a grade point average of at least 3.0 in the bridge courses (if taking the bridge courses is required).

Students may not repeat a course without approval of both the Program Director and the Office of Graduate Studies. If a student repeats a course, the grades received in the first two repeated courses will replace the original grades in the calculation of the cumulative grade point average, although the old grades will still appear on the transcripts. However, the grades received in all repeated courses beyond the first two will count in the calculation of the cumulative grade point average. Students who receive an F in a course are required to repeat the course.

## Program of Study/Curriculum

A minimum of 30 credits is required for degree completion. Of these, 21 credits must be obtained by taking seven (7) prescribed Core Courses, which include Pharmaceutical Bioprocessing (PhB) courses as well as Pharmaceutical Engineering (PhEn) courses. In addition, engineering applicants with little or no biology background, but not biology or pharmacy applicants, may be required to take an additional Foundation Course (PHB 505 Principles of Pharm. Microbiology and Biochemistry), which will count toward the 30 credits required to complete the PhB program. The remaining credits needed to achieve the required 30 credits may be obtained by taking either elective courses only or a combination of an elective course and M.S. Thesis credits. As already indicated, applicants with a science background or an engineering degree in a discipline other than chemical engineering may be required to additionally take one or more bridge courses. Bridge courses do not count toward the 30 credits required to complete the program.

## Course Requirements

### M.S. in Biopharmaceutical Engineering (non-engineering applicants with little or no biology background, courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I [1] | 3 |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II [1] | 3 |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | 3 |
| **Total Credits** | | **9** |

[1] PHEN 500 Pharmaceutical Engineering Fundamentals I and PHEN 501 Pharmaceutical Engineering Fundamentals II should be taken concurrently.

| | | |
|---|---|---|
| **Foundation Course** | | |
| PHB 505 | Principles of Pharm. Microbiology and Biochemistry | 3 |
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| PHB 610 | Biotechnology-Biopharmaceutical, Processes and Products | 3 |
| PHB 615 | Bioseparation Processes | 3 |
| PHB 630 | Pharmaceutical Bioprocess Engineering | 3 |
| **Electives** | | |
| Elective courses [1] | | 6 |
| **Total Credits** | | **30** |

[1] Partial list of approved electives is in Electives table. Electives can be selected from among *appropriate* courses in disciplines including but not limited to pharmaceutical engineering, chemical engineering, mechanical engineering, industrial engineering, engineering management, pharmaceutical system management, biomedical engineering, chemistry, biology, mathematics and others. Students are encouraged to choose electives from a variety of offering departments. In general, all technical and scientific courses that are relevant to the program could be selected, typically in consultation with the Program Advisor.

### M.S. in Biopharmaceutical Engineering (non-engineering applicants with little or no biology background, Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I [1] | 3 |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II [1] | 3 |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | 3 |
| **Total Credits** | | **9** |

[1] PHEN 500 Pharmaceutical Engineering Fundamentals I and PHEN 501 Pharmaceutical Engineering Fundamentals II should be taken concurrently.

| | | |
|---|---|---|
| **Foundation Course** | | |
| PHB 505 | Principles of Pharm. Microbiology and Biochemistry | 3 |
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| PHB 610 | Biotechnology-Biopharmaceutical, Processes and Products | 3 |
| PHB 615 | Bioseparation Processes | 3 |
| PHB 630 | Pharmaceutical Bioprocess Engineering | 3 |
| **Thesis** | | |

| | |
|---|---|
| PHB 701 Master's Thesis [1] | 6 |
| **Total Credits** | **30** |

1 Must register during the last semester before graduation, even if this requires taking additional thesis credits beyond the required six (6) credits.

## M.S. in Biopharmaceutical Engineering (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| PHB 610 | Biotechnology-Biopharmaceutical, Processes and Products | 3 |
| PHB 615 | Bioseparation Processes | 3 |
| PHB 630 | Pharmaceutical Bioprocess Engineering | 3 |
| **Electives** | | |
| Elective courses [1] | | 9 |
| **Total Credits** | | **30** |

1 Partial list of approved electives is in Electives table. Electives can be selected from among *appropriate* courses in disciplines including but not limited to pharmaceutical engineering, chemical engineering, mechanical engineering, industrial engineering, engineering management, pharmaceutical system management, biomedical engineering, chemistry, biology, mathematics and others. Students are encouraged to choose electives from a variety of offering departments. In general, all technical and scientific courses that are relevant to the program could be selected, typically in consultation with the Program Advisor.

## M.S. in Biopharmaceutical Engineering (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| PHB 610 | Biotechnology-Biopharmaceutical, Processes and Products | 3 |
| PHB 615 | Bioseparation Processes | 3 |
| PHB 630 | Pharmaceutical Bioprocess Engineering | 3 |
| **Thesis** | | |
| PHB 701 Master's Thesis [1] | | 6 |
| **Electives** | | |
| Elective course [2] | | 3 |
| **Total Credits** | | **30** |

1 Must register during the last semester before graduation, even if this requires taking additional thesis credits beyond the required six (6) credits.

2 Partial list of approved electives is in Electives table. Electives can be selected from among *appropriate* courses in disciplines including but not limited to pharmaceutical engineering, chemical engineering, mechanical engineering, industrial engineering, engineering management, pharmaceutical system management, biomedical engineering, chemistry, biology, mathematics and others. Students are encouraged to choose electives from a variety of offering departments. In general, all technical and scientific courses that are relevant to the program could be selected, typically in consultation with the Program Advisor.

## Electives

| | | |
|---|---|---|
| PHEN 698 | Special Topics in Pharmaceutical Engineering I | 3 |
| PHEN 699 | Special Topics in Pharmaceutical Engineering II | 3 |
| PHB 701B | Master's Thesis | 3 |
| PHB 701C | Master's Thesis | 6 |
| PHB 725 | Independent Study I | 3 |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |

| | | |
|---|---|---|
| PHEN 612 | Pharmaceutical Reaction Engineering | 3 |
| PHEN 614 | Pharmaceutical Separation Processes | 3 |
| BME 651 | Principles of Tissue Engineering | 3 |
| BME 672 | Biomaterials | 3 |
| CHE 611 | Thermodynamics | 3 |
| CHE 624 | Transport Phenomena I | 3 |
| CHE 626 | Mathematical Methods in Chemical Engineering | 3 |
| CHE 656 | Industrial Catalysis: Fundamentals and Applications | 3 |
| CHE 675 | Statistical Thermodynamics | 3 |
| CHE 681 | Polymerization-Principles and Practice | 3 |
| CHEM 601 | Special Topics in Chemistry I (Special Topics in Chemistry I) | 3 |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 606 | Physical Organic Chemistry | 3 |
| CHEM 658 | Advanced Physical Chemistry | 3 |
| CHEM 661 | Instrumental Analysis Laboratory | 3 |
| CHEM 664 | | 3 |
| CHEM 673 | Biochemistry | 3 |
| EM 636 | Project Management | 3 |
| EM 637 | Project Control | 3 |
| EM 640 | Distribution Logistics | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 605 | Engineering Reliability | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| IE 672 | Industrial Quality Control | 3 |
| IE 673 | Total Quality Management | 3 |
| IE 674 | Quality Maintenance and Support Systems | 3 |
| IE 704 | Sequencing and Scheduling | 3 |
| MATH 613 | Advanced Applied Mathematics I: Modeling | 3 |
| MATH 635 | Analytical Computational Neuroscience | 3 |
| MATH 637 | Foundations of Mathematical Biology | 3 |
| MATH 654 | Clinical Trials Design and Analysis | 3 |
| MATH 661 | Applied Statistics | 3 |
| MATH 663 | Introduction to Biostatistics | 3 |
| MATH 664 | Methods for Statistical Consulting | 3 |
| R120 512 | Cell Biology: Methods & Appl | 3 |
| R120 515 | Molecular Bio Of Eukaryotes | 3 |
| R120 601 | Human Molecular Genetics | 3 |

## M.S. Thesis

Full-time students receiving full or partial financial support must complete a Master's Thesis. Part-time students can also complete a Master's Thesis if they so choose. Part-time students working in industry are also eligible, and encouraged, to pursue the thesis option, possibly even conducted at their site and in collaboration with their supervisor. Students doing a thesis must select a Thesis Advisor who will guide them trough their thesis work. The students must also complete a form indicating the three (3) faculty members composing their MS Thesis Committee, to be selected in consultation with their Thesis Advisor. Students who are required, or choose, to do a thesis must take six (6) credits of PHB 701 Master's Thesis in lieu of six (6) credits worth of electives courses, and must choose their remaining elective course(s) in concultation with their Thesis Advisor. NJIT requires that students who elect to do a thesis must register for thesis during the last semester before graduation, even if this requires taking addition thesis credits beyond the required six (6) credits. Completion of the thesis requirements also includes:

1. writing the thesis document, to be approved by the Thesis Committee, and
2. making a final oral presentation to the MS Thesis Committee.

## Student Involvement in Research

In addition to taking courses, students have the opportunity to work, one-on-one, with faculty members on research projects in areas of common interest, allowing maximum flexibility for independent work, and providing students with valuable research experience. Students have the option to complete a

Master's Thesis. Part-time students working in the pharmaceutical industry are encouraged to pursue a Master's Thesis, possibly conducted at their site and in collaboration with their supervisor.

Qualified and research oriented students have the option of continuing their studies at NJIT by pursuing a Ph.D. in chemical engineering, industrial engineering, chemistry, or related disciplines. The NJIT-Industry Collaborative Ph.D. Program allows greater flexibility to industrial students who are interested in pursuing their Ph.D. while working *full-time* in industry.

# M.S. in Chemical Engineering

## Degree Requirements

A minimum of 30 credits is required. Students must attain a minimum GPA of 3.0 in the core courses listed below, and a minimum overall GPA of 3.0.

## Degree Options

### M.S. in Chemical Engineering (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| CHE 611 | Thermodynamics | 3 |
| CHE 612 | Kinetics of Reactions and Reactor Design | 3 |
| CHE 624 | Transport Phenomena I | 3 |
| CHE 626 | Mathematical Methods in Chemical Engineering | 3 |
| **Elective Courses** | | |
| Three 600 or 700-level Chemical Engineering courses | | 9 |
| Chemical Engineering, Pharmaceutical Engineering, or Chemistry course | | 3 |
| Two Elective courses | | 6 |
| **Total Credits** | | **30** |

[1] 500-level courses offered in the department do not count toward degree requirements.

### M.S. in Chemical Engineering (students receiving departmental or research-based support)

| | | |
|---|---|---|
| **Core Courses** | | |
| CHE 611 | Thermodynamics | 3 |
| CHE 612 | Kinetics of Reactions and Reactor Design | 3 |
| CHE 624 | Transport Phenomena I | 3 |
| CHE 626 | Mathematical Methods in Chemical Engineering | 3 |
| **Thesis** [1] | | |
| CHE 701 Master's Thesis | | 6 |
| **Seminar** | | |
| CHE 791 | Graduate Seminar [2] | 0 |
| **Elective Courses** | | |
| 600 or 700-level Chemical Engineering course | | 3 |
| Chemical Engineering, Pharmaceutical Engineering, or Chemistry course | | 3 |
| Two Elective courses | | 6 |
| **Total Credits** | | **30** |

[1] Before deciding on a thesis topic and advisor, students must discuss thesis topics with at least three faculty members and get their signature on a form provided by the department. The signed form with the name of advisor selected and tentative title of thesis topic must be returned to the department for approval. Change of advisor requires consent of the previous advisor and departmental approval. The completed thesis must be examined and signed by three faculty members at least two of which must be on the department faculty. An oral presentation is also required. The MS thesis committee must be formed and submitted to the department for approval at least one semester before the expected graduation date. The department provides a form for the formation of the MS thesis committee.

[2] All students who receive departmental or research-based support must enroll each semester in CHE 791 Graduate Seminar.

[3] 500-level courses offered in the department do not count toward degree requirements.

### M.S. in Chemical Engineering (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| CHE 611 | Thermodynamics | 3 |

| | | |
|---|---|---|
| CHE 612 | Kinetics of Reactions and Reactor Design | 3 |
| CHE 624 | Transport Phenomena I | 3 |
| CHE 626 | Mathematical Methods in Chemical Engineering | 3 |
| **Thesis** [1] | | |
| CHE 701 Master's Thesis | | 6 |
| **Elective Courses** | | |
| 600 or 700-level course(s) in Chemical Engineering | | 3 |
| Chemical Engineering, Pharmaceutical Engineering, or Chemistry course | | 3 |
| Two elective courses | | 6 |
| **Total Credits** | | **30** |

1 Before deciding on a thesis topic and advisor, students must discuss thesis topics with at least three faculty members and get their signature on a form provided by the department. The signed form with the name of advisor selected and tentative title of thesis topic must be returned to the department for approval. Change of advisor requires consent of the previous advisor and departmental approval. The completed thesis must be examined and signed by three faculty members at least two of which must be on the department faculty. An oral presentation is also required. The MS thesis committee must be formed and submitted to the department for approval at least one semester before the expected graduation date. The department provides a form for the formation of the MS thesis committee.

2 500-level courses offered in the department do not count toward degree requirements.

# M.S. in Pharmaceutical Engineering

Depending on the background of the applicant this bridge program may consist of up to (but generally speaking less, at least for students with engineering degrees) three 3-credit courses specifically designed to provide non-chemical engineers with the necessary prerequisites to enter the program.

A grade point average of at least 3.0 must be achieved in the bridge courses. Students should pay special attention to the successful completion of the bridge courses, since failure to do so may preclude them from enrolling in regular PhEn courses. Students must take the bridge courses before taking any other PhEn courses, with the exception of PHEN 601 Principles of Pharmaceutical Engineering and PHEN 604 Validation and Regulatory Issues in the Pharmaceutical Industry, which can be taken concurrently with the bridge courses. As already mentioned, admission conditions may also include taking additional undergraduate or graduate courses, if needed.

## Degree Requirements

The Master of Science in Pharmaceutical Engineering is a 30-credit program structured along two different tracks. The two tracks have a common 15-credit core. Each track has an additional 6-credit track-core, as described below. Each track has 9 credits of electives selected by the student in consultation with, and subject to, the approval of the program advisor for the selected track

Students have the option of fulfilling 6 of the 9 credits of electives by doing a Master's Thesis. The thesis option is primarily, but not exclusively, meant for full-time students. Full-time students receiving support (full or partial) must complete a Master's Thesis. Part-time students working in the pharmaceutical industry are encouraged to pursue a Master's Thesis, possibly conducted at their site and in collaboration with their supervisor.

Students must maintain an overall cumulative grade point average of at least 3.0 throughout their academic career. Students are certified for graduation only if they:

- achieve an OVERALL cumulative grade point average of at least 3.0; and
- achieve a grade point average of at least 3.0 in the required seven CORE COURSES; and
- achieve a grade point average of at least 3.0 in the BRIDGE COURSES.

Students may not repeat a course without approval of both the Program Director and the Office of Graduate Studies, located in the East Building, Suite 140. The grade received in a repeated course will replace the original grade in the calculation of the cumulative grade point average, although the first grade will still appear on the transcript. A MAXIMUM OF TWO COURSES MAY BE REPEATED. Students who receive an F in a course are required to repeat the course.

## Program of Study

The program of study includes common core courses, track-specific core courses, elective courses, and, if the students so chooses, a thesis (in lieu of some elective courses), as specified below. The common core courses cover a variety of topics ranging from drug dosage forms to drug manufacturing processes, validation and regulatory issues, design criteria and unit operations for pharmaceutical processes, pharmacokinetics and drug delivery.

The program has two tracks, i.e.:

- Track 1 - Process Development and Design for Drug Substance Manufacturing. This track is focused on the engineering aspects of chemical reaction and separation processes required for the manufacturing of active pharmaceutical ingredients.
- Track 2 - Process Development and Design for Drug Product Manufacturing. This track is focused on the engineering aspects of processes required for the manufacturing of final drug products.

All students must take the same five (5) common core courses as well as the two (2) track-specific core courses for the track that they have selected. Irrespective of the track selected, the total number of core courses (7) and the corresponding core credits (21) are the same for both tracks.

## Course Requirements

### M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Substance Manufacturing (applicants with science background or engineering degree other than chemical or mechanical, courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I [1] | 3 |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II [1] | 3 |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | 3 |
| **Total Credits** | | **9** |

[1] PHEN 500 Pharmaceutical Engineering Fundamentals I and PHEN 501 Pharmaceutical Engineering Fundamentals II are offered in the fall and should be taken concurrently.

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 612 | Pharmaceutical Reaction Engineering | 3 |
| PHEN 614 | Pharmaceutical Separation Processes | 3 |
| **Electives** | | |
| Elective courses [1] | | 9 |
| **Total Credits** | | **30** |

[1] Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

### M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Substance Manufacturing (applicants with science background or engineering degree other than chemical or mechanical, Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I [1] | 3 |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II [1] | 3 |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | 3 |
| **Total Credits** | | **9** |

[1] PHEN 500 Pharmaceutical Engineering Fundamentals I and PHEN 501 Pharmaceutical Engineering Fundamentals II are offered in the fall and should be taken concurrently.

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |

| | | |
|---|---|---|
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Thesis** | | |
| PHEN 701 Master's Thesis [1] | | 6 |
| **Electives** | | |
| Elective courses [2] | | 3 |
| **Total Credits** | | **30** |

1 A student must register for thesis during the last semester before graduation, even if this requires taking additional thesis credit beyond the required 6.

2 Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

## M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Substance Manufacturing (courses only)

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 612 | Pharmaceutical Reaction Engineering | 3 |
| PHEN 614 | Pharmaceutical Separation Processes | 3 |
| **Electives** | | |
| Elective courses [1] | | 9 |
| **Total Credits** | | **30** |

1 Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

## M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Substance Manufacturing (Master's thesis)

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Thesis** | | |
| PHEN 701 Master's Thesis [1] | | 6 |
| **Electives** | | |

| | | |
|---|---|---|
| Elective courses [2] | | 3 |
| **Total Credits** | | **30** |

1. A student must register for thesis during the last semester before graduation, even if this requires taking additional thesis credit beyond the required 6.
2. Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

## M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Product Manufacturing (applicants with science background or engineering degree other than chemical or mechanical, courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I [1] | 3 |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II [1] | 3 |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | 3 |
| **Total Credits** | | **9** |

1. PHEN 500 Pharmaceutical Engineering Fundamentals I and PHEN 501 Pharmaceutical Engineering Fundamentals II are offered in the fall and should be taken concurrently.

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Electives** | | |
| Elective courses [1] | | 9 |
| **Total Credits** | | **30** |

1. Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

## M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Product Manufacturing (applicants with science background or engineering degree other than chemical or mechanical, Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| PHEN 500 | Pharmaceutical Engineering Fundamentals I [1] | 3 |
| PHEN 501 | Pharmaceutical Engineering Fundamentals II [1] | 3 |
| PHEN 502 | Pharmaceutical Engineering Fundamentals III | 3 |
| **Total Credits** | | **9** |

1. PHEN 500 Pharmaceutical Engineering Fundamentals I and PHEN 501 Pharmaceutical Engineering Fundamentals II are offered in the fall and should be taken concurrently.

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |

| | | |
|---|---|---|
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Thesis** | | |
| PHEN 701 | Master's Thesis [1] | 6 |
| **Electives** | | |
| Elective course [2] | | 3 |
| **Total Credits** | | **30** |

1. A student must register for thesis during the last semester before graduation, even if this requires taking additional thesis credit beyond the required 6.
2. Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

| | | |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Electives** | | |
| Elective courses [1] | | 3 |
| **Thesis** | | |
| PHEN 701 | Master's Thesis [2] | 6 |
| **Total Credits** | | **30** |

1. Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.
2. A student must register for thesis during the last semester before graduation, even if this requires taking addition thesis credit beyond the required 6.

## M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Product Manufacturing (courses only)

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Electives** | | |

| | |
|---|---|
| Elective courses [1] | 9 |
| **Total Credits** | **30** |

1 Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

## M.S. in Pharmaceutical Engineering, Process Development and Design for Drug Product Manufacturing (Master's thesis)

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 603 | Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| PHEN 606 | Pharmaceutical Unit Operations: Solids Processing | 3 |
| PHEN 618 | Principles of Pharmacokinetics and Drug Delivery | 3 |
| **Track Core Courses** | | |
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| **Thesis** | | |
| PHEN 701 | Master's Thesis [1] | 6 |
| **Electives** | | |
| Elective course [2] | | 3 |
| **Total Credits** | | **30** |

1 A student must register for thesis during the last semester before graduation, even if this requires taking additional thesis credit beyond the required 6.

2 Partial list of approved electives is in Electives table. Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others.

## Electives

The following is a non-exhaustive, partial list of courses that can be taken as elective courses:

| | | |
|---|---|---|
| PHEN 602 | Pharmaceutical Facility Design | 3 |
| PHEN 605 | Pharmaceutical Packaging Technology | 3 |
| PHEN 612 | Pharmaceutical Reaction Engineering | 3 |
| PHEN 614 | Pharmaceutical Separation Processes | 3 |
| PHEN 701 | Master's Thesis | 0 |
| PHEN 702 | Selected Topics in Pharmaceutical Engineering | 3 |
| PHEN 725 | Independent Study | 3 |
| BME 672 | Biomaterials | 3 |
| BME 675 | Computer Methods in Biomedical Engineering | 3 |
| CHE 611 | Thermodynamics | 3 |
| CHE 624 | Transport Phenomena I | 3 |
| CHE 626 | Mathematical Methods in Chemical Engineering | 3 |
| CHE 627 | Introduction to Biomedical Engineering | 3 |
| CHE 628 | Biochemical Engineering | 3 |
| CHE 656 | Industrial Catalysis: Fundamentals and Applications | 3 |
| CHE 675 | Statistical Thermodynamics | 3 |
| CHE 681 | Polymerization-Principles and Practice | 3 |
| CHEM 601 | Special Topics in Chemistry I | 3 |
| CHEM 605 | Advanced Organic Chemistry I: Structure | 3 |
| CHEM 606 | Physical Organic Chemistry | 3 |

| | | |
|---|---|---|
| CHEM 658 | Advanced Physical Chemistry | 3 |
| CHEM 661 | Instrumental Analysis Laboratory | 3 |
| CHEM 664 | | 3 |
| CHEM 673 | Biochemistry | 3 |
| CS 610 | Data Structures and Algorithms | 3 |
| CS 631 | Data Management System Design | 3 |
| EM 636 | Project Management | 3 |
| EM 637 | Project Control | 3 |
| EM 640 | Distribution Logistics | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 605 | Engineering Reliability | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| IE 672 | Industrial Quality Control | 3 |
| IE 673 | Total Quality Management | 3 |
| IE 674 | Quality Maintenance and Support Systems | 3 |
| IE 704 | Sequencing and Scheduling | 3 |
| ME 624 | Microlevel Modeling in Particle Technology | 3 |
| MNE 601 | Computerized Manufacturing Systems | 3 |
| MNE 602 | Flexible and Computer Integrated Manufacturing | 3 |

## M.S. Thesis

Part-time students working in the pharmaceutical industry are eligible and encouraged to pursue the thesis option.

## Student Involvement in Research

In addition to taking courses, students have the opportunity to work, one-on-one, with faculty members on research projects in areas of common interest, allowing maximum flexibility for independent work, and providing students with valuable research experience. Students have the option to complete a Master's thesis. PART-TIME STUDENTS WORKING IN THE PHARMACEUTICAL INDUSTRY ARE ENCOURAGED TO PURSUE A MASTER'S THESIS, POSSIBLY CONDUCTED AT THEIR SITE AND IN COLLABORATION WITH THEIR SUPERVISOR.

Qualified and research oriented students have the option of continuing their studies at NJIT by pursuing a Ph.D. in chemical engineering, industrial engineering, chemistry, or related disciplines. The NJIT-Industry Collaborative Ph.D. Program allows greater flexibility to industrial students who are interested in pursuing their Ph.D. while working full-time in industry.

# Ph.D. in Chemical Engineering

## Degree Requirements

To graduate, students must have an approved dissertation and attain an overall GPA of at least 3.0. Students need always to get departmental approval for the courses they take for their degree requirements.

## Ph.D. in Chemical Engineering (students with master's in chemical engineering)

| | | |
|---|---|---|
| **Electives** | | |
| 700-level courses | | 12 |
| **Dissertation** | | |
| CHE 790 Doct Dissertation & Res [2] | | |
| **Seminar** | | |
| CHE 791 | Graduate Seminar [3] | 0 |
| **Total Credits** | | **12** |

[1] No more than 6 credits may be CHE 705 Independent Study. No more than 3 credits in CHE 705 Independent Study may be taken with the same supervising faculty member. The supervising faculty member may never be the student's dissertation advisor. 700-level courses may be substituted by 600-level courses if the academic advisor appeals on behalf of the student to the Office of Graduate Studies and receives approval.

[2] Ph.D. students who pass the Qualifying Examination (QE) must then register for 3 credits of pre-doctoral research (CHE 792 Pre-Doctoral Research) per semester until they defend successfully the dissertation proposal. Ph.D. students who defend the dissertation proposal successfully must then register for the 1-credit dissertation course (CHE 790 Doct Dissertation & Res) each semester until they complete all degree requirements. Students may take courses simultaneously with the 790 or 792 course as per Ph.D. program guidelines or dissertation committee recommendation.

[3] Students must register every semester for this seminar. Part-time students may request that this requirement be waived for some semesters.

## Ph.D. in Chemical Engineering (students without master's in chemical engineering)

| | | |
|---|---|---|
| **Required Courses** [1] | | |
| CHE 611 | Thermodynamics | 3 |
| CHE 612 | Kinetics of Reactions and Reactor Design | 3 |
| CHE 624 | Transport Phenomena I | 3 |
| CHE 626 | Mathematical Methods in Chemical Engineering | 3 |
| **Electives** | | |
| 700-level chemical engineering or chemistry courses | | 6 |
| 700-level courses [2] | | 6 |
| Electives | | 12 |
| **Dissertation** | | |
| CHE 790 Doct Dissertation & Res [3] | | |
| **Seminar** | | |
| CHE 791 | Graduate Seminar [4] | 0 |
| **Total Credits** | | **36** |

[1] Must attain a minimum GPA of 3.0 in the required courses.

[2] No more than 6 credits may be CHE 705 Independent Study. No more than 3 credits in CHE 705 Independent Study may be taken with the same supervising faculty member. The supervising faculty member may never be the student's dissertation advisor. 700-level courses may be substituted by 600-level courses if the academic advisor appeals on behalf of the student to the Office of Graduate Studies and receives approval.

[3] Ph.D. students who pass the Qualifying Examination (QE) must then register for 3 credits of pre-doctoral research (CHE 792 Pre-Doctoral Research) per semester until they defend successfully the dissertation proposal. Ph.D. students who defend the dissertation proposal successfully must then register for the 1-credit dissertation course (CHE 790 Doct Dissertation & Res) each semester until they complete all degree requirements. Students may take courses simultaneously with the 790 or 792 course as per Ph.D. program guidelines or dissertation committee recommendation.

[4] Students must register every semester for this seminar. Part-time students may request that this requirement be waived for some semesters.

## Selection of Dissertation Advisor

Students must select a dissertation topic and advisor within 6 months of joining the program. Before making a decision, students should discuss research topics with at least five faculty members of the department and get their signature on a form provided by the department. The signed form with the names of advisors selected must be returned to the department for further processing. Advisors are assigned based on student preferences and availability of funding. Change of advisor requires consent of the previous advisor and departmental approval. In cases where more than one advisor is directing the dissertation, the primary advisor must be on the departmental faculty.

## Qualifying Examination

All PhD candidates must pass a qualifying examination. Students must take the examination by the end of the second semester after enrolling in the PhD program. If repeated examination is necessary, the examination must be passed by the end of the third semester after enrolling in the PhD program.

***Pre-requisites for the qualifying examination:***

- Average grade of 3.5 for all four core courses and a minimum grade B in each of the core courses taken at NJIT

- Equivalent grade for the same subject course based on the MS transcript from an institution other than NJIT may be acceptable, as decided by the Graduate Studies Committee
- Students whose subject courses differ from those offered at NJIT, so that their MS transcript grades are not deemed acceptable as equivalent to the NJIT core courses by the Graduate Studies Committee are required to take final examinations for each of the core courses during their first two semesters after enrolling into PhD program to satisfy the present requirement.

- A student can take the final examination in each core course up to two times to satisfy the present requirement.

- Failing the present requirement is equivalent to the failing the qualifying examination.

***Qualifying examination format***

The examination is administered by an Examination Committee including at least three members of the CBPE graduate faculty.  The Examination Committee is appointed by the Graduate Studies Committee each semester.  The Examination Committee does not include the student’s current or potential PhD thesis adviser.

Three months before the examination date, an assignment is given to a student to prepare for the qualifying examination.  The assignment is given by the student’s current or potential PhD thesis adviser in coordination with Examination Committee.  The assignment identifies a research topic to be addressed in two parts of the examination:

- A written paper, comprising a literature review (no longer than 20 pages excluding references; 12 pts font, double spaced) on the identified research topic. The review needs to

- Identify an open research problem,
- Outline state of the art, and
- Propose an approach for future research in this area.
- If pertinent, results of preliminary work may be included.

- An oral presentation no longer than 20 min, followed by questions.  The presentation will be open to the public; committee deliberations following the presentations will be restricted to the committee members only.

The result of the examination is determined by the Examination Committee based on the review of the written paper, oral examination, and feedback from the current or potential PhD thesis adviser.

A student is allowed to repeat the qualifying examination only once.

## Formation of Dissertation Committee

Within three months of passing the qualifying examination, doctoral students must form a dissertation committee. The department provides a special form. The signed form must be submitted for the approval of the Associate Chair for Graduate Studies in Chemical Engineering. The committee must consist of the doctoral student's dissertation advisor, three additional faculty members from the department, and one member from outside the department (preferably outside the university). The committee may consist of more than five persons, subject to the approval of the Associate Chair. Once formed, the committee cannot change unless there is a written explanation and request from the doctoral student and/or his/her advisor. The Associate Chair for Graduate Studies handles such requests.

## Research Proposal

Within six months of forming the dissertation committee (i.e., no more than nine months after passing the qualifying examination), doctoral students must make an oral presentation to their dissertation committee and other interested persons on the scope of their proposed research. The committee must formally approve the proposal within a maximum of three additional months. This ensures meeting the requirements that doctoral students must have an approved dissertation committee and an approved dissertation proposal within a year of passing the qualifying examination. The approved and signed proposal must be submitted to the Associate Chair for Graduate Studies so that it is kept in the student's file.

## Dissertation Defense

An oral defense of the dissertation is required after submission of the final document to the dissertation committee for approval. Signatures of all members of the dissertation committee must be received for final approval to be granted. The oral defense is open to the university community and general public and must be announced early.

# Civil and Environmental Engineering

## Civil Engineering

In the information technology age, more resources are available for building new cities, repairing the infrastructure, cleaning up the environment: these are all tasks for the civil engineer. Major corporations, government agencies, private consulting and construction firms, and universities are just some of the organizations that employ civil engineers.

In-depth knowledge in one of the areas of civil engineering is essential for professional practice as well as for research. Courses are taught by full-time faculty members with a range of academic and professional experience as well as by adjunct instructors who are experts in their fields. Those students interested in research at the master's level or continuing their education at the doctoral level should consider working with faculty involved in one of the university's related research centers.

## Master of Science in Civil Engineering

The M.S. in Civil Engineering is designed for those who want both specialized course work and the flexibility to tailor their program to their needs.

### Admission Requirements

Applicants are expected to have an undergraduate degree in civil engineering or its equivalent, and must have proficiency in basic sciences and mathematics. Students who lack an appropriate undergraduate background may be granted conditional admission in order to complete a bridge program or its equivalent. These courses are taken in addition to regular degree requirements; descriptions may be found in the undergraduate catalog. A minimum bachelor's GPA of 2.8 on a 4.0 scale, or equivalent, is normally required for admission. The Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) is required for all international applicants. The Graduate Record Examination (GRE) is required for international applicants and full-time domestic applicants.

### Graduate Certificate Program

A 12-credit graduate certificate in Construction Management is available as a step toward this degree. Please see **Graduate Certificates** in this catalog for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

### Master of Architecture (M.Arch.) and M.S. in Civil Engineering Dual Degree Program

This program permits students to obtain a Master of Architecture with a Master of Science in Civil Engineering. There is no reduction in the degree requirements for the Master of Architecture program. This dual degree program permits students to obtain the M.S. in Civil Engineering in substantially less time; in some cases, in only one more semester of full-time study. This dual degree program is described in the Architecture degree program section (p. 642) in this catalog.

## Civil Engineering - Online Master of Science in Civil Engineering

Online learning allows students the chance to earn a master's degree without coming to campus. Online courses are virtual learning communities with instructor-led online classrooms that use rich platforms to present course material. There are three specialty areas to choose from: Construction Management, Structural Design and Construction and Transportation.

### Admission Requirements

Students are expected to have an undergraduate degree in engineering or its equivalent.

## PhD in Civil Engineering

This is a program for superior students with master's degrees in civil engineering or allied fields who wish to do advanced research in an area of civil engineering. In exceptional circumstances, highly qualified students with bachelor's degrees in civil engineering may be accepted directly into the doctoral program.

### Admission Requirements

A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is normally required for admission. The GRE (general section) is required of all applicants. The Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) is required for international applicants.

## M.S. in Critical Infrastructure Systems Admission Requirements

Students are expected to have an undergraduate degree in engineering or its equivalent.

Bridge program-Students who lack an appropriate background are asked to make up deficiencies by taking a program of courses that is designed in consultation with the graduate advisor. These courses are taken in addition to the degree requirements, and typically center around upgrading their background in statistics and mathematics. If this background is not sufficient, the minimal bridge course consists of EM 503 Methods and Applications of Industrial Statistics and Probability.

# Environmental Engineering

Environmental engineers are essential participants in the planning, design and construction of waste water and potable water treatment plants, solid waste disposal systems, site remediation and emission control measures, and other similar projects. Major corporations, government agencies, private consulting and construction firms, and universities are just some of the organizations that employ environmental engineers.

In-depth knowledge in environmental engineering is essential for professional practice as well as for research. Full-time faculty members with a range of academic and professional practice experience as well as by adjunct instructors who are experts in their field teach the courses. Those students interested in research at the master's level or continuing their education at the doctoral level should consider working with faculty involved in one of the university's related major research centers.

## Master of Science in Environmental Engineering

The M.S. in Environmental Engineering is designed for those who want both specialized course work and the flexibility to tailor their program to their needs.

### Admission Requirements

Applicants are expected to have an undergraduate degree in engineering or its equivalent. Students who lack an appropriate undergraduate background may be granted conditional admission in order to complete a bridge program or its equivalent. These courses are taken in addition to regular degree requirements; descriptions may be found in the undergraduate catalog. A minimum bachelor's GPA of 2.8 on a 4.0 scale, or equivalent, is normally required for admission. The Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) is required for all international applicants. The Graduate Record Examination (GRE) is required for international applicants and full-time domestic applicants.

## Doctor of Philosophy in Environmental Engineering

This is a program for superior students with master's degrees in environmental engineering, civil engineering, or allied fields who wish to conduct advanced research in an area of environmental engineering. In exceptional circumstances, highly qualified students with bachelor's degrees in civil engineering or environmental engineering may be accepted directly into the doctoral program.

### Admission Requirements

A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is normally required for admission. The GRE (general section) is required of all applicants. The Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) is required for international applicants.

# Transportation

NJIT's transportation program prepares students to be transportation planners, engineers, and managers who can plan, design, operate, and manage transportation systems capable of satisfying society's transportation needs.

Transportation is vital to our society's proper functioning, providing mobility of people, goods and services. It enables people to access job markets and participate in recreational, cultural, educational, and social activities. It adds value to products by moving them to their destination in time for their use. The transportation field also is a major contributor to the economy, as a consumer of resources and as a supplier of jobs.

Transportation functions in a very complex environment which, at the beginning of the 21st Century, is characterized by constant change in the technological, regulatory and legal frameworks. Transportation professionals must not only be able to meet the technological challenges of new systems, they must also be capable of fitting these systems into the social, economic, and physical environments in a manner that improves the quality of life for all.

Through the NJIT-based Institute for Transportation, the transportation graduate program provides excellent opportunities for students to engage in research on all forms of transportation, including all phases of activities concerned with the provision of services and the movement of people and goods. The Institute for Transportation is a major resource for public and private organizations and is well-known for its academic programs and research activities.

## Master of Science in Transportation

This is a program for students from diverse educational backgrounds with a variety of career goals that prepares them for careers in designing, planning, operating, maintaining and managing urban and rural transportation systems. The master's degree is a valued professional credential for individuals engaged in the transportation field.

## Graduate Certificate Program

A 12-credit graduate certificate in Transportation Studies is available as a step toward this degree. Please see **Graduate Certificates** in this catalog for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

*Off-Campus Programs:* At the New Jersey Department of Transportation (NJ DOT), in Trenton, NJIT offers sufficient courses to fulfill all degree requirements. All courses are taught by NJIT faculty.

### Admission Requirements

Applicants should have a bachelor's degree from an accredited institution with some undergraduate background in economics, mathematics, probability and statistics, and computers.

## Doctor of Philosophy in Transportation

The doctoral program is for well-qualified students who are mature in scholarship and purpose. It offers a well-balanced mixture of theoretical studies and experimental research. A student must demonstrate creative thinking, self-motivation, and ability to do independent research. In their research, students are expected to deal with complex issues, effectively formulate difficult problems, devise new methodology, and achieve new and exceptional results.

### Admission Requirements

Students should have adequate preparation in mathematical and other analytical techniques, and substantial knowledge of the ideas and techniques of synthesis. A thorough understanding of the social and economic factors intrinsic to the functioning and development of transport in urban areas also is necessary. It is expected that students will have earned a minimum GPA of 3.5 in a master's degree program in engineering, planning, or business administration from an accredited university. Outstanding students with baccalaureate degrees also may be accepted. All applicants must take the GRE. Full-time study is preferred for doctoral studies.

# NJIT Faculty

## A

Adams, Matthew, Assistant Professor

Axe, Lisa B., Professor

## B

Bagheri, Sima, Professor

Bandelt, Matthew, Assistant Professor

Boufadel, Michel, Professor

## C

Chien, I Jy, Steven, Professor

## D

Daniel, Janice R., Associate Professor

Dauenheimer, Edward G., Professor Emeritus

Ding, Yuan, Associate Professor

Dresnack, Robert, Professor

## E

Esmaili, Danial, University Lecturer

## G

Golub, Eugene B., Professor

Goncalves da Silva, Bruno, Assistant Professor

Greenfeld, Joshua S., Professor Emeritus

H

Hsieh, Hsin-Neng, Professor

## K

Karaa, Fadi A., Associate Professor

Khera, Raj P., Professor Emeritus

Kimmel, Howard S., Professor Emeritus

Konon, Walter, Professor

## L

Lee, Joyoung, Assistant Professor

Liu, Rongfang, Associate Professor

## M

Marhaba, Taha F., Professor

Meegoda, Jay N, Professor

Milano, Geraldine, Senior University Lecturer

## O

Olenik, Thomas J., Associate Professor

## R

Raghu, Dorairaja, Professor Emeritus

## S

Saadeghvaziri, Mohamad A., Professor

Saigal, Sunil, Distinguished Professor

Salek, Franklin, Professor Emeritus

Santos, Stephanie R, University Lecturer

Schuring, John, R., Professor

Spasovic, Lazar, Professor

## W

Wecharatana, Methi, Professor

## Z

Zhang, Wen, Assistant Professor

# Programs

- Civil Engineering - M.S. (p. 901)
- Civil Engineering - M.S. online (p. 900)
- Critical Infrastructure Systems - M.S. (p. 909)
- Environmental Engineering - M.S. (p. 910)
- Transportation - M.S. (p. 912)

# **Double Majors** (p. 589)

- Architecture - M.Arch. and Civil Engineering - M.S. (p. 642)

# Programs

- Civil Engineering - Ph.D. (p. 920)
- Environmental Engineering - Ph.D. (p. 921)
- Transportation - Ph.D. (p. 922)

Transportation Studies

Intelligent Transportation Systems

Construction Management

## Civil and Environmental Engineering Courses

**CE 501. Introduction to Soil Behavior. 3 credits, 4 contact hours.**
Prerequisites: MECH 320, MECH 235 with a grade of C or better and MECH 236 with a grade of C or better(see undergraduate catalog for descriptions). Open only to the students in bridge program. Permission from CEE department graduate advisor is required. Covers the necessary concepts in strength of materials, geology and soil mechanics required for the bridge program in M.S. in Environmental Engineering and Geoenvironmental Engineering option.

**CE 502. Civil Construction Methods. 3 credits, 3 contact hours.**
Prerequisites: PHYS 111 and MATH 112, or equivalents Open only to students in Online M.S. in Civil Engineering, Construction Management Option. Covers essential concepts in civil and construction engineering including site surveys, construction materials, and soil behavior to partially satisfy bridge requirements.

**CE 506. Remote Sensing of Environment. 3 credits, 3 contact hours.**
Prerequisite: PHYS 234 (see undergraduate catalog for description). Covers the principles of remote sensing, general concepts, data acquisition procedures, data analysis and role of remote sensing in terrain investigations for civil engineering practices. Data collection from airborne and satellite platforms will be emphasized. Photographic and non-photographic sensing methodologies will be covered as well as manual and computer assisted data analysis techniques for site investigations and examination of ground conditions.

**CE 531. Design of Masonry and Timber Structures. 3 credits, 3 contact hours.**
Prerequisite: CE 332 (see undergraduate catalog for description). Study of basic properties of clay and concrete masonry units and wood. The masonry segment includes discussion of unreinforced bearing walls subjected to concentric as well as eccentric loads. Lateral-force resistance of unreinforced and reinforced masonry systems are introduced and new developments to strengthen and retrofit unreinforced masonry walls are discussed. The timber design portion includes design and behavior of wood fasteners, beams, columns, and beam-columns as well as introduction to plywood and glued laminated members.

**CE 545. Rock Mechanics I. 3 credits, 3 contact hours.**
Restriction: approved undergraduate course in soil mechanics within last five years or permission of instructor. Rock mechanics including geological aspects, mechanical properties, testing, and in-situ measurements of rock properties, and a brief introduction to design of structures in rock.

**CE 552. Geometric Design of Transportation Facilities. 3 credits, 3 contact hours.**
Prerequisite: CE 350 or equivalent (see undergraduate catalog for description). Design principles and criteria related to highways and railroads resulting from requirements of safety, vehicle performance, driver behavior, topography, traffic, design speed, and levels of service. Elements of the horizontal and vertical alignments and facility cross-section, and their coordination in the design. Computer-aided design procedures including COGO, CADAM, Digital Terrain Modeling. Same as TRAN 552.

**CE 553. Design and Construction of Asphalt Pavements. 3 credits, 3 contact hours.**
Importance of designing proper asphalt pavements. Topics include the origin of crude, refining crude, types of asphalts, desired properties of asphalt cement, specification and tests for asphalt cement, aggregates for asphalt mixtures, aggregate analysis, gradation and blending, hot-mix asphalt (HMA) mix design, manufacture of HMA and HMA-paving, hot and cold recycling. Same as TRAN 553.

**CE 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: permission from the civil engineering department and the Division of Career Development Services. Cooperative education/internship providing on-the-job reinforcement of academic programs in civil engineering. Work assignments and projects are developed by the co-op office in consultation with the civil engineering department; and evaluated by civil engineering faculty co-op advisors.

**CE 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: permission from the civil engineering department and the Division of Career Development Services.

**CE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: permission from the civil engineering department and the Division of Career Development Services.

**CE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer and approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**CE 602. Geographic Information System. 3 credits, 3 contact hours.**
Restriction: course or working knowledge of CADD or permission of instructor. Geographical/Land Information System (GIS/LIS) is a computerized system capable of storing, manipulating and using spatial data describing location and significant properties of the earth's surface. GIS is an interdisciplinary technology used for studying and managing land uses, land resource assessment, environmental monitoring and hazard/toxic waste control. Introduces this emerging technology and its applications. Same as MIP 652 and Tran 602.

**CE 605. Research Methods in Remote Sensing. 3 credits, 3 contact hours.**
Prerequisites: CE 601 and MATH 661. Major components of RS data acquisition systems, overview of image processing techniques with emphasis on neural network and traditional pattern recognition, principal component transformations, and data reduction. Emphasizes geometric and mapping aspects of RS/GIS techniques for linking RS images with spatial data, sources of error, and accuracy assessment techniques. Hands-on experience with existing hardware/software (ERDAS & GENESIS).

**CE 606. Geospatial Data Applications. 3 credits, 3 contact hours.**
Prerequisite: CE 602. The course focuses on geospatial data processing, information extraction and analysis tools. It provides visualization and decision support applications using desktop GIS software. Examples of the student projects include: Applications of integrated geospatial date in environmental, infrastructure, urban planning and homeland security.

**CE 610. Construction Management. 3 credits, 3 contact hours.**
Restriction: B.S. degree in CE, technology, architecture, or related field. Managerial aspects of contracting. Study of an individual firm in relation to the entire construction industry. Topics include contractor organization and management, legal aspects of construction, and financial planning.

**CE 611. Project Planning and Control. 3 credits, 3 contact hours.**
Prerequisite: CE 610. Management tools as related to construction projects are analyzed and applied to individual projects. Emphasis is on network scheduling techniques, time-cost analysis, resource allocation and leveling, cost estimating, bidding strategy, and risk analysis.

**CE 614. Underground Construction. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in soil mechanics. Various aspects of underground construction, including rock and soft ground tunneling; open cut construction; underpinning; control of water; drilling and blasting rock; instrumentation; and estimating underground construction costs. Case studies and a field trip to an underground construction site will be included.

**CE 615. Infrastructure and Facilities Remediation. 3 credits, 3 contact hours.**
Restriction: graduate standing in civil engineering and basic knowledge of structures, and material science. Examines the methodology of inspection, field testing, evaluation and remediation of existing infrastructure and facilities, which include pipelines, tunnels, bridges, roadways, dams, and buildings. Typical materials distress and failure scenarios will be covered with remediation options through the use of case studies.

**CE 616. Construction Cost Estimating. 3 credits, 3 contact hours.**
Prerequisite: CE 610. Full range of construction cost-estimating methods including final bid estimates for domestic building and heavy/highway projects; computerized takeoff and estimating techniques; international construction; financial and cost reporting; databases; indices; risk; competition; performance; and profit factors.

**CE 617. Historic Preservation. 3 credits, 3 contact hours.**
This course addresses the many aspects of structural preservation from both an engineering and aesthetic perspective. Course topics include: permits and regulations, an overview of architectural styles, designation of historic structures, past methods of construction, current methods of preservation and the availability of grants and funding. Knowledge gained from the course will be applied directly to course projects involving the evaluation and recommendations needed for the proposed preservation of an existing structure.

**CE 618. Applied Hydrogeology. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in earth science/geology, fluid mechanics, and calculus or permission of instructor. Examines ground water and contaminant movement through the subsurface environment. A basic understanding of the aquifer geology is emphasized. Hydrogeologic applications including well design, pumping tests, and computer modeling of subsurface flow, and methods to monitor and remediate contaminated groundwater are introduced.

**CE 620. Open Channel Flow. 3 credits, 3 contact hours.**
Prerequisite: undergraduate fluid mechanics. The principles developed in fluid mechanics are applied to flow in open channels. Steady and unsteady flow, channel controls, and transitions are considered. Application is made to natural rivers and estuaries.

**CE 621. Hydrology. 3 credits, 3 contact hours.**
Prerequisite: undergraduate fluid mechanics. The statistical nature of precipitation and runoff data is considered with emphasis on floods and droughts. The flow of groundwater is analyzed for various aquifers and conditions. Flood routing, watershed yield, and drainage problems are considered.

**CE 622. Coastal Engineering. 3 credits, 3 contact hours.**
Prerequisite: fluid mechanics and calculus. An introductory course covering basic wave theory, sediment transport and ocean circulation. The application of these principles to various coastal engineering problems will be discussed, including beach erosion, pollution transport in coastal waters, and the design of shore protection structures.

**CE 623. Groundwater Hydrology. 3 credits, 3 contact hours.**
Prerequisite: undergraduate fluid mechanics and computer programming, or consent of instructor. Basic principles of groundwater hydraulics; Darcian analysis of various aquifer systems; unsaturated flow into porous mediums; transport of contaminants in soil media; and mathematical models for fluid and contaminant transport.

**CE 631. Advanced Reinforced Concrete Design. 3 credits, 3 contact hours.**
Prerequisite: an undergraduate course in theory and design of reinforced concrete. A review of basic concepts of elastic and ultimate strength theories and a study of the present design codes. Topics include: design of concrete building frames, two-way slabs, flat slabs, deep beams, and other structural elements using the above two theories.

**CE 632. Prestressed Concrete Design. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in theory and design of reinforced concrete. Analysis and design of pre-tensioned and post-tensioned prestressed concrete elements for both determinate and indeterminate structures will be studied. Examples of prestressed elements used in buildings and bridges will be discussed, as well as the source and magnitude of prestress losses.

**CE 634. Structural Dynamics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in structural analysis. Dynamic analysis of beams, frames, and other types of structures. Practical methods developed are applied to problems such as the analysis of the effects of earthquakes on buildings and moving loads on bridges.

**CE 635. Fracture Mechanics of Engineering Materials. 3 credits, 3 contact hours.**
Restriction: graduate standing in civil and/or mechanical engineering and basic knowledge of structures and mechanics of materials. Basic principles of fracture mechanics to increase understanding of cracking and fracture behavior of materials and structures. Emphasis on practical applications of fracture mechanics.

**CE 636. Stability of Structures. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in theory of structural analysis. Topics include structural design concept; stability criteria; elastic and inelastic buckling; column buckling; lateral buckling of beams; stability of frames; stability of plates and shell; local buckling and post-buckling.

**CE 637. Short Span Bridge Design. 3 credits, 3 contact hours.**
Prerequisite: undergraduate courses in steel design and concrete design, and some knowledge of prestressed concrete fundamentals. Design and performance of highway and railroad bridges, particularly steel and prestressed concrete structures since they are most common in the northeast; and computer applications including bridge geometry, abutment design and composite beam design.

**CE 638. Nondestructive Testing Methods in Civil Engineering. 3 credits, 3 contact hours.**
Familiarizes the civil engineering student with nondestructive testing (NDT) techniques currently employed for evaluation and condition monitoring of civil structures and construction materials. Major emphasis in the application of NDT methodologies to steel, concrete, and timber as the construction material. Covers theories, principles, and testing methodologies associated with individual technologies from specific material point of view. Discusses advantages and limitations pertaining to the application of individual NDT technologies to construction materials.

**CE 639. Applied Finite Element Methods. 3 credits, 3 contact hours.**
Prerequisites: CE 332 and CS 101. Introduction to application of finite element method to problems of structural analysis and design. Review of matrix algebra and the stiffness method of structural analysis. Applications include trusses, frames, plates, shells, and problems of plane stress/strain. Application of finite element method to design.

**CE 641. Engineering Properties of Soils. 3 credits, 3 contact hours.**
Prerequisite: approved undergraduate course in soil mechanics within last five years. An in-depth study of physical and mechanical properties of soils. Topics include clay mineralogy, shear behavior and compressibility of fine and coarse grained soil; and in-situ measuring techniques such as vane shear, core penetration and pressure meter. Laboratory work includes consolidation test and triaxial test, with emphasis on analysis, interpretation and application of data to design problems.

**CE 642. Foundation Engineering. 3 credits, 3 contact hours.**
Prerequisite: approved undergraduate courses in soil mechanics and foundation engineering. The salient aspects of shallow foundation design such as bearing capacity and settlement analyses. Topics are relevant to the deep foundation, selection of the type and the determi-nation of load bearing capacity from soil properties, load tests, and driving characteristics utilizing wave equation analyses. Earth pressure theory and retaining wall design.

**CE 643. Advanced Foundation Engineering. 3 credits, 3 contact hours.**
Prerequisite: CE 642. Lateral and earth pressure computations for the design of retaining walls, bulkheads, cellular cofferdams, and sheetpiles. Also considers the design of internal bracing systems and anchors, soil nailing and reinforced earth. Slope stability of embankments and dams.

**CE 644. Geology in Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in geology or permission of instructor. Geology has a significant influence on how we plan, design, and construct engineering works. This course examines how the geologic formations underlying a locale will ultimately determine land use, control structure design, and affect construction material availability. Included is a study of the various rock-forming processes and geologic agents that have shaped Earth's surface. The course also explores the role of geologic factors in assessing environmental impacts and natural hazards such as earthquakes, subsiding soils, and landslides. Case study applications and a field trip are included.

**CE 645. Rock Mechanics II. 3 credits, 3 contact hours.**
Prerequisite: CE 545 or equivalent, or permission of instructor. Applications of design problems in underground structures, subways, stability of rock slopes, blasting, and seismic effects. A design project is a course requirement.

**CE 647. Geotechnical Aspects of Solid Waste. 3 credits, 3 contact hours.**
Prerequisites: CE 341, CE 341A or equivalents (see undergraduate catalog for descriptions). Geotechnical aspects of solid waste such as municipal landfill, dredged materials, coal and incinerator ashes, identification and classification of waste materials, geological criteria for siting, laboratory and field testing, design for impoundment and isolation of waste, methods of stability analyses of landfill sites, techniques for stabilizing waste sites, leachate and gas collection and venting systems. Primary emphasis is on municipal wastes.

**CE 648. Flow Through Soils. 3 credits, 3 contact hours.**
Prerequisite: CE 641. Explains the fundamentals of fluid flow through saturated and unsaturated soils and the use of computer programs for the solution of boundary value fluid flow problems in soils. The first two-thirds of the course are devoted to flow through saturated soils. The topics are mathematical description of flow through soils, solutions for steady state and transient state fluid flow and geotechnical applications. The last one-third is devoted to flow through unsaturated soils. Topics include steady state of transient state fluid flow and a presentation of how these concepts are applied to geoenvironmental problems.

**CE 649. Design & Construction of Concr. 3 credits, 3 contact hours.**
Importance of designing concrete pavements to resist distress or failure. Topics include the stresses in Rigid Pavement, Traffic and Loading, Material Characterization, Drainage, Pavement Performance, Rigid Pavement Design and Overlay Design.

**CE 659. Flexible and Rigid Pavements. 3 credits, 3 contact hours.**
Prerequisite: CE 341 or equivalent (see undergraduate catalog for description). Types of rigid (Portland cement) and flexible (bituminous) pavements. Properties of materials, including mineral aggregates. Design methods as functions of traffic load and expected life. Importance and consequences of construction methods. Maintenance and rehabilitation of deteriorated pavements. Same as TRAN 659.

**CE 671. Performance and Risk Analysis of Infrastructure Systems. 3 credits, 3 contact hours.**
This course presents a comprehensive systems approach to infrastructure asset management across areas of public and private infrastructure. Topics include the framework of integrated asset management illustrated in transportation, water and wastewater systems, the economic evaluation of infrastructure options, using life cycle cost analysis (LCCA) and cost-benefit analysis (CBA). The elements of performance measurement and modeling, including condition assessment and information management, failure and impact analysis are covered. Decision and risk analysis are covered to enable students to develop a holistic economic, performance and risk analysis approach to infrastructure management illustrated in a term project.

**CE 672. Security Management of Critical Infrastructure. 3 credits, 3 contact hours.**
This course focuses on the areas of vulnerability assessment and security management of critical infrastructure systems. A review of techniques for facility and network modeling and performance simulation, leads to sector-specific approaches to vulnerability analysis and critical infrastructure protection strategies using a Model-Based Vulnerability Analysis (MBVA). Covered critical infrastructure systems include water supply/environmental, transportation, power and energy systems, SCADA systems, cyber-infrastructure and telecommunications. The course ends with a review of the combined use of multi-criteria analysis techniques, expert heuristic response to scenarios and network analysis techniques in a general framework for vulnerability and security management of infrastructure systems in its key aspects: prevention, warning/detection and event mitigation and response planning and execution.

**CE 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: student must have sufficient experience and/or graduate courses in major field to work on the project. Subject matter to be approved by the department. Permission to register must be obtained from the project advisor. Extensive investigation, analysis, or design of civil engineering problems not covered by regular graduate course work is required. A student with an exceptional project in CE 700 may, upon his/her own initiative and with the approval of his/her advisor, substitute the work of this course as the equivalent of the first 3 credits for CE 701 Master's Thesis. Students must register for 3 credits every semester until the project is completed.

**CE 700B. Civil Engr Project. 3 credits, 3 contact hours.**

**CE 701. Masters Thesis. 0 credits, 0 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester until completion and submittal of an approved document. Credit will be limited, however, to the 6 credits indicated for the thesis.

**CE 701B. Master's Thesis. 3 credits, 3 contact hours.**

**CE 701C. Master's Thesis. 6 credits, 3 contact hours.**

**CE 702. Special Topics in Civil Engineering. 3 credits, 3 contact hours.**
Restriction: advisor's approval. Topics of special current interest in civil engineering.

**CE 705. Mass Transportation Systems. 3 credits, 3 contact hours.**
Prerequisites: CE 625 and TRAN 610 or IE 610. An investigation of bus, rapid transit, commuter railroad, and airplane transportation systems. Existing equipment, economics, capacity, and terminal characteristics are discussed, as well as new systems and concepts. Long- and short-range transportation systems are compared. Same as TRAN 705.

**CE 711. Methods Improvement in Construction. 3 credits, 3 contact hours.**
Prerequisite: CE 610. Improved methods in construction; various techniques of work sampling and productivity measurement; and current innovations in the construction industry for increasing efficiency.

**CE 720. Water Resource Systems. 3 credits, 3 contact hours.**
Prerequisites: CE 620, CE 621. A system methodology is applied to the analysis of water resource development and operation. Topics include operational hydrology, water quality criteria, streamflow requirements, resource allocation, and economics. Mathematical models are developed and employed in the evaluation of a case study.

**CE 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**CE 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**CE 727. Independent Study III. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**CE 730. Plastic Analysis and Design. 3 credits, 3 contact hours.**
Prerequisite: CE 639. Theory of plasticity applied to structural design. Study of methods of predicting strength and deformation of single and multi-story steel frames in the plastic range. Comparison of plastic and prestressed concrete.

**CE 733. Design of Metal Structures. 3 credits, 3 contact hours.**
Prerequisites: CE 639 and CE 636. Methods of design of metal structural systems. Topics include combined action of unsymmetrical sections, torsion of open and closed sections, buckling of columns and plates with various end conditions, and design of curved and boxed girders.

**CE 734. Design of Tall Buildings and Space Structures. 3 credits, 3 contact hours.**
Prerequisites: CE 639 and CE 636. Design of tall buildings and space structures emphasizing framing systems, and recent developments and current research related to the design of such structures.

**CE 736. Finite Element Methods in Structural and Continuum Mechanics. 3 credits, 3 contact hours.**
Prerequisite: MECH 630 and CE 630. Restriction: a working knowledge of computer programming. Finite element approaches for analysis of plane stress problems, plates in flexure, shells, and three-dimensional solids; and choice of interpolation functions, convergence, and the capabilities of the methods.

**CE 737. Earthquake Engineering. 3 credits, 3 contact hours.**
Prerequisite: CE 634. Practical design solutions for resisting the damaging effects of earthquake ground motions and other severe dynamic excitations. Factors which control dynamic response in elastic and inelastic ranges, and the nature of severe dynamic excitations. Theories of structural analysis and dynamics, and modern design methodologies on the behavior of structures.

**CE 739. Structural Optimization. 3 credits, 3 contact hours.**
Prerequisite: CE 639. Application of methods of mathematical programming to problems of optimal structural design. Optimal criteria methods, discrete and continuous systems, and code design will be covered.

**CE 742. Geotechnology of Earthquake Engineering. 3 credits, 3 contact hours.**
Prerequisite: CE 641. Explains the fundamentals of propagation of the earthquakes through soils to supporting structures and the use of computer programs in the solution of boundary value problems in soils. The first half is devoted to synthesis of earthquakes, mathematical formulation of the problem, measurement of applicable soil parameters, use of computer programs to solve 1-D wave propagation problems in soils with structures. The second half is devoted to soil liquefaction, soil-structure interaction, and design of machine foundations.

**CE 753. Airport Design and Planning. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or EM 693 and CE 660. Planning of individual airports and statewide airport systems. Functional decision of air and landside facilities. Orientation, number and length of runways. Concepts of airport capacity. Passenger and freight terminal facility requirements. Airport access systems. FAA operating requirements. Financial, safety and security issues. Same as IE 753 and TRAN 753.

**CE 765. Multi-modal Freight Transportation Systems Analysis. 3 credits, 3 contact hours.**
Prerequisites: TRAN 610 or equivalent and CE 650 or EM 602 or equivalent. Quantitative methods for the analysis and planning of freight transportation services. The supply-performance-demand paradigm for freight transportation systems. Cost and performance as determined by system design and operations. Relationship of traffic and revenue to service levels and pricing. Optimal service design and redesign for transportation enterprises and operations planning. Fleet and facility investment planning. Applications to various modes. Same as EM 765 and TRAN 765.

**CE 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Required of all candidates for the degree of Doctor of Philosophy. A minimum of 36 credits is required. Students must register for at least 6 credits of dissertation per semester until 36 credits are reached. Registration for additional credits may be permitted beyond the 6, with the approval of the advisor, to a maximum of 12 credits per semester. If the dissertation is not completed after 36 credits, registration for an additional 3 credits per semester is required thereafter. Registration for 3 credits is permitted during the summer session, hours to be arranged.

**CE 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.**

**CE 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.**

**CE 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**CE 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**CE 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**CE 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.**

**CE 791. Graduate Seminar. 0 credits, 1 contact hour.**
A seminar in which faculty or others present summaries of advanced topics suitable for research. Students and faculty discuss research procedures, thesis organization, and content. Students present their own research for discussion and criticism. Required of all doctoral students registered for CE 790 unless requirement is waived, in writing, by the dean of graduate studies.

**CE 792. Pre-Doctoral Dissertation. 3 credits, 3 contact hours.**

**CE 793B. Professional Project. 3 credits, 3 contact hours.**

**ENE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisite: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**ENE 630. Physical Processes of Env Syst. 3 credits, 3 contact hours.**

**ENE 660. Introduction to Solid and Hazardous Waste Problems. 3 credits, 3 contact hours.**
Prerequisite: ENE 663. (May be taken concurrently.) Introduction to solid waste disposal. Industrial and urban sources of solid waste and conventional methods of waste disposal. Application of engineering principles related to these topics.

**ENE 661. Environmental Microbiology. 3 credits, 3 contact hours.**

**ENE 662. Site Remediation. 3 credits, 3 contact hours.**
Prerequisite: EM 631. Can be taken concurrently with EM 631. Examines site remediation from start to finish. Includes regulations, cleanup standards, remedial investigations, feasibility studies, risk assessment, and safety. Examines established and innovative cleanup technologies such as incineration, containment, bioremediation, vapor extraction and ground water recovery.

**ENE 663. Water Chemistry. 3 credits, 3 contact hours.**
Prerequisite: undergraduate general chemistry. The ability to analyze and solve a wide range of chemical equilibrium problems in water chemistry is developed.

**ENE 664. Physical and Chemical Treatment. 3 credits, 3 contact hours.**
Prerequisite: ENE 663. Physical and chemical operations and processes employed in the treatment of water and wastewater. Topics include gas transfer, coagulation, flocculation, solid-liquid separation, filtration, and disinfection.

**ENE 665. Biological Treatment. 3 credits, 3 contact hours.**
Prerequisites: ENE 663, ENE 661. (May be taken concurrently.) Principles of evaluation and control of water pollution that describe aerobic treatment processes: oxidation ponds, trickling filters, and activated sludge. Anaerobic digestion and sludge handling and disposal as well as biodegradability study techniques for various wastes.

**ENE 666. Analysis of Receiving Waters. 3 credits, 3 contact hours.**
Prerequisites or corequisites: ENE 663 and ENE 661. Ecological responses of various types of receiving waters to municipal and industrial waste loadings. Mathematical models for water quality prediction and planning.

**ENE 667. Solid Waste Disposal Systems. 3 credits, 3 contact hours.**
Prerequisite: ENE 663. Review and evaluation of design criteria, methods, and equipment employed in handling and disposal of industrial and municipal solid wastes. Emphasis is on hazardous toxic waste, resource recovery, and regulatory constraints.

**ENE 671. Environmental Impact Analysis. 3 credits, 3 contact hours.**
Prerequisite or corequisite: ENE 663. A graduate course dealing with physical aspects of the environment. Overview of environmental problems, federal and state standards, methodology for developing impact statements, case studies based on recent experience, basis for assessment and decision making.

**ENE 672. Stormwater Management. 3 credits, 3 contact hours.**
This course provides a comprehensive study of stormwater management with emphasis on design practices. Topics include regulatory framework, an overview of structural and non-structural BMPs, groundwater recharge analysis, estimate of runoff, and design of detention basin and drainage systems.

**ENE 673. Sustainability and Life Cycle Analysis. 3 credits, 3 contact hours.**
The course provides a systematic foundation for the connection between evolving technology and human activity impacts on natural systems by emphasizing the sources of environmental degradation and energy use and strategies to reduce risk and promote sustainability. The course provides hands-on experience with life cycle assessment computer tools and approaches. The course emphasizes relationships between industrial activities and regional and global natural systems-physical, chemical and biological-focusing on the importance of sustainability goals and practices.

**ENE 700. Master'S Project. 0 credits, 0 contact hours.**
Prerequisite: student must have sufficient experience and/or graduate courses in major field to work on the project. Subject matter to be approved by the department. Permission to register must be obtained from the project advisor. Extensive investigation, analysis, or design of environmental engineering problems not covered by regular graduate course work is required. A student with an exceptional project in EnE may, upon his/her own initiative and with the approval of his/her advisor, substitute the work of this course as the equivalent of the first 3 credits for EnE 701 Master's Thesis.

**ENE 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: student must have sufficient experience and/or graduate courses in major field to work on the project. Subject matter to be approved by the department. Permission to register must be obtained from the project advisor. Extensive investigation, analysis, or design of environmental engineering problems not covered by regular graduate course work is required. A student with an exceptional project in EnE may, upon his/her own initiative and with the approval of his/her advisor, substitute the work of this course as the equivalent of the first 3 credits for EnE 701 Master's Thesis.

**ENE 701. Master'S Thesis. 0 credits, 0 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated for the thesis.

**ENE 701B. Master'S Thesis. 3 credits, 3 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated for the thesis.

**ENE 701C. Master'S Thesis. 6 credits, 3 contact hours.**
The thesis is to be prepared on a subject in the student's major field approved by the department. Approval to register for thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated for the thesis.

**ENE 702. Special Topics in Environmental Engineering. 3 credits, 3 contact hours.**
Restriction: advisor's approval. Topics of special current interest in environmental engineering.

**ENE 720. Environmental Chemodynamics. 3 credits, 3 contact hours.**
Introduction to concepts, mechanisms and models used to describe the transport of chemicals in the environment. Concepts and models are applied to air-water, sediment-water and soil-air interfaces.

**ENE 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**ENE 726. Independent Study II. 3 credits, 3 contact hours.**
Restriction: written permission from department chairperson plus courses to be prescribed by the supervising faculty member. Covers areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering.

**ENE 790. Doctoral Dissert & Res. 0 credits, 0 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790A. Doctoral Dissert & Res. 1 credit, 1 contact hour.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790B. Doctoral Dissert & Res. 3 credits, 3 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790C. Doctoral Dissertation. 6 credits, 0 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790D. Doctoral Dissertation. 9 credits, 9 contact hours.**

**ENE 790E. Doctoral Dissertation & Res. 12 credits, 3 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 790F. Doctoral Dissertation & Res. 15 credits, 3 contact hours.**
Required of all students working toward the doctoral degree. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student has not completed the dissertation after completion of 36 credits, continued registration of 3 credits per semester is required.

**ENE 791. Graduate Seminar. 0 credits, 0 contact hours.**
Seminar in which faculty or others present summaries of advanced topics suitable for research. Students and faculty discuss research procedures, thesis organization, and content. Students present their own research for discussion and criticism. Required of all doctoral students registered for ENE790 unless requirement is waived, in writing, by the dean of graduate studies.

**ENE 792. Pre-Doctoral Dissertation. 3 credits, 3 contact hours.**

**ENE 792C. Pre-Doctoral Research. 6 credits, 3 contact hours.**

# M.S. Online in Civil Engineering

## Degree Requirements

Students who lack an appropriate background are asked to make up deficiencies by taking a program of bridge courses that is designed in consultation with the graduate advisor. These courses are not typically available online and taken in addition to the degree requirements. Please note that the prerequisites for bridge course must also be met.

A minimum of 30 credits, not including any bridge courses, is required. Candidates must consult with the graduate advisor (not thesis advisor) in designing appropriate programs of study.

Students must attain a minimum GPA of 3.0 in the core courses listed bellow, and a minimum overall GPA of 3.0.

## Online M.S. in Civil Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 112 | Calculus II | 4 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MECH 320 | Statics and Strength of Materials | 3 |
| CE 200 | Surveying | 3 |
| or CE 200A | Surveying Laboratory | |
| CE 210 | Construction Materials and Procedures | 3 |
| CE 320 | Fluid Mechanics | 4 |
| CE 321 | Water Resources Engineering | 3 |
| CE 341 | Soil Mechanics | 3 |
| CE 350 | Transportation Engineering | 3 |
| **Total Credits** | | **35** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 610 | Construction Management | 3 |
| CE 611 | Project Planning and Control | 3 |
| CE 616 | Construction Cost Estimating | 3 |
| CE 620 | Open Channel Flow | 3 |
| CE 621 | Hydrology | 3 |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 752 | Traffic Control | 3 |
| **Management/Leadership Electives** | | |
| EM 602 | Management Science | 3 |
| HRM 601 | Organizational Behavior | 3 |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| **Total Credits** | | **30** |

## Online M.S. in Civil Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 112 | Calculus II | 4 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MECH 320 | Statics and Strength of Materials | 3 |
| CE 200 | Surveying | 3 |
| or CE 200A | Surveying Laboratory | |
| CE 210 | Construction Materials and Procedures | 3 |
| CE 320 | Fluid Mechanics | 4 |

| | | |
|---|---|---|
| CE 321 | Water Resources Engineering | 3 |
| CE 341 | Soil Mechanics | 3 |
| CE 350 | Transportation Engineering | 3 |
| **Total Credits** | | **35** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 610 | Construction Management | 3 |
| CE 611 | Project Planning and Control | 3 |
| CE 616 | Construction Cost Estimating | 3 |
| CE 620 | Open Channel Flow | 3 |
| CE 621 | Hydrology | 3 |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 752 | Traffic Control | 3 |
| **Thesis** | | |
| TRAN 701 Master's Thesis [1] | | 6 |
| **Management/Leadership Electives** | | |
| EM 602 | Management Science | 3 |
| HRM 601 | Organizational Behavior | 3 |
| EM 631 | Legal Aspects in Environmental Engineering | 3 |
| **Total Credits** | | **36** |

1 Students receiving financial aid at any point in their studies must complete 6 credits of CE 701 Masters Thesis.

# M.S. in Civil Engineering

## Degree Requirements

Students who do not have a bachelor's degree in civil engineering, but who want to obtain a master's degree in civil engineering must complete a bridge program for their chosen area of specialization. These courses are not counted for degree credit. See the areas of specialization in this section for specific bridge programs. Please note that prerequisites for bridge courses also must be met. See the undergraduate catalog for descriptions of 100- to 400-level courses. Some of the bridge courses may be waived depending on the student's background.

The program as shown below offers numerous areas of specialization, each with its own list of required and elective courses and bridge program. Once the choice of specialization is made, the student consults his/her specialization advisor to plan and develop an individualized and cohesive sequence of courses that will meet the program requirements of at least 30 degree credits.

Other suitable electives may be taken subject to approval of program advisor.

## M.S. in Civil Engineering, Construction Engineering and Management (courses only)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 210 | Construction Materials and Procedures | 3 |
| CE 501 | Introduction to Soil Behavior | 3 |
| MECH 320 | Statics and Strength of Materials | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| MATH 112 | Calculus II | 4 |
| **Total Credits** | | **17** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 610 | Construction Management | 3 |
| CE 611 | Project Planning and Control | 3 |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| CE 614 | Underground Construction | |
| CE 615 | Infrastructure and Facilities Remediation | |
| CE 616 | Construction Cost Estimating | |

| | | |
|---|---|---|
| CE 617 | Historic Preservation | |
| CE 644 | Geology in Engineering | |
| CE 700 | Master's Project | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| **General Electives** | | |
| Select zero to two from the List of Department General Electives | | 0-6 |
| **Management/Leadership Electives** | | |
| Select one to two of the following: | | 3-6 |
| CE 711 | Methods Improvement in Construction | |
| EM 632 | Legal Aspects in Construction | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

## M.S. in Civil Engineering, Construction Engineering and Management (Master's thesis)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 210 | Construction Materials and Procedures | 3 |
| CE 501 | Introduction to Soil Behavior | 3 |
| MECH 320 | Statics and Strength of Materials | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 225 | Survey of Probability and Statistics | 1 |
| MATH 112 | Calculus II | 4 |
| **Total Credits** | | **17** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 610 | Construction Management | 3 |
| CE 611 | Project Planning and Control | 3 |
| **Thesis** | | |
| CE 701 Master's Thesis [1] | | 6 |
| CE 791 | Graduate Seminar [2] | 0 |
| **Specialty Electives** | | |
| Select four of the following: | | 12 |
| CE 614 | Underground Construction | |
| CE 615 | Infrastructure and Facilities Remediation | |
| CE 616 | Construction Cost Estimating | |
| CE 617 | Historic Preservation | |
| CE 644 | Geology in Engineering | |
| CE 700 | Master's Project | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| **Management/Leadership Electives** | | |
| Select two of the following: | | 6 |
| CE 711 | Methods Improvement in Construction | |
| EM 632 | Legal Aspects in Construction | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

1. Students receiving departmental awards are required to write a thesis.
2. All students who receive departmental or research-based awards must enroll in the seminar each semester.

## M.S. in Civil Engineering, Environmental Engineering, Water Quality Program(courses only)

| | | |
|---|---|---|
| **Water Quality Bridge Program** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 321 | Water Resources Engineering | 3 |

| | | |
|---|---|---|
| CHEM 126 | General Chemistry II | 3 |
| **Total Credits** | | **10** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ENE 663 | Water Chemistry | 3 |
| ENE 661 | Environmental Microbiology | 3 |
| or EVSC 627 | Environmental Microbiology | |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| ENE 664 | Physical and Chemical Treatment | |
| ENE 665 | Biological Treatment | |
| ENE 672 | Stormwater Management | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| **General Electives** | | |
| Select zero to two from the List of Department General Electives | | 0-6 |
| **Management/Leadership Electives** | | |
| Select one to two of the following: | | 3-6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

## M.S. in Civil Engineering, Environmental Engineering Integrated Site Remediation (courses only)

| | | |
|---|---|---|
| **Integrated Site Remediation Bridge Program** | | |
| CHEM 126 | General Chemistry II | 3 |
| CE 321 | Water Resources Engineering | 3 |
| CE 501 | Introduction to Soil Behavior | 3 |
| **Total Credits** | | **9** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ENE 663 | Water Chemistry | 3 |
| ENE 661 | Environmental Microbiology | 3 |
| or EVSC 627 | Environmental Microbiology | |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| ENE 660 | Introduction to Solid and Hazardous Waste Problems | |
| ENE 662 | Site Remediation | |
| ENE 671 | Environmental Impact Analysis | |
| CE 602 | Geographic Information System | |
| **General Electives** | | |
| Select zero to two from the List of Department General Electives | | 0-6 |
| **Management/Leadership Electives** | | |
| Select one to two of the following: | | 3-6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

## M.S. in Civil Engineering, Environmental Engineering Water Quality (Master's thesis)

| | | |
|---|---|---|
| **Water Quality Bridge Program** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 321 | Water Resources Engineering | 3 |
| CHEM 126 | General Chemistry II | 3 |
| **Total Credits** | | **10** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ENE 663 | Water Chemistry | 3 |
| ENE 661 | Environmental Microbiology | 3 |
| or EVSC 627 | Environmental Microbiology | |
| **Thesis** | | |
| ENE 701 Master's Thesis [1] | | 6 |
| CE 791 | Graduate Seminar [2] | 0 |
| **Specialty Electives** | | |
| Select four of the following: | | 12 |
| ENE 664 | Physical and Chemical Treatment | |
| ENE 665 | Biological Treatment | |
| ENE 672 | Stormwater Management | |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| **Management/Leadership Electives** | | |
| Select two of the following: | | 6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

1. Students receiving departmental awards are required to write a thesis.
2. All students who receive departmental or research-based awards must enroll in the seminar each semester.

## M.S. in Civil Engineering, Environmental Engineering Integrated Site Remediation (Master's thesis)

| | | |
|---|---|---|
| **Integrated Site Remediation Bridge Program** | | |
| CHEM 126 | General Chemistry II | 3 |
| CE 321 | Water Resources Engineering | 3 |
| CE 501 | Introduction to Soil Behavior | 3 |
| **Total Credits** | | **9** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ENE 663 | Water Chemistry | 3 |
| ENE 661 | Environmental Microbiology | 3 |
| or EVSC 627 | Environmental Microbiology | |
| **Thesis** | | |
| ENE 701 Master's Thesis [1] | | 6 |
| CE 791 | Graduate Seminar [2] | 0 |
| **Specialty Electives** | | |
| Select four of the following: | | 12 |
| ENE 660 | Introduction to Solid and Hazardous Waste Problems | |
| ENE 662 | Site Remediation | |
| ENE 671 | Environmental Impact Analysis | |
| CE 602 | Geographic Information System | |

| | | |
|---|---|---|
| **Management/Leadership Electives** | | |
| Select two of the following: | | 6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 631 | Legal Aspects in Environmental Engineering | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

[1] Students receiving departmental awards are required to write a thesis.

[2] All students who receive departmental or research-based awards must enroll in the seminar each semester.

## M.S. in Civil Engineering, Geotechnical Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 332 | Structural Analysis | 3 |
| CE 333 | Reinforced Concrete Design | 3 |
| CE 341 | Soil Mechanics | 3 |
| CE 341A | Soil Mechanics Laboratory | 1 |
| CE 443 | Foundation Design | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 222 | Differential Equations | 4 |
| **Total Credits** | | **24** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 641 | Engineering Properties of Soils | 3 |
| CE 642 | Foundation Engineering | 3 |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| CE 545 | Rock Mechanics I | |
| CE 602 | Geographic Information System | |
| CE 643 | Advanced Foundation Engineering | |
| CE 644 | Geology in Engineering | |
| CE 645 | Rock Mechanics II | |
| CE 606 | Geospatial Data Applications | |
| CE 647 | Geotechnical Aspects of Solid Waste | |
| CE 648 | Flow Through Soils | |
| CE 700 | Master's Project | |
| CE 742 | Geotechnology of Earthquake Engineering | |
| **General Electives** | | |
| Select zero to two from the List of Department General Electives | | 0-6 |
| **Management/Leadership Electives** | | |
| Select one to two of the following: | | 3-6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 632 | Legal Aspects in Construction | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

## M.S. in Civil Engineering, Geotechnical Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 332 | Structural Analysis | 3 |
| CE 333 | Reinforced Concrete Design | 3 |

| | | |
|---|---|---|
| CE 341 | Soil Mechanics | 3 |
| CE 341A | Soil Mechanics Laboratory | 1 |
| CE 443 | Foundation Design | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 222 | Differential Equations | 4 |
| **Total Credits** | | **24** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 341 | Soil Mechanics | 3 |
| CE 342 | Geology | 3 |
| **Thesis** | | |
| CE 701 | Masters Thesis [1] | 6 |
| CE 791 | Graduate Seminar [2] | 0 |
| **Specialty Electives** | | |
| Select four of the following: | | 12 |
| CE 545 | Rock Mechanics I | |
| CE 602 | Geographic Information System | |
| CE 643 | Advanced Foundation Engineering | |
| CE 644 | Geology in Engineering | |
| CE 645 | Rock Mechanics II | |
| CE 606 | Geospatial Data Applications | |
| CE 647 | Geotechnical Aspects of Solid Waste | |
| CE 648 | Flow Through Soils | |
| CE 700 | Master's Project | |
| CE 742 | Geotechnology of Earthquake Engineering | |
| **Management/Leadership Electives** | | |
| Select two of the following: | | 3-6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 632 | Legal Aspects in Construction | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

1. Students receiving departmental awards are required to write a thesis.
2. All students who receive departmental or research-based awards must enroll in the seminar each semester.

## M.S. in Civil Engineering, Structural Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 333 | Reinforced Concrete Design | 3 |
| CE 341 | Soil Mechanics | 3 |
| CE 341A | Soil Mechanics Laboratory | 1 |
| CE 432 | Steel Design | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 222 | Differential Equations | 4 |
| MECH 236 | Dynamics | 2 |
| **Total Credits** | | **19** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 639 | Applied Finite Element Methods | 3 |
| CE 636 | Stability of Structures | 3 |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| CE 531 | Design of Masonry and Timber Structures | |

| | | |
|---|---|---|
| CE 631 | Advanced Reinforced Concrete Design | |
| CE 632 | Prestressed Concrete Design | |
| CE 634 | Structural Dynamics | |
| CE 635 | Fracture Mechanics of Engineering Materials | |
| CE 637 | Short Span Bridge Design | |
| CE 638 | Nondestructive Testing Methods in Civil Engineering | |
| CE 700 | Master's Project | |
| CE 702 | Special Topics in Civil Engineering | |
| CE 730 | Plastic Analysis and Design | |
| CE 733 | Design of Metal Structures | |
| CE 734 | Design of Tall Buildings and Space Structures | |
| CE 736 | Finite Element Methods in Structural and Continuum Mechanics | |
| CE 737 | Earthquake Engineering | |
| CE 739 | Structural Optimization | |
| MECH 630 | Theory of Elasticity | |
| **General Electives** | | |
| Select zero to two from the List of Department General Electives | | 0-6 |
| **Management/Leadership Electives** | | |
| Select one to two of the following: | | 3-6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 632 | Legal Aspects in Construction | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

## M.S. in Civil Engineering, Structural Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 333 | Reinforced Concrete Design | 3 |
| CE 341 | Soil Mechanics | 3 |
| CE 341A | Soil Mechanics Laboratory | 1 |
| CE 432 | Steel Design | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 222 | Differential Equations | 4 |
| MECH 236 | Dynamics | 2 |
| **Total Credits** | | **19** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CE 639 | Applied Finite Element Methods | 3 |
| CE 636 | Stability of Structures | 3 |
| **Thesis** | | |
| CE 701 | Masters Thesis [1] | 6 |
| CE 791 | Graduate Seminar [2] | 0 |
| **Specialty Electives** | | |
| Select four of the following: | | 12 |
| CE 531 | Design of Masonry and Timber Structures | |
| CE 631 | Advanced Reinforced Concrete Design | |
| CE 632 | Prestressed Concrete Design | |
| CE 634 | Structural Dynamics | |
| CE 635 | Fracture Mechanics of Engineering Materials | |
| CE 637 | Short Span Bridge Design | |
| CE 638 | Nondestructive Testing Methods in Civil Engineering | |
| CE 700 | Master's Project | |

| | | |
|---|---|---|
| CE 702 | Special Topics in Civil Engineering | |
| CE 730 | Plastic Analysis and Design | |
| CE 733 | Design of Metal Structures | |
| CE 734 | Design of Tall Buildings and Space Structures | |
| CE 736 | Finite Element Methods in Structural and Continuum Mechanics | |
| CE 737 | Earthquake Engineering | |
| CE 739 | Structural Optimization | |
| MECH 630 | Theory of Elasticity | |
| **Management/Leadership Electives** | | |
| Select two of the following: | | 6 |
| CE 610 | Construction Management | |
| CE 711 | Methods Improvement in Construction | |
| EM 632 | Legal Aspects in Construction | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

[1] Students receiving departmental awards are required to write a thesis.

[2] All students who receive departmental or research-based awards must enroll in the seminar each semester.

## M.S. in Civil Engineering, Transportation Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 350 | Transportation Engineering | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 650 | Urban Systems Engineering | 3 |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| CE 659 | Flexible and Rigid Pavements | |
| TRAN 552 | Geometric Design of Transportation Facilities | |
| TRAN 603 | Introduction to Urban Transportation Planning | |
| TRAN 625 | Public Transportation Operations and Technology | |
| TRAN 653 | Traffic Safety | |
| TRAN 655 | Land Use Planning | |
| TRAN 700 | Master's Project | |
| TRAN 752 | Traffic Control | |
| **Total Credits** | | **18-24** |

## M.S. in Civil Engineering, Transportation Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Program** | | |
| CE 350 | Transportation Engineering | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

**Core Courses**

| | | |
|---|---|---|
| TRAN 650 | Urban Systems Engineering | 3 |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| **Thesis** | | |
| TRAN 701 Master's Thesis [1] | | 6 |
| CE 791 | Graduate Seminar [2] | 0 |
| **Specialty Electives** | | |
| Select four to six of the following: | | 12-18 |
| CE 659 | Flexible and Rigid Pavements | |
| TRAN 552 | Geometric Design of Transportation Facilities | |
| TRAN 603 | Introduction to Urban Transportation Planning | |
| TRAN 625 | Public Transportation Operations and Technology | |
| TRAN 653 | Traffic Safety | |
| TRAN 655 | Land Use Planning | |
| TRAN 700 | Master's Project | |
| TRAN 752 | Traffic Control | |
| **Total Credits** | | **24-30** |

1 Students receiving departmental awards are required to write a thesis.

2 All students who receive departmental or research-based awards must enroll in the seminar each semester.

# M.S. in Critical Infrastructure Systems

## Degree Requirements

A minimum of 30 degree credits, not including any bridge courses, is required. Candidates must consult with the graduate advisor (not thesis advisor) in designing appropriate programs of study.

Students must attain a minimum GPA of 3.0 in the core courses listed below, and a minimum overall GPA of 3.0.

## Master of Science in Critical Infrastructure Systems

| | | |
|---|---|---|
| **Core Courses** | | |
| 4 Core Courses are required and are: [1] | | 12 |
| CE 671 | Performance and Risk Analysis of Infrastructure Systems | |
| CE 672 | Security Management of Critical Infrastructure | |
| EM 602 | Management Science | |
| MIP 675 | Elements of Infrastructure Planning | |
| **Electives** | | |
| Select six courses (or 4 courses and a Thesis) from the following: | | 18 |
| **Critical Infrastructure Life-Cycle Management (CILC)** | | |
| Planning and Facilities Management: | | |
| CE 602 | Geographic Information System | |
| CE 615 | Infrastructure and Facilities Remediation | |
| Engineered Systems: | | |
| TRAN 705 | Mass Transportation Systems | |
| ECE 610 | Power System Steady-State Analysis | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 683 | Computer Network Design and Analysis | |
| ECE 673 | Random Signal Analysis I | |
| ECE 642 | Communication Systems I | |
| Program/Impact Management: | | |
| CE 610 | Construction Management | |
| CE 611 | Project Planning and Control | |
| CE 616 | Construction Cost Estimating | |
| IE 651 | Industrial Simulation | |

| | | |
|---|---|---|
| IE 605 | Engineering Reliability | |
| IE 614 | Safety Engineering Methods | |
| ENE 662 | Site Remediation | |
| ENE 663 | Water Chemistry | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| **Critical Infrastructure Security and Emergency Management (CISE)** | | |
| Emergency and Preparedness Management (Joint UMDNJ): | | |
| IS 613 | Design of Emergency Management Information Systems | |
| IS 614 | Command and Control Systems | |
| Enabling Systems and Technologies: | | |
| MIS 648 | Decision Support Systems for Managers | |
| TRAN 615 | Traffic Studies and Capacity | |
| TRAN 752 | Traffic Control | |
| TRAN 755 | Intelligent Transportation Systems | |
| EM 771 | Operations Cost and Management Control | |
| MGMT 635 | Data Mining and Analysis | |
| MGMT 650 | Knowledge Management | |
| CS 631 | Data Management System Design | |
| CS 632 | Advanced Database System Design | |
| CS 782 | Pattern Recognition and Applications | |
| IE 706 | A Queueing Approach to Performance Analysis | |
| IE 621 | Systems Analysis and Simulation | |
| Public Health Systems and Emergency Preparedness: | | |
| RBHS Courses | | |
| Principles and Methods of Epidemiology | | |
| Introduction to Environmental Health | | |
| Public Health Preparedness I:Agents of Mass Injury or Destruction | | |
| Public Health Preparedness II:Emergency Management and Response | | |
| Health/Risk Communications | | |
| Other Electives: Master's Thesis [2] | | |
| **Total Credits** | | **30** |

[1] Students receiving financial aid at any point in their studies must complete 6 credits of CE 701 Masters Thesis.

[2] Other suitable electives may be taken subject to approval of program advisor, particularly in the area of Public Health Systems and Emergency Preparedness.

# M.S. in Environmental Engineering

## Degree Requirements

Students who lack appropriate background are asked to make up deficiencies by taking a program of bridge courses, including any prerequisites, that is designed in consultation with graduate advisors. See the **undergraduate catalog** for description of bridge courses.

The program comprises 30 credits of required and elective courses. The student consults the graduate advisor to plan and maintain an individualized and cohesive sequence of courses.

## M.S. in Environmental Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 321 | Water Resources Engineering | 3 |
| CE 322 | Hydraulic Engineering | 3 |
| CE 501 | Introduction to Soil Behavior | 3 |
| CHEM 126 | General Chemistry II | 3 |

| | | |
|---|---|---|
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 222 | Differential Equations | 4 |
| MECH 234 | Engineering Mechanics | 2 |
| MECH 236 | Dynamics | 2 |
| **Total Credits** | | **27** |

| | | |
|---|---|---|
| **Required Courses** | | |
| ENE 663 | Water Chemistry | 3 |
| ENE 660 | Introduction to Solid and Hazardous Waste Problems | 3 |
| ENE 661 | Environmental Microbiology | 3 |
| Graduate mathematics or computer science course approved by graduate advisor | | 3 |
| **Electives** | | |
| Select six of the following: | | 18 |
| CE 602 | Geographic Information System | |
| CE 605 | Research Methods in Remote Sensing | |
| CE 618 | Applied Hydrogeology | |
| CE 620 | Open Channel Flow | |
| CE 621 | Hydrology | |
| CE 623 | Groundwater Hydrology | |
| CE 647 | Geotechnical Aspects of Solid Waste | |
| CE 702 | Special Topics in Civil Engineering | |
| ENE 662 | Site Remediation | |
| ENE 664 | Physical and Chemical Treatment | |
| ENE 665 | Biological Treatment | |
| ENE 666 | Analysis of Receiving Waters | |
| ENE 671 | Environmental Impact Analysis | |
| ENE 672 | Stormwater Management | |
| ENE 700 | Master'S Project | |
| ENE 702 | Special Topics in Environmental Engineering | |
| ENE 720 | Environmental Chemodynamics | |
| **Total Credits** | | **30** |

## M.S. in Environmental Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 320 | Fluid Mechanics | 4 |
| CE 321 | Water Resources Engineering | 3 |
| CE 322 | Hydraulic Engineering | 3 |
| CE 501 | Introduction to Soil Behavior | 3 |
| CHEM 126 | General Chemistry II | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| MATH 222 | Differential Equations | 4 |
| MECH 234 | Engineering Mechanics | 2 |
| MECH 236 | Dynamics | 2 |
| **Total Credits** | | **27** |

| | | |
|---|---|---|
| **Required Courses** | | |
| ENE 663 | Water Chemistry | 3 |
| ENE 660 | Introduction to Solid and Hazardous Waste Problems | 3 |
| ENE 661 | Environmental Microbiology | 3 |
| Graduate mathematics or computer science course approved by graduate advisor | | 3 |
| **Thesis** | | |
| ENE 701 | Master'S Thesis [1] | 6 |
| **Electives** | | |

| | | |
|---|---|---|
| Select four of the following: | | 12 |
| CE 602 | Geographic Information System | |
| CE 605 | Research Methods in Remote Sensing | |
| CE 618 | Applied Hydrogeology | |
| CE 620 | Open Channel Flow | |
| CE 621 | Hydrology | |
| CE 623 | Groundwater Hydrology | |
| CE 647 | Geotechnical Aspects of Solid Waste | |
| CE 702 | Special Topics in Civil Engineering | |
| ENE 662 | Site Remediation | |
| ENE 664 | Physical and Chemical Treatment | |
| ENE 665 | Biological Treatment | |
| ENE 666 | Analysis of Receiving Waters | |
| ENE 671 | Environmental Impact Analysis | |
| ENE 672 | Stormwater Management | |
| ENE 700 | Master'S Project | |
| ENE 702 | Special Topics in Environmental Engineering | |
| ENE 720 | Environmental Chemodynamics | |
| **Seminar** | | |
| ENE 791 | Graduate Seminar [2] | 0 |
| **Total Credits** | | **30** |

1 Required of those receiving departmental awards; elective for all others.

2 Students who receive departmental or research-based awards must enroll in the seminar each semester.

# M.S. in Transportation

## Degree Requirements

Students who lack an appropriate background may be admitted and required to make up deficiencies by taking a program of bridge courses designed in consultation with graduate advisors. These courses are taken in addition to the degree requirements. See the undergraduate catalog for descriptions of 100- to 400-level courses. Students may be required to take or demonstrate that they already have taken courses equivalent to the bridge courses.

Students must select one area of specialization and take a minimum of 30 credits.TRAN 792 Pre-Doctoral Research is required for all students who receive departmental or research-based awards. A maximum of 6 credits may be taken from the 500-level courses for the master of science.

Three general areas of specialization are available. While they share a common methodological core, each is designed to suit various interests:

- **Transportation Engineering** focuses on traffic engineering, physical design and operational aspects of transportation systems. This area is best suited for students with an undergraduate engineering degree.
- **Transportation Planning** emphasizes the analysis and planning aspects, in particular the integration of transportation systems with urban and regional considerations such as economics, land use, and the environment.
- **Advanced Transportation Systems and Technologies** emphasizes the use of emerging technologies such as intelligent transportation systems in planning, design and operations of multi- and inter-modal transportation systems.

Additional elective courses for all areas of specialization may be taken with approval of the graduate advisor.

## M.S. in Transportation Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

[1] Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| TRAN 625 | Public Transportation Operations and Technology | 3 |
| TRAN 752 | Traffic Control | 3 |
| **Electives** | | |
| Select four of the following: | | 12 |
| CE 611 | Project Planning and Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| IE 651 | Industrial Simulation | |
| MATH 661 | Applied Statistics | |
| ME 635 | Computer-Aided Design | |
| MGMT 692 | Strategic Management | |
| MIS 648 | Decision Support Systems for Managers | |
| TRAN 552 | Geometric Design of Transportation Facilities | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 640 | Distribution Logistics | |
| TRAN 653 | Traffic Safety | |
| TRAN 659 | Flexible and Rigid Pavements | |
| TRAN 753 | Airport Design and Planning | |
| TRAN 754 | Port Design and Planning | |
| TRAN 755 | Intelligent Transportation Systems | |
| TRAN 760 | Urban Trans Networks | |
| **Total Credits** | | **30** |

## M.S. in Transportation Engineering (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

[1] Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| TRAN 625 | Public Transportation Operations and Technology | 3 |

| | | |
|---|---|---|
| TRAN 752 | Traffic Control | 3 |
| **Project** | | |
| TRAN 700 | Master's Project | 3 |
| **Electives** | | |
| Select three of the following: | | 9 |
| CE 611 | Project Planning and Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| IE 651 | Industrial Simulation | |
| MATH 661 | Applied Statistics | |
| ME 635 | Computer-Aided Design | |
| MGMT 692 | Strategic Management | |
| MIS 648 | Decision Support Systems for Managers | |
| TRAN 552 | Geometric Design of Transportation Facilities | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 640 | Distribution Logistics | |
| TRAN 653 | Traffic Safety | |
| TRAN 659 | Flexible and Rigid Pavements | |
| TRAN 753 | Airport Design and Planning | |
| TRAN 754 | Port Design and Planning | |
| TRAN 755 | Intelligent Transportation Systems | |
| TRAN 760 | Urban Trans Networks | |
| **Total Credits** | | **30** |

## M.S. in Transportation Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

[1] Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| TRAN 625 | Public Transportation Operations and Technology | 3 |
| TRAN 752 | Traffic Control | 3 |
| **Thesis** | | |
| TRAN 701 | Master's Thesis | 6 |
| **Electives** | | |
| Select two of the following: | | 6 |
| CE 611 | Project Planning and Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| ENE 671 | Environmental Impact Analysis | |

| | | |
|---|---|---|
| HRM 601 | Organizational Behavior | |
| IE 651 | Industrial Simulation | |
| MATH 661 | Applied Statistics | |
| ME 635 | Computer-Aided Design | |
| MGMT 692 | Strategic Management | |
| MIS 648 | Decision Support Systems for Managers | |
| TRAN 552 | Geometric Design of Transportation Facilities | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 640 | Distribution Logistics | |
| TRAN 653 | Traffic Safety | |
| TRAN 659 | Flexible and Rigid Pavements | |
| TRAN 753 | Airport Design and Planning | |
| TRAN 754 | Port Design and Planning | |
| TRAN 755 | Intelligent Transportation Systems | |
| TRAN 760 | Urban Trans Networks | |
| **Total Credits** | | **30** |

## M.S. in Transportation Planning (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

1 Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 655 | Land Use Planning | 3 |
| TRAN 625 | Public Transportation Operations and Technology | 3 |
| or TRAN 705 | Mass Transportation Systems | |
| TRAN 765 | Multi-modal Freight Transportation Systems Analysis | 3 |
| **Electives** | | |
| Select four of the following: | | 12 |
| CE 611 | Project Planning and Control | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| HRM 606 | Human Resource Management | |
| MATH 661 | Applied Statistics | |
| MGMT 691 | Legal and Ethical Issues | |
| MGMT 692 | Strategic Management | |
| MIS 620 | E-Commerce Technologies | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 615 | Traffic Studies and Capacity | |
| TRAN 640 | Distribution Logistics | |

| | | |
|---|---|---|
| TRAN 643 | Transportation Finance | |
| TRAN 653 | Traffic Safety | |
| TRAN 720 | Discrete Choice Modeling for Travel Demand Forecasting | |
| TRAN 753 | Airport Design and Planning | |
| TRAN 755 | Intelligent Transportation Systems | |
| **Total Credits** | | **30** |

## M.S. in Transportation Planning (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

[1] Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 655 | Land Use Planning | 3 |
| TRAN 625 | Public Transportation Operations and Technology | 3 |
| or TRAN 705 | Mass Transportation Systems | |
| TRAN 765 | Multi-modal Freight Transportation Systems Analysis | 3 |
| **Project** | | |
| TRAN 700 | Master's Project | 3 |
| **Electives** | | |
| Select three of the following: | | 9 |
| CE 611 | Project Planning and Control | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| HRM 606 | Human Resource Management | |
| MATH 661 | Applied Statistics | |
| MGMT 691 | Legal and Ethical Issues | |
| MGMT 692 | Strategic Management | |
| MIS 620 | E-Commerce Technologies | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 615 | Traffic Studies and Capacity | |
| TRAN 640 | Distribution Logistics | |
| TRAN 643 | Transportation Finance | |
| TRAN 653 | Traffic Safety | |
| TRAN 720 | Discrete Choice Modeling for Travel Demand Forecasting | |
| TRAN 753 | Airport Design and Planning | |
| TRAN 755 | Intelligent Transportation Systems | |
| **Total Credits** | | **30** |

## M.S. in Transportation Planning (Master's thesis)

**Bridge Courses**

| | | |
|---|---|---|
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

[1] Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 655 | Land Use Planning | 3 |
| TRAN 625 | Public Transportation Operations and Technology | 3 |
| or TRAN 705 | Mass Transportation Systems | |
| TRAN 765 | Multi-modal Freight Transportation Systems Analysis | 3 |
| **Thesis** | | |
| TRAN 701 | Master's Thesis | 6 |
| **Electives** | | |
| Select two of the following: | | 6 |
| CE 611 | Project Planning and Control | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| HRM 606 | Human Resource Management | |
| MATH 661 | Applied Statistics | |
| MGMT 691 | Legal and Ethical Issues | |
| MGMT 692 | Strategic Management | |
| MIS 620 | E-Commerce Technologies | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 615 | Traffic Studies and Capacity | |
| TRAN 640 | Distribution Logistics | |
| TRAN 643 | Transportation Finance | |
| TRAN 653 | Traffic Safety | |
| TRAN 720 | Discrete Choice Modeling for Travel Demand Forecasting | |
| TRAN 753 | Airport Design and Planning | |
| TRAN 755 | Intelligent Transportation Systems | |
| **Total Credits** | | **30** |

## Advanced Transportation Systems and Technologies (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

[1] Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| TRAN 755 | Intelligent Transportation Systems | 3 |
| TRAN 765 | Multi-modal Freight Transportation Systems Analysis | 3 |
| **Electives** | | |
| Select four of the following: | | 12 |
| CS 610 | Data Structures and Algorithms | |
| CS 651 | Data Communications | |
| CS 661 | Systems Simulation | |
| ECE 609 | Artificial Neural Networks | |
| ECE 642 | Communication Systems I | |
| EM 714 | Multicriteria Decision Making | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| IE 624 | Heuristic Methods | |
| IE 642 | Network Flows and Applications | |
| IE 644 | Application of Stochastic Modeling in Systems Control | |
| IE 651 | Industrial Simulation | |
| IE 705 | Mathematical Programming in Management Science | |
| IE 706 | A Queueing Approach to Performance Analysis | |
| MATH 661 | Applied Statistics | |
| ME 635 | Computer-Aided Design | |
| MIS 648 | Decision Support Systems for Managers | |
| MRKT 636 | Design and Development of High Technology Products | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 625 | Public Transportation Operations and Technology | |
| TRAN 640 | Distribution Logistics | |
| TRAN 752 | Traffic Control | |
| **Total Credits** | | **30** |

## Advanced Transportation Systems and Technologies (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

1 Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |

| | | |
|---|---|---|
| TRAN 615 | Traffic Studies and Capacity | 3 |
| TRAN 755 | Intelligent Transportation Systems | 3 |
| TRAN 765 | Multi-modal Freight Transportation Systems Analysis | 3 |
| **Project** | | |
| TRAN 700 | Master's Project | 3 |
| **Electives** | | |
| Select three of the following: | | 9 |
| CS 610 | Data Structures and Algorithms | |
| CS 651 | Data Communications | |
| CS 661 | Systems Simulation | |
| ECE 609 | Artificial Neural Networks | |
| ECE 642 | Communication Systems I | |
| EM 714 | Multicriteria Decision Making | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| IE 624 | Heuristic Methods | |
| IE 642 | Network Flows and Applications | |
| IE 644 | Application of Stochastic Modeling in Systems Control | |
| IE 651 | Industrial Simulation | |
| IE 705 | Mathematical Programming in Management Science | |
| IE 706 | A Queueing Approach to Performance Analysis | |
| MATH 661 | Applied Statistics | |
| ME 635 | Computer-Aided Design | |
| MIS 648 | Decision Support Systems for Managers | |
| MRKT 636 | Design and Development of High Technology Products | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 625 | Public Transportation Operations and Technology | |
| TRAN 640 | Distribution Logistics | |
| TRAN 752 | Traffic Control | |
| **Total Credits** | | **30** |

## Advanced Transportation Systems and Technologies (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| CE 350 | Transportation Engineering [1] | 3 |
| CS 101 | Computer Programming and Problem Solving | 3 |
| ECON 265 | Microeconomics | 3 |
| MATH 105 | Elementary Probability and Statistics | 3 |
| MATH 309 | Mathematical Analysis for Technology | 4 |
| **Total Credits** | | **16** |

1 Students who have demonstrated professional transportation work experience may have this course waived.

| | | |
|---|---|---|
| **Core Courses** | | |
| TRAN 603 | Introduction to Urban Transportation Planning | 3 |
| TRAN 610 | Transportation Economics | 3 |
| TRAN 650 | Urban Systems Engineering | 3 |
| or EM 602 | Management Science | |
| **Area of Specialization Required Courses** | | |
| TRAN 615 | Traffic Studies and Capacity | 3 |
| TRAN 755 | Intelligent Transportation Systems | 3 |
| TRAN 765 | Multi-modal Freight Transportation Systems Analysis | 3 |
| **Thesis** | | |

| | | |
|---|---|---|
| TRAN 701 | Master's Thesis | 6 |
| **Electives** | | |
| Select two of the following: | | 6 |
| CS 610 | Data Structures and Algorithms | |
| CS 651 | Data Communications | |
| CS 661 | Systems Simulation | |
| ECE 609 | Artificial Neural Networks | |
| ECE 642 | Communication Systems I | |
| EM 714 | Multicriteria Decision Making | |
| ENE 671 | Environmental Impact Analysis | |
| HRM 601 | Organizational Behavior | |
| IE 624 | Heuristic Methods | |
| IE 642 | Network Flows and Applications | |
| IE 644 | Application of Stochastic Modeling in Systems Control | |
| IE 651 | Industrial Simulation | |
| IE 705 | Mathematical Programming in Management Science | |
| IE 706 | A Queueing Approach to Performance Analysis | |
| MATH 661 | Applied Statistics | |
| ME 635 | Computer-Aided Design | |
| MIS 648 | Decision Support Systems for Managers | |
| MRKT 636 | Design and Development of High Technology Products | |
| TRAN 602 | Geographic Information Systems | |
| TRAN 608 | Behavioral Issues in Transportation Studies | |
| TRAN 625 | Public Transportation Operations and Technology | |
| TRAN 640 | Distribution Logistics | |
| TRAN 752 | Traffic Control | |
| **Total Credits** | | **30** |

# Ph.D. in Civil Engineering

## Degree Requirements

The department approves specific degree requirements and dissertation topics on an individual basis. Students must attain a minimum overall GPA of 3.0. Students must conduct independent original research in a specific area of civil engineering. Students must select an advisor willing to supervise dissertation work.

| | | |
|---|---|---|
| 600-level or 700-level course work | | 12 |
| 700-level course work | | 12 |
| CE 790 | Doct Dissertation & Res [1] | 36 |
| CE 790 | Doct Dissertation & Res [2] | 0 |
| CE 791 | Graduate Seminar [3] | 0 |
| **Total Credits** | | **60** |

1. Credits should be completed before submission of the final dissertation document.
2. Students must register for a minimum of 3 credits of CE 790 Doct Dissertation & Res until the dissertation has been submitted and accepted.
3. Required of all doctoral students every semester.

## Preliminary Qualifying Examination

Full-time students must take the preliminary qualifying exam for the first time within one year of beginning active study and must pass it completely by the next time the examination is offered. Part-time students must take the preliminary qualifying exam for the first time within three years of the beginning of active study and must pass it completely by the next time the examination is offered. Exceptional students having only bachelor's degrees who are admitted directly into the doctoral program must take the preliminary qualifying examination within one and one-half years of admission and must pass it within two years. All students are permitted to take the examination only twice.

### Dissertation Committee

After passing the preliminary qualifying examination, each student in consultation with the major faculty member develops a list of five faculty members who have agreed to serve on an advisory committee as follows: two or three members of the graduate faculty in the student's major area of interest; a member of the graduate faculty in the student's major area appointed by the department chairperson; a member of the graduate faculty of the Department of Civil and Environmental Engineering from another field of interest; a member of the graduate faculty from the area of the student's minor field of interest.

### Research Proposal

Doctoral students must prepare a written research proposal and make an oral presentation for approval by their dissertation committee. The proposal must be presented after formation of the committee but within six months after passing the qualifying examination. Research is expected to investigate or develop a unique contribution to science and technology.

### Dissertation Defense

An oral defense of the dissertation is required after submission of the final document to the department for approval. Signatures of all members of the dissertation committee must be received for final approval to be granted.

# Ph.D. in Environmental Engineering

## Degree Requirements

The department approves specific degree requirements and dissertation topics on an individual basis. Students must attain a minimum overall GPA of 3.0. Students must conduct independent original research in a specific area of environmental engineering. Students must select an advisor willing to supervise dissertation work.

| | | |
|---|---|---|
| 600- or 700-level course work | | 12 |
| 700-level course work | | 12 |
| ENE 790 | Doctoral Dissert & Res [1] | 36 |
| ENE 791 | Graduate Seminar [2] | 0 |
| **Total Credits** | | **60** |

1. The 36 credits should be completed before submission of the final dissertation document. Students must register for a minimum of 3 credits of until the dissertation has been submitted and accepted.
2. Doctoral students are required to register for the seminar every semester.

### Qualifying Examination

Full-time students must take the qualifying examination for the first time within one year of beginning active study and must pass it completely by the next time the examination is offered. Part-time students must take the qualifying examination for the first time within three years of the beginning of active study and must pass it completely by the next time it is offered. Exceptional students having only bachelor's degrees who are admitted directly into the doctoral program must take the qualifying examination within one and one-half years of admission and must pass it within two years. All students are permitted to take the examination only twice.

### Dissertation Committee

After passing the qualifying examination, each student in consultation with the major faculty member develops a list of five faculty members who have agreed to serve on an advisory committee as follows: two or three members of the graduate faculty in the student's major area of interest; a member of the graduate faculty in the student's major area appointed by the department chairperson; a member of the graduate faculty of the Department of Civil and Environmental Engineering from another field of interest; a member of the graduate faculty from the area of the student's minor field of interest.

### Research Proposal

Doctoral students must prepare a written research proposal and make an oral presentation for approval by their dissertation committee. The proposal must be presented after formation of the committee but within six months after passing the qualifying examination. Research is expected to investigate or develop a unique contribution to science and technology.

### Dissertation Defense

An oral defense of the dissertation is required after submission of the final document to the department for approval. Signatures of all members of the dissertation committee must be received for final approval to be granted.

# Ph.D. in Transportation

## Degree Requirements

| | | |
|---|---|---|
| Graduate-level course work | | 42 |
| 700-level courses | | 12 |
| TRAN 790 | Doctoral Dissertation | 36 |
| TRAN 791 | Doctoral Seminar | 0 |
| **Total Credits** | | **90** |

Requirements consist of a minimum of 54 credits of course work beyond the bachelor's degree, including at least 12 credits of 700-level courses, passage of a qualifying examination, a minimum of 36 credits of TRAN 790 Doctoral Dissertation and TRAN 791 Doctoral Seminar. Independent original research must be conducted by the candidate in a specific area of transportation. Dissertation work must be of publishable quality.

### Dissertation

A program committee must approve a dissertation topic and an NJIT faculty member, approved by the program, must be available to supervise the dissertation research. An oral defense of the dissertation is required after the dissertation committee accepts the written document.

### Qualifying Examination

All doctoral students must pass a doctoral qualifying examination. To prepare adequately for the examination, students should take appropriate course work in transportation engineering, transportation planning, and advanced transportation systems and technologies, as well as other related subjects.

The examination has four parts: the first three are written, and the fourth is oral. The oral part is given after the written parts are evaluated.

- Part I Analytical Techniques
- Part II Transportation Facilities and Operations
- Part III Transportation Planning and Technologies
- Part IV Oral (includes a field problem)

For additional information about doctoral degree requirements, refer to the **Academic Policies and Procedures** section.

# Electrical and Computer Engineering

## Electrical Engineering

The Department of Electrical and Computer Engineering serves the community, the state and the nation by educating engineers, expanding knowledge and developing new tools for solving complex technological problems. The department's graduate programs offer students with backgrounds in electrical engineering or related areas unusual opportunities to specialize in advanced phases of electrical engineering. In addition to more than 30 full-time faculty members devoted to teaching and research, students are taught by adjunct professors from industry who offer specialty courses in their area of expertise and serve on thesis and dissertation committees.

The master's degree programs provide state-of-the-art training at advanced levels in areas of technical specialization, including faculty-supervised research. Students in the doctoral program conduct significant original research in areas of interest to department members. Students also have opportunities to conduct thesis research at industrial sites, hospitals, biomedical engineering facilities, and university centers and departments.

### Master of Science in Electrical Engineering

A program for students with an undergraduate degree in engineering who wish either to specialize in an advanced phase of electrical engineering or prepare for a more advanced degree.

### Admission Requirements

Applicants are expected to have undergraduate backgrounds in physics, mathematics (through differential equations and vector analysis), electrical networks and devices, electronics, analysis and design methods, transients, electromagnetic fields, and appropriate laboratory work in some of these areas. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (213 computer-based). For further information, see the Admissions section in this catalog.

### Graduate Certificate Program

A 12-credit graduate certificate in Telecommunications Networking is available as a step toward this degree. See **Graduate Certificates** in the Degree Programs section of this catalog. For further information, call the Associate Vice President of Continuing and Distance Education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; e-mail cpe@njit.edu

## Doctor of Philosophy in Electrical Engineering

This is a program for superior students with master's degrees in electrical engineering or allied fields who wish to conduct advanced research in an area of electrical engineering.

Exceptional Candidates with a Bachelor of Science in Electrical Engineering

Highly qualified students with bachelor's degrees in electrical engineering may be accepted directly into the doctoral program. Contact the doctoral program coordinator for further information.

### Admission Requirements

Applicants are expected to have a broad background in engineering, mathematics, physics, and computer science. At least half of undergraduate course work should have been in the physical sciences or similar fields. Doctoral students should have majored in electrical engineering or related field, with course work at the master's level in mathematics, physics and/or computer science. In addition, students are expected to be proficient in computer programming. A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is required for admission. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (213 computer-based).

Students who lack an appropriate background will be required to take additional courses that cannot be applied as degree credits.

# Computer Engineering

Focus on interdisciplinary course work and research provides students enrolled in the M.S. and Ph.D. in Computer Engineering programs with an advanced background in both the hardware and software aspects of computing.

The master's program prepares computer engineers to successfully make the hardware-software design trade-offs inherent to computing today. The rapid development of computer hardware and software in the last decade has created a demand for engineers who are not only knowledgeable in both these areas, but who also understand their interaction. The fields of embedded computer system design and computer networks are based squarely on this knowledge.

The doctoral program is designed for superior students with a master's degree in computer engineering, computer science, electrical engineering, or other related fields, who wish to pursue advanced research in the area of computer engineering. The master's and doctoral programs emphasize computer architecture and systems, computer networking, intelligent systems, microprocessor-based systems, and VLSI system design.

## Master of Science in Computer Engineering

This program prepares its graduates to successfully handle problems requiring in-depth knowledge of both computer hardware and software, and more important, their interaction. Students may concentrate in microprocessor-based systems, parallel computing systems, computer networking, VLSI system design, or machine vision systems. All applicants must submit GRE scores. International students must achieve a minimum TOEFL score of 550 (pencil and paper) and (213 computer-based).

### Admission Requirements

Applicants are expected to have an undergraduate education in engineering or computer science. Applicants with baccalaureate degrees in areas other than computer engineering may be admitted and required to complete a bridge program. Those with undergraduate degrees in other fields should consult the MSCOE Program Advisor for bridge requirements. Bridge courses do not count toward degree requirements.

### Graduate Certificate Program

A 12-credit graduate certificate in Information Assurance is available as a step toward this degree. Please see **Graduate Certificates** in this catalog for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

## Doctor of Philosophy in Computer Engineering

This program is intended for superior students with a master's degree in computer engineering, computer science, electrical engineering, or other related fields, who wish to pursue advanced research in computer engineering. The program emphasizes the following areas: computer architecture and systems, computer networking, intelligent systems, microprocessor-based systems, and VLSI systems design.

### Admission Requirements

Applicants are expected to have a master's degree in computer engineering, computer science, electrical engineering, or other related fields. Students who lack an appropriate background may be admitted and required to take bridge courses that cannot be applied as degree credits.

Students must demonstrate superior academic background in engineering, mathematics, and physical science; skills in programming; and proficiency in major areas of computer engineering and science. A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is required for admission. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (213 computer-based).

Superior undergraduate students may apply to be admitted directly into the Ph.D. program. Such an accelerated program requires a minimum entrance GPA of 3.5 and an interview with the Electrical and Computer Engineering Department Graduate Affairs Committee.

# Internet Engineering

The objective of the master of science in internet engineering program is to educate students in the field of internet engineering, with emphasis on computer internetworking and relevant applications.

## Admission Requirements

Applicants should have an undergraduate degree in Computer Engineering, Electrical Engineering or other relevant discipline from an accredited institution (or its equivalent). All applicants must submit scores on the Graduate Record Examinations (GRE) verbal, quantitative, and analytical aptitude tests. International students must also achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based). Applicants with undergraduate degrees in computer science, computer engineering or electrical engineering from an accredited institution are expected to have a GPA of at least 3.0 on a 4.0 scale. These students should have taken ECE 321 Random Signals and Noise), or another equivalent course; ECE 333 Signals and Systems; and proficiency in C++ programming.

# Power and Energy Systems (PES)

The master of science in power and energy systems is a program for students with an undergraduate degree in engineering who wish either to specialize in an advanced phase of electrical power engineering and energy systems to prepare for a more advanced degree.

## Admission Requirements

Applicants are expected to have undergraduate backgrounds in physics, mathematics (through differential equations and vector analysis), electrical networks and devices, electronics, analysis and design methods, transients, electromagnetic fields, and appropriate laboratory work in some of these areas. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 79 out 120 (or 550 in the old score system). For further information, see the **Admissions** section in this catalog.

## Graduate Certificate Program

A 12-credit graduate certificate in Power and Energy Systems is available and can be taken as a step toward this degree. See **Graduate Certificates** in the Degree Programs section of this catalog. For further information, call the Associate Vice President of Continuing and Distance Education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; e-mail cpe@njit.edu.

# Telecommunications

Telecommunications is one of the most rapidly growing fields in engineering. Telecommunications specialization also is rapidly becoming necessary in such diverse fields as banking, reservation systems, office information systems, corporate networks, and the Internet. Rapid technological progress in gigabit optical networks, multimedia communications, and wireless network access, make the future of the field very exciting.

## Master of Science in Telecommunications

The objective of this program is to educate individuals in one or more telecommunication specializations.

### Admission Requirements

Applicants are expected to have an undergraduate degree in computer science, computer engineering or electrical engineering from an accredited institution (or its equivalent) with a minimum GPA of 3.0 on a 4.0 scale. These students should have taken CS 333 Introduction to UNIX Operating Systems, ECE 321 Random Signals and Noise and ECE 333 Signals and Systems (or their equivalents) or ECE 501 Linear Systems and Random Signals. Students without this course work will be required to complete a bridge program. Applicants having degrees in other fields may be considered for admission on an individual basis and required to complete a bridge program. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based).

### Graduate Certificate Program

A 12-credit graduate certificate in Telecommunications Networking is available as a step toward this degree. See "**Graduate Certificates**" in this catalog. For further information about extension programs and graduate certificates, call the associate vice president of continuing and distance education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; e-mail cpe@njit.edu

# NJIT Faculty

## A

Kam, Moshe, Professor

Akansu, Ali N., Professor

Ansari, Nirwan, Professor

## B

Bar-Ness, Yeheskel, Distinguished Professor Emeritus

## C

Carpinelli, John D., Professor

Carr, William N., Professor Emeritus

Clements, Wayne I., Associate Professor Emeritus

Cornely, Roy H., Professor Emeritus

## F

Feknous, Mohammed, University Lecturer

Frank, Joseph Associate Professor Emeritus

Friedland, Bernard, Distinguished Professor

## G

Ge, Hongya, Associate Professor

Grebel, Haim, Professor

## H

Haddad, Richard A., Professor Emeritus

Haimovich, Alexander M., Professor

Hou, Sui-Hoi Edwin, Associate Professor

Hubbi, Walid, Associate Professor

## K

Kam, Moshe, Professor

Khreishah, Abdallah, Assistant Professor

Klapper, Jacob, Professor Emeritus

Kliewer, Joerg, Associate Professor

Kuo, Marshall C., Professor Emeritus

## L

Levkov, Serhiy P., University Lecturer

## M

Manzhura, Oksana Yu, University Lecturer

Meyer, Andrew U., Professor Emeritus

Misra, Durgamadhab, Professor

## N

Niver, Edip, Professor

## R

Rojas-Cessa, Roberto, Associate Professor

Rosenstark, Solomon, Professor Emeritus

## S

Savir, Jacob, Distinguished Professor

Shi, Yun-Qing, Professor

Simeone, Osvaldo, Associate Professor

Sohn, Kenneth S., Professor Emeritus

Sosnowski, Marek, Professor

Steele, Timothy W., University Lecturer

## T

Tsybeskov, Leonid, Professor

## W

Whitman, Gerald, Professor

## Z

Zhou, Mengchu, Distinguished Professor

Ziavras, Sotirios G., Professor

# Programs

- Computer Engineering - M.S. (p. 934)
- Electrical Engineering - M.S. (p. 936)
- Internet Engineering - M.S. (p. 949)
- Power and Energy Systems - M.S. (p. 952)
- Telecommunications - M.S. (p. 953)

# Programs

- Computer Engineering - Ph.D. (p. 956)
- Electrical Engineering - Ph.D. (p. 957)

Power Systems Engineering - Cert.

# Electrical and Computer Engineering Courses

**ECE 501. Linear Systems and Random Signals. 3 credits, 3 contact hours.**
This course, serving as a bridge course for non-electrical and computer engineering department graduate students, provides fundamental coverage of signal and system analysis, including probabilistic methods. Topics include signal models, system properties, Fourier Transform, introduction to probability, random variables, random processes, correlation functions, and spectral density.

**ECE 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: permission from Department of Electrical and Computer Engineering and Division of Career Development Services. Cooperative education/internship providing on-the-job reinforcement of academic programs in electrical and computer engineering. Assignments and projects are developed by the co-op office in consultation with the electrical and computer engineering department. Work assignments are related to student's major and are evaluated by faculty coordinators in the ECE department. Credits for this course may not be used to fulfill any electrical or computer engineering degree requirement.

**ECE 591. Graduate Co-op Work Experience II. 3 credits, 0 contact hours.**
Prerequisites: ECE 590 and permission from Department of Electrical and Computer Engineering and Division of Career Development Services. See ECE 590 course description. Credits for this course may not be used to fulfill any electrical or computer engineering degree requirement.

**ECE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: graduate standing and permission from Department of Electrical and Computer Engineering and Division of Career Development Services. See ECE 590 course description. Credits for this course may not be used to fulfill any electrical or computer engineering degree requirement.

**ECE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**ECE 601. Linear Systems. 3 credits, 3 contact hours.**
Methods of linear-system analysis, in both time and frequency domains, are studied. Techniques used in the study of continuous and discrete systems include state-variable representation, matrices, Fourier transforms, LaPlace transforms, inversion theorems, sampling theory, discrete and fast Fourier transforms, and Z-transforms. Computer simulation of linear systems is used, and, where feasible, computer solutions are obtained.

**ECE 605. Discrete Event Dynamic Systems. 3 credits, 3 contact hours.**
Corequisite: MATH 630 or ECE 601 or MNE 603 or equivalent. Covers the theory of discrete event dynamic systems with applications in modeling, control, analysis, validation, simulation, and performance evaluation of computer systems, flexible manufacturing systems, robotic systems, intelligent supervisory control systems, and communication networks. Emphasis on Petri net and automation based approaches.

**ECE 609. Artificial Neural Networks. 3 credits, 3 contact hours.**
Prerequisites: ECE 601 and ECE 673 or consent of instructor. Artificial Neural Networks (ANN) are networks consisting of massively parallel connected simple processing elements arranged in various topology, usually in layers. Various ANN models, learning paradigms, and applications are covered. The course evolves from a simple single-neuron structure to more complex networks.

**ECE 610. Power System Steady-State Analysis. 3 credits, 3 contact hours.**
Prerequisite: B.S. in EE or ME. Steady-state analysis of power system networks, particularly real and reactive power flows under normal conditions and current flows under faulty conditions. Symmetrical components and digital solutions are emphasized.

**ECE 611. Transients in Power Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 610. Transient performance of power systems with lumped properties, interruption of arcs, restriking voltage, re-ignition inertia effects, switching of rotational systems, magnetic saturation in stationary networks, harmonic oscillations, saturated systems, transient performance of synchronous machines.

**ECE 612. Computer Methods Applied to Power Systems. 3 credits, 3 contact hours.**
Prerequisite: undergraduate computer programming. Digital computer techniques proven successful in the solution of power system problems, particularly in the electric utility industry. Emphasis on short-circuit, load flow, and transient stability problems. Matrix sparsity is considered.

**ECE 613. Protection of Power Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 610 or equivalent Coils, condensers, and resistors as protective devices; fundamental principles of protective relaying; relay operating characteristics; power and current directional relays; differential relays; distance and wire pilot relays; heating and harmonic effects; and Computer-based protective device coordination.

**ECE 616. Power Electronics. 3 credits, 3 contact hours.**
Prerequisite: B.S. in electrical engineering. Principles of thyristor devices, dynamic characteristics of choppers, commutation, protection, voltage-fed and current-fed inverter drives, cycloconverters, pulse width modulation, phase control, and microcomputer control, with case studies.

**ECE 617. Economic Control of Interconnected Power Systems. 3 credits, 3 contact hours.**
Economic Control of Interconnected Power Systems: Advanced techniques for operating power systems in the most economic manner while meeting various network constraints; economic dispatch, penalty factors, optimal power flow, short-term electricity markets and locational marginal prices will be studied.

**ECE 618. Renewable Energy Systems. 3 credits, 3 contact hours.**
This course introduces renewable energy systems. It covers the fundamental concepts of energy and radiation with specific solar energy applications and photovoltaics, electrical energy storage systems, and thermal energy and storage. The second part covers the basic science of wind energy systems and their electrical sytem designs. The third part covers the bioenergy systems from resources to final products and conversion technologies. It finally introduces other promising energy sources.

**ECE 620. Electromagnetic Field Theory. 3 credits, 3 contact hours.**
Prerequisite: undergraduate electromagnetic field theory or equivalent. Maxwell's equations, boundary conditions and formulation of potentials. LaPlace and Poisson equations for electrostatic and magnetostatic problems and the method of images. Dielectric and magnetic materials, force and energy concepts. Quasi-static and time varying fields, plane, cylindrical and spherical waves. Green's functions, transmission lines.

**ECE 622. Wave Propagation. 3 credits, 3 contact hours.**
Prerequisite: ECE 620 or equivalent. Fundamentals of electromagnetics; radiation and scattering; Green's functions; integral equations; numerical methods; ray optics and asymptotics.

**ECE 623. Fourier Optics. 3 credits, 3 contact hours.**
Prerequisite: EE 362 (see undergraduate catalog for description) or equivalent. Theoretical background needed to analyze various optical systems: two-dimensional Fourier transforms, vector and scalar diffractions, Fresnel and Fraunhofer approximations, the properties of lenses, coherence theory, frequency analysis of optical imaging systems, spatial filtering, optical information processing, and wavefront-reconstruction imaging.

**ECE 624. Optical Engineering. 3 credits, 3 contact hours.**
This course covers basic optical concepts, emphasizing those common to many optical instruments, such as light sources and their characteristics, polarization, coherence, and interferometry. The course introduces CAD tools for lenses, optical filters, and instrument design. The course also focuses on topics concerning optical systems, such as flat panel displays and micromechanical optical systems.

**ECE 625. Fiber and Integrated Optics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate electromagnetic field theory and solid-state circuits. Planar dielectric waveguides, step and graded index fibers and dispersion in fibers. The p-n junction and heterostructures, light emitting diodes and semiconductor lasers, p-i-n and avalanche photodetectors, optical transmitter and receiver designs, optical fiber communication system design concepts.

**ECE 626. Optoelectronics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate electromagnetic field theory and solid-state circuits. Optical propagation in anisotropic materials, polarization, birefringence and periodic media. Concepts of electro-optics and acousto-optic devices, optical modulators, switches, active filters for optical communication and optical processing.

**ECE 630. Microwave Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electromagnetic field theory. Review of transmission line theory and the Smith chart; scattering matrix representation, LC and microstrip matching networks; signal flow graph analysis; micro-wave transistor amplifier design, which includes power gain, stability, noise figure circles; oscillator design.

**ECE 632. Antenna Theory. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electromagnetic field theory. Fundamentals of electromagnetic field theory; far field approximation, antenna characteristics (gain, impedance, pattern, etc.); elementary antenna types (dipoles, loops, etc.), antenna array theory, wire antennas; broadband antennas.

**ECE 635. Conduction in Plasma. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in direct power generation. Maxwellian velocity distribution function, concentration and diffusion gradients, mean free path, methods of ionization, field intensified ionization, drift velocity, plasma temperature methods of deionization, plasma oscillations and plasma sheath, spark breakdown and mechanism of arcs.

**ECE 636. Computer Networking Laboratory. 3 credits, 3 contact hours.**
Prerequisites: ECE 637 or CS 656. This course provides students with hands on training regarding the design, troubleshooting, modeling and evaluation of computer networks. In this course, students are going to experiment in a real test-bed networking environment, and learn about network design and troubleshooting topics and tools such as: network addressing, Address Resolution Protocol (ARP), basic troubleshooting tools (e.g. ping, ICMP), IP routing (e,g, RIP), route discovery (e.g. traceroute), TCP and UDP, IP fragmentation and many others. Student will also be introduced to the network modeling and simulation, and they will have the opportunity to build some simple networking models using the OPNET modeling tool and perform simulations that will help them evaluate their design approaches and expected network performance.

**ECE 637. Internet and Higher-Layer Protocols. 3 credits, 3 contact hours.**
The course introduces the protocols and standards of the TCP/IP suite that govern the functioning of the Internet. The material covered in class is a top-down approach on introduction, discussion, and analysis of protocols from the data-link layer to the application layer. Alternative protocols to the TCP/IP suite and new protocols adopted by this suite are discussed. Numerical examples related to network planning and proocol functioning are analyzed.

**ECE 638. Network Management and Security. 3 credits, 3 contact hours.**
Prerequisites: ECE 683 or CS 652, and ECE 637 or CS 656. Thorough introduction to current network management technology and techniques, and emerging network management standards. In-depth study of the existing network security technology and the various practical techniques that have been implemented for protecting data from disclosure, for guaranteeing authenticity of messages, and from protecting systems for network-based attacks. SNMP family of standards including SNMP, SNMPv2, and RMON (Remote Monitoring), OSI systems management. Various types of security attacks (such as intruders, viruses, and worms), Conventional Encryption and Public Key Cryptology. Various security services and standards (such as Kerberos, Digital Signature Standard, Pretty Good Privacy, SNMPv2 security facility). Same as CIS 696.

**ECE 639. Principles of Broadband Networks. 3 credits, 3 contact hours.**
Prerequisites: ECE 673, ECE 683 or CS 652 or equivalent. This course covers fundamental concepts of broadband networks. Topics include Broadband ISDN, Switching Techniques, ATM, SONET/SDH, Congestion Control, High-Speed Switching Architectures, Traffic Modeling of Broadband Services, Admission Control, Traffic Scheduling, IP/ATM Convergence, QoS Provisioning in IP Networks, and Optical Networks.

**ECE 640. Digital Signal Processing. 3 credits, 3 contact hours.**
Prerequisite: ECE 601 or equivalent. The theory of digital signals and basic processing techniques: Discrete Fourier Series, Discrete Fourier Transform and FFT, Linear and Circular Convolution, Digital Filter Design Techniques, Discrete Hilbert Transforms, Discrete Random Signals, Chirp-Z and other advanced transforms. Introduction to multivariate signal processing. The typical applications of signal processing tools are discussed and connected to the theoretical foundations.

**ECE 641. Laboratory for High Performance Digital Signal Processing. 3 credits, 3 contact hours.**

**ECE 642. Communication Systems I. 3 credits, 3 contact hours.**
Corequisite: ECE 673. Principles of communication theory applied to the representation and transmission of information. Topics include analysis of deterministic and random signals, amplitude modulation, angle modulation, sampling, quantization, PCM, DM, DPCM, geometric representation of signals, error probability, matched filter and correlation receivers and performance analysis of communication systems signal to noise ratio.

**ECE 643. Digital Image Processing I. 3 credits, 3 contact hours.**
Prerequisite: ECE 601. Introductory course in digital image processing. Topics include image models, digitization and quantization, image enhancement in spatial and frequency domains, image restoration, image segmentation and analysis.

**ECE 644. Wireless Communication. 3 credits, 3 contact hours.**
Prerequisites ECE 321 or MATH 333. This course is focused on the technical challenges and solutions to physical and link layer design of wireless communication systems. Course topics include characterization of the wireless channel, the cellular concept, digital modulation techniques, spread spectrum, multiple access techniques including CDMA and OFDMA, diversity techniques. Advanced techniques such as MIMO, 3G and 4G wireless technologies are introduced. Matlab is used for examples and assignments. Team projects based on advanced wireless technologies.

**ECE 645. Wireless Networks. 3 credits, 3 contact hours.**
Prerequisites: EE 321 or MATH 333, or equivalent (see undergraduate catalog for descriptions). Introduction to wireless network design, management, and planning stages. Topics include demand modeling, radio planning, network optimization, and information handling architecture with emphasis on resource allocation and mobility management aspects. Investigation of signaling load optimizations and internetworking problems.

**ECE 646. Introduction to Data Communications. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673, or equivalent. Introduces the theory and technology of data communications over voice-grade and broadband channels. Provides the analytical tools required to understand and design data communication systems. Topics include: an overview of data communication systems, channel capacity, channel coding (block codes, cyclic codes, convolutional codes), data transmission, synchronization, equalization, and an introduction to adaptive equalization.

**ECE 648. Digital Microelectronics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate semiconductor circuits. Topics include: linear wave shaping with RC circuits, clipping and clamping circuits; theory of operation of semiconductor diode, bipolar transistor (BJT), and MOSFET; BJT and MOSFET inverters, gate circuits, and regenerative logic circuits.

**ECE 649. Compression in Multimedia Engineering. 3 credits, 3 contact hours.**
Prerequisite: ECE 640 or instructor's permission. Foundations of information theory, audio/speech and video compression technologies. Detailed discussion of JPEG, image compression, H.261, MPEG-1 and MPEG-2 international video compression standard algorithms. Current status and future directions of very low bit rate MPEG-4 video compression standards activities.

**ECE 650. Electronic Circuits. 3 credits, 3 contact hours.**
Prerequisite: senior undergraduate level semiconductor circuits. Methods of analysis and design of linear and digital semiconductor circuits are studied. Topics include low and high frequency models, passive and active biasing techniques, I-C analysis and design, op-amp circuits, and active filters.

**ECE 653. Micro/Nanotechnologies for Interacing Live Cells. 3 credits, 3 contact hours.**
In this course, we will study technologies and tools available for interfacing live cells from a sub-cellular, single-cell, and multi-cellular (tissue models) approach. We will introduce key concepts of the biology of cells and tissues and will explore the technologies (micro-/nanotechnologies) and tools (sensors and actuators) available for the investigation of cell and tissue biology. Same as BME 653.

**ECE 655. Modeling of Biological Neural Systems. 3 credits, 3 contact hours.**
This course introduces biological neural networks and systems as the essential parts of the autonomous, peripheral and central nervous systems in human body to perform physiological functions and determine behavior. The difference in neural architecture and function in different nervous systems will be discussed. Approaches for modeling of neural circuits with examples of simulation of small and large neural networks in human nervous systems for pattern generation, recall and recognition are discussed and studied.

**ECE 657. Semiconductor Devices. 3 credits, 3 contact hours.**
Fundamental principles of solid state materials necessary for understanding semiconductor devices. Topics include crystal structure; energy bands; electron and hole generation, and transport phenomena; generation and recombination processes, and high field effects. P-N junction diode, metal semiconductor contact, and bipolar and metal oxide semiconductor transistors, including switching phenomena and circuit models. Introduction to: photonic devices~light emitting diodes, semiconductor lasers, photodetectors, and solar cells; microwave devices~tunnel and IMPATT diodes, transferred electron devices, and charge-coupled capacitors.

**ECE 658. VLSI Design I. 3 credits, 3 contact hours.**
Prerequisite: ECE 657 or equivalent. Analysis and design of digital integrated circuits; basic building blocks and dependence on circuit parameters of propagation delay; noise margin; fan-out; fan-in; and power dissipation for circuits of different logic families, including NMOS, CMOS and BiCMOS; subsystem designs in combinational and sequential logic; Memory Systems; HSPICE circuit simulation is used for digital characteristics evaluation. Mentor Graphics Layout design tools are used for chip design.

**ECE 659. Fabrication Principles of Electronic and Optoelectronic Devices. 3 credits, 3 contact hours.**
Prerequisite: ECE 657 or equivalent. Overview of all major processing steps in fabrication of integrated circuits such as crystal growth, epitaxy, oxidation, diffusion, ion implantation and etching. Formation of thin film structures along with techniques for defining submicron structures. Emphasizes silicon device technology but also includes processing of compound semiconductors such as gallium arsenide.

**ECE 660. Control Systems I. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course equivalent to EE 333 or ME 305 (see undergraduate catalog for descriptions) and ECE 601 or equivalent or permission from instructor. Introduction to feedback control. Review of state-space analysis. Frequency-domain methods for analysis: Routh-Hurwitz stability algorithms, Root-loci; Nyquist and Bode plots; system ?type.? Controllability and observability. The separation principle and design by pole placement. Linear observers. Optimization of quadratic performance criteria. Elements of random processes. The Kalman filter as an optimum observer. Robustness considerations.

**ECE 661. Control System Components. 3 credits, 3 contact hours.**
Prerequisite: ECE 660. The theoretical and practical requirements for analog and digital state-of-the-art control system components are covered. Actuators, amplifiers, sensors, encoders, resolvers and other electromagnetic devices are included. A complete system is designed using current vendor catalog data. Problems affecting the system performance are analyzed using measures of functionality, reliability and cost.

**ECE 664. Real-time Computer Control Systems. 3 credits, 3 contact hours.**
Prerequisite: EE 486 or equivalent (see undergraduate catalog for description). Emphasizes the practical aspects of modern computer control systems. Topics include: Architecture of digital signal processors (DSP) and microcontrollers, real-time data acquisition devices and interface, programming a DSP, review of sampling theorems and properties of discrete-time systems, introduction of control systems theory, design and implementation of parameter optimized controllers, state variable controllers, and cancellation controllers. An experimental project using a TMS320C2x DSP-based data acquisition system is an integral part of this course.

**ECE 666. Control Systems II. 3 credits, 3 contact hours.**
Prerequisites: ECE 601 and ECE 660. Properties of nonlinear systems and basic concepts of stability including small-signal linearization. State plane methods are introduced, with emphasis on controller design for systems that can be represented by second-order approximations. Concepts of equivalent gain, describing function, and dual-input describing function as applied to a large class of nonlinear systems. Representation of linear sampled-data systems in discrete state variable form, stability and performance of discrete-event systems. Full-state feedback, pole placement and observer design. Linear quadratic control and Kalman filtering.

**ECE 667. Bio-Control Systems. 3 credits, 3 contact hours.**
The course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves which govern the basic operations of all living organisms and especially higher order life forms. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Same as BME 667.

**ECE 668. Mecial Imaging Systems. 3 credits, 3 contact hours.**
This course provides a detailed introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound and optical imaging modalities are included. Same as BME 668.

**ECE 669. Engineering Physiology. 3 credits, 3 contact hours.**
To enable students to apply basic tools in engineering analysis, mathematics, computer science, general physics and chemistry courses so that they can develop models that quantitatively predict the functioning of physiological systems in the human body. To enable students to apply engineering systems analysis to systematic physiology and employ the ideas of feedback control, signal procession, mathematical modeling and numerical simulation. Same as BME 669.

**ECE 673. Random Signal Analysis I. 3 credits, 3 contact hours.**
Fundamentals of the theory of random variables. Introduction to the theory of random processes. Topics include functions of random variables, sequences of random variables, central limit theorem, properties of random processes, correlation, spectral analysis and linear systems with random inputs.

**ECE 677. Optimization Techniques. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in differential equations. Analytical and numerical methods for finding an extremum emphasizing how and when to apply them. Classical differentiation, Lagrange multipliers, the calculus of variations, penalty functions, slack variables, search techniques, and stochastic approximation are covered.

**ECE 681. High Performance Routers and Switches. 3 credits, 3 contact hours.**
The course introduces the different system comprising and Internet routing including the processors for networking function and protocol compliance, switching functions and packet classification for deep-layer inspection capable routers or network appliances. This course material describe the different functions that Internet routers perform and discusses the different approaches used for improving performance of high-end routers. The content includes a discussion on switch architectures.

**ECE 682. Introduction to Computer Network Design: Internet Perspective. 3 credits, 0 contact hours.**
Explicit emphasis on design considerations. Covers the basics of computer networking and the important current network technologies including the premier local area network and wide area network technologies and services, as well as the description of the relevant protocols. Also covers explicit related design considerations and implications. Amplifies the conclusions with discussions of relevant examples and case studies.

**ECE 683. Computer Network Design and Analysis. 3 credits, 3 contact hours.**
Corequisite: ECE 673. Queueing models and state-transition models are introduced to model, design and analyze computer networks. The OSI model, LANS (including token ring, token bus, and Ethernet), and useful network protocols. Emphasis on the physical, data link and network layers. ALOHA, Stop-and-Wait protocol, Go-Back-N protocol, window-flow-control, and shortest-path routing.

**ECE 684. Advanced Microprocessor Systems. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in computer architecture and microprocessors, and some experience in assembly language programming. Architecture of advanced microprocessors; CPU architecture, memory management and protection, interrupt and exception facilities, instruction sets, systems aspects including peripheral interfaces, communications ports, and real-time systems.

**ECE 685. Network Interface Design. 3 credits, 3 contact hours.**
Prerequisite: ECE 683 or equivalent. Provides a working knowledge of data communications networking devices, the building blocks upon which networks are constructed. Emphasizes devices and their function in data communication networks. Covers the use of devices in the design, implementation, modification, and optimization of data communications networks.

**ECE 686. Instrumentation Systems and Microprocessors. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in microprocessors. Principles of instrumentation transducers and the electronic amplifiers and filters needed to process the electrical signals generated by them; types and characteristics of A/D and D/A converters and other circuits necessary for the interfacing of instrumentation data to a computer or digital data transmission system. Emphasis placed on development of stand-alone analog instrumentation systems as well as microprocessor-based systems. Tradeoffs and alternatives for both implementations are emphasized as well as cost effectiveness of each design. Hardware and software are developed as needed.

**ECE 687. Design of Medical Instrumentation. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in electronics. Principles and practice of medical instrumentation. Instrument components and medical instrument systems design. Examples taken from electrocardiography, clinical chemistry, medical imaging. Microprocessor-based systems emphasized.

**ECE 688. Microcontrollers in Instrumentation. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in microprocessors. Microcontroller as single chip computer system for diverse applications. System microcontroller real-time design concepts from architecture to interface. Assembly language programs. Real-time facilities of advanced microcontrollers are emphasized.

**ECE 689. Computer Arithmetic Algorithms. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in logic design. Data representation, integers, floating point and residue representation. Bounds on arithmetic speed, algorithms for high speed addition, multiplication, and division. Pipelined arithmetic. Hardware implementation and control issues.

**ECE 690. Computer Systems Architecture. 3 credits, 3 contact hours.**
Prerequisites: ECE 684 and COE 353 (see undergraduate catalog for description) or CS 650. Discusses advanced topics in modern computer systems architecture such as pipelined and superscalar processors, parallel computers (vector, SIMD, MIMD), multithreaded and dataflow architectures, cache and memory hierarchy, and system interconnect architectures. Also discusses relevant system software design issues such as shared memory and message-passing communication models, cache coherence and synchronization mechanisms, latency-hiding techniques, virtual memory management, program partitioning and scheduling. Examples are drawn from real systems.

**ECE 692. Embedded Computing Systems. 3 credits, 3 contact hours.**
Pre-requisites: ECE 353 (COE) or ECE 684 (EE) and CS 105 (or equivalents). Introduction of the methodology for the design and implementation of embedded computing systems, and its application to real-world problems. Topics include Embedded System Design Process, UML, ARM Instruct Set Architectures, CPU's Hardware Platforms, Software Design and Analysis, Embedded Operating Systems, Real-Time Scheduling, Hardware Accelerators, Distributed Embedded Systems, and Design Methodology and Quality Assurance.

**ECE 698. Selected Topics in Electrical and Computer Engineering. 3 credits, 3 contact hours.**
Special area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

**ECE 699. Selected Topics in Electrical and Computer Engineering II. 3 credits, 3 contact hours.**
See description for ECE 698 above.

**ECE 700. Master's Project. 0 credits, 0 contact hours.**
Prerequisite: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry may be acceptable. Work is carried out under the supervision of a member of the department faculty. A maximum of 3 credits may be applied to the degree.

**ECE 700B. Master's Project. 3 credits, 3 contact hours.**
Restriction: written approval of project advisor. An extensive paper involving design, construction, and analysis, or theoretical investigation. Joint projects with industry may be acceptable. Work is carried out under the supervision of a member of the department faculty. A maximum of 3 credits may be applied to the degree.

**ECE 701. Master's Thesis. 0 credits, 0 contact hours.**
Prerequisite: written approval of thesis advisor. Projects involving design, construction, experimental or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried on under the supervision of a designated member of the department faculty. Completed work in the form of a written thesis should be of a quality leading to journal publication. The completed thesis must be defended by the student in an open forum and must be approved by a committee of at least three people. A student must register for a minimum of 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

**ECE 701B. Master's Thesis. 3 credits, 3 contact hours.**
Restriction: written approval of thesis advisor. Projects involving design, construction, experimental or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried on under the supervision of a designated member of the department faculty. Completed work in the form of a written thesis should be of a quality leading to journal publication. The completed thesis must be defended by the student in an open forum and must be approved by a committee of at least three people. A student must register for a minimum of 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

**ECE 701C. Master's Thesis. 6 credits, 3 contact hours.**
Restriction: written approval of thesis advisor. Projects involving design, construction, experimental or theoretical investigation. Joint projects with industry or governmental agencies may be acceptable. Work is carried on under the supervision of a designated member of the department faculty. Completed work in the form of a written thesis should be of a quality leading to journal publication. The completed thesis must be defended by the student in an open forum and must be approved by a committee of at least three people. A student must register for a minimum of 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

**ECE 711. Power System Dynamics and Stability. 3 credits, 3 contact hours.**
Prerequisites: ECE 610 and undergraduate course in electric machines. Elements of the stability problem: principal factors affecting stability, ordinary simplified methods of making stability calculations, and illustrations of the application of these methods to studies of power systems, damping, and saturation.

**ECE 725. Independent Study I. 3 credits, 3 contact hours.**
Restriction: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Master's degree students cannot count ECE 725 as degree credit but can count these credits to qualify for full-time status.

**ECE 726. Independent Study II. 3 credits, 3 contact hours.**
See description for ECE 725 above. This course is not available to master's students.

**ECE 730. Theory of Guided Waves. 3 credits, 3 contact hours.**
Prerequisite: ECE 620 or equivalent. Modes, rays and beam propagation in guiding structures. Non-uniform waveguides and transitions, excitation of waveguides and optical fibers. Coupled modes theory with applications to resonators and couplers. Wave propagation in anisotropic media.

**ECE 739. Laser Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 620 or permission of instructor. Optical resonators, laser radiation and oscillation. Laser characteristics: semiconductor lasers, gas and glass lasers; mode-locking, Q-switching. Quantum-well lasers, noise; modulation and detection of laser light, optical systems for communication and computation.

**ECE 740. Advanced Digital Signal Processing. 3 credits, 3 contact hours.**
Prerequisites: ECE 601, ECE 640 and ECE 673. Topics in stationary discrete time stochastic processes; modeling of discrete time processes, Yule-waker equations, aspects of discrete wiener theory; principle of orthogonality, linear predictors; Levinson-Durbin recursion and algorithm, lattice predictors, method of least squares (RLS) algorithm, systolic array implementation of QRD-Ls.

**ECE 742. Communication Systems II. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalents. Principles of digital communication. Topics include fundamentals of information theory, digital modulation techniques, optimum detector receivers for digitally modulated signals, the bandlimited gaussian channel and intersymbol interference, equalization, spread spectrum, CDMA.

**ECE 743. Image Data Hiding, Forensics. 3 credits, 3 contact hours.**
Prerequisites: ECE 643 or CS 659 or equivalent As we have entered digital world, information forensics and security have become critically important. With digital images as media, this course covers digital watermarking, reversible data hiding, steganography and steganalysis, forensics and counter-forensics, including image tampering detection, classification of double JPEG/MPEG compressions, camera classification from given images, classification of photographic images from computer graphic images, and so on.

**ECE 744. Optimization for Communication Networks. 3 credits, 3 contact hours.**
Modern communication are required to provide optimal performance in terms of quality-of-service under strict constrains on the utilization of resources, such as spectrum of power. In addition, the emerging paradigm of decentralized communication systems, such as ad hoc and sensor networks, calls for distributed, and possibly competitive, optimization techniques. This course covers the basic analytical and algorithmic tools that enable such centralized and decentralized optimization.

**ECE 746. Adaptive Array Processing and Interference Cancellation. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673. Principles of array processing, performance criteria used, and adaptive algorithms for realization of these processors; and ideas and principles of array processing in the design of contemporary radar systems.

**ECE 747. Signal Decomposition Techniques: Transforms, Sub-bands, and Wavelets. 3 credits, 3 contact hours.**
Prerequisites: ECE 640 and ECE 673. Multiresolution signal decomposition techniques, transforms, sub-bands, and wavelets. Time-frequency localization properties of multiresolution algorithms. Evaluation and critique of proposed decomposition strategies from compression and performance standpoints. Applications to speech and video compression, and localized feature extraction. These are basic signal processing tools used in diverse applications such as speech and image processing and storage, seismology, machine vision.

**ECE 755. Advanced Topics in Digital Communications. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalent. Advanced topics in digital communication systems in the presence of intersymbol interference, noise, and fading: modulation and demodulation in the presence of gaussian noise, efficient signaling with coded modulation, trellis decoding, Viterbi algorithm, digital transmission with intersymbol interference, and digital signaling over imperfect channels.

**ECE 756. Advanced Topics in Semiconductor Devices. 3 credits, 3 contact hours.**
Prerequisite: ECE 657 or permission of instructor. Builds on ECE 657. Covers photonic devices particularly semiconductor laser and photodetectors for optical systems; microwave and other high speed devices; scaled advanced MOS, FET, and bipolar transistors.

**ECE 757. Advanced Wireless Communications. 3 credits, 3 contact hours.**
Prerequisite: ECE 742 or equivalent. Introduction of digital cellular radio. In-depth analytical characterization of linear, time-variant systems as they apply to wireless channels. Thorough consideration of the principles of the CDMA multiuser system, together with methods for reducing multiple-access interference. Emphasis on general topics such as diversity interleaving.

**ECE 758. VLSI Design II. 3 credits, 3 contact hours.**
Prerequisite: ECE 658 (with ECE 657 suggested). Use of CMOS, biCMOS and bipolar semiconductor technology for VLSI design. Digital techniques are emphasized with minor coverage of analog design. Application areas for full custom, gate arrays, standard cell, and compiled designs are compared. Mentor VLSI design tools running on the HP and Sun workstations are used in the course projects for each enrollee. The course attempts to provide a design environment for projects that is similar to that encountered by VLSI designers in industry.

**ECE 759. Principles of Phase Lock and Frequency Feedback. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalents. Principles of operation and design for phase locked and frequency feedback loops, linear equivalent circuit, nonlinear effects, and optimization against noise used in a wide range of applications including low-level signal reception, tracking, phase extraction, filtering, and frequency synchronization. F.M. communication is emphasized.

**ECE 760. Solid-State Image Sensors. 3 credits, 3 contact hours.**
Prerequisites: ECE 657 and ECE 648 or ECE 658. Construction, operation, and performance evaluation of visible and infrared image sensors. Included are a review of the main approaches for photodetectors and readout structures, image sensor architectures, performance evaluation and trade-offs, noise considerations, modulation transfer function, techniques for control of blooming, interlacing, color-coding for visible imagers, HDTV imagers, photo-counting amplifiers, and radiometry and figures of merit for infrared imagers.

**ECE 766. Stability Theory of Nonlinear Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 666. Concepts of stability in dynamic systems, theory and application of Lyapunov's direct method. Use of functional analysis, and frequency response method of Popov and its extensions including their application to the investigation of stability, boundedness, and damping in a class of unforced and forced nonlinear systems.

**ECE 768. Optimal Control Theory. 3 credits, 3 contact hours.**
Prerequisite: ECE 677. Optimal control for classes of deterministic systems with various constraints using calculus of variations, dynamic programming and the maximum principle, state variable constraints, and application of theory to design problems.

**ECE 769. Stochastic Estimation and Control. 3 credits, 3 contact hours.**
Prerequisites: ECE 660 and ECE 673. Markov processes. The discrete-time Kalman filter as a minimum variance estimator. The continuous-time Kalman-Bucy filter. Relationship to the Wiener filter. Nonlinear systems: the extended Kalman filter and other generalizations. Computational difficulties and methods for avoiding them: separated-bias estimation, ?UDU? factorization. Applications in navigation and control.

**ECE 776. Information Theory. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673 or equivalents. Classical theory of information developed from Shannon's theory. Information measure, Markov sources and extensions, the adjoint source, uniquely decodable and instantaneous codes and their construction, Shannon's first and second theorems, mutual information, and performance bounds on block and convolutional codes.

**ECE 777. Statistical Decision Theory in Communications. 3 credits, 3 contact hours.**
Prerequisite: ECE 642 or equivalent. Relation between detection theory and statistical hypothesis testing problem. Use of Bayes decision criteria, Neyman-Pearson, and mini-max tests; receiver operating characteristics. Representation of signals in signal space, probability of error calculations. Estimation of random and non-random signal parameters, Cramer-Rao Inequality. The general Gaussian problem and the use of covariance matrices.

**ECE 778. Algebraic Coding for Information Transmission. 3 credits, 3 contact hours.**
Prerequisites: ECE 642 and ECE 673. Coding for reliable digital transmission and storage, error detection and correction codes. Decoding techniques and performance evaluation of block and convolutional codes, including BCH, Reed-Solomon code and Trellis coded modulation.

**ECE 782. Advanced Data Security and Privacy. 3 credits, 3 contact hours.**
Prerequisites: CS 608, CS 696, or instructor approval. In-depth study of the security and privacy issues associated with the massive amount of data that is collected, stored, shared and distributed in today's society. New paradigms are needed to address the security/privacy challenges when data is outsourced at untrusted servers (such as in cloud computing), when data is anonymized in order to be shared among untrusted parties, or when copyrighted data needs to be protected from unauthorized use.

**ECE 783. Computer Communication Networks. 3 credits, 3 contact hours.**
Prerequisites: ECE 673 and ECE 683. Data link control and communication channels. Delay models in data networks. Queueing analysis techniques are taught in detail. Multi-access communication techniques. Routing in computer communication networks.

**ECE 785. Parallel Processing Systems. 3 credits, 3 contact hours.**
Prerequisite: ECE 684 or equivalent. Parallel computer architectures. General purpose and specialized parallel computers. Shared-memory multiprocessors, message-passing multicomputers, and vector supercomputers. Principles of scalable performance. MPP designs. SIMD and MIMD computers. Design of parallel algorithms (merging and sorting of data, FFT, etc.) and performance evaluation. Load balancing, data decomposition, and scheduling of operations.

**ECE 788. Selected Topics in Electrical and Computer Engineering. 3 credits, 3 contact hours.**
Special-area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

**ECE 789. Selected Topics in Electrical and Computer Engineering II. 3 credits, 3 contact hours.**
See description for ECE 788.

**ECE 790. Doctrl Dissrtn & Research. 0 credits, 0 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790A. Doctrl Dissrtn & Research. 1 credit, 1 contact hour.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790B. Doctrl Dissrtn & Research. 3 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790C. Doctrl Dissertation & Resrch. 6 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790D. Doctrl Dissertation & Resrch. 9 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790E. Doct Dissrtation & Resrch. 12 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790F. Doct Dissertation & Resrch. 15 credits, 3 contact hours.**
Required of all students working toward the Ph.D. in Computer Engineering or in Electrical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester; registration for additional credits may be permitted beyond the 6, with the approval of the advisor, up to a maximum of 12 credits per semester. If the student is still actively engaged in the research after completion of 36 credits, continued registration of 3 credits per semester is required.

**ECE 790G. Doct Dissertation & Resrch. 18 credits, 3 contact hours.**

**ECE 791. Graduate Seminar. 0 credits, 0.5 contact hours.**
All master's and doctoral students must register for two semesters and six semesters of ECE 791 Graduate Seminar, respectively. To receive a satisfactory grade, students must attend at least five seminars during the semester, as approved by the seminar supervisor.

**ECE 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**ECE 792C. Pre-Doctoral Research. 6 credits, 3 contact hours.**

# M.S. in Computer Engineering

## Degree Requirements

Students must complete 30 credits; 21 or more credits must be from ECE courses. They include two required computer engineering core courses, two more required courses for one of the five areas of specialization, and a master's project or thesis. As a requirement for graduation, students must achieve a 3.0 cumulative GPA, not including the master's thesis or project. The master's thesis or project grade must be B or higher.

### M.S. in Computer Engineering (Master's project)

| **Bridge Courses (undergraduate degree in computer science)** | | |
|---|---|---|
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 395 | Microprocessor Laboratory | 2 |
| ECE 231 | Circuits and Systems I | 3 |

| | | |
|---|---|---|
| ECE 684 | Advanced Microprocessor Systems | 3 |
| **Total Credits** | | **11** |

**Bridge Courses (undergraduate degree in electrical engineering)**

| | | |
|---|---|---|
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| or CS 506 | Foundations of Computer Science | |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 395 | Microprocessor Laboratory | 2 |
| ECE 684 | Advanced Microprocessor Systems | 3 |
| **Total Credits** | | **11** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| ECE 690 | Computer Systems Architecture | 3 |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Electives** | | |
| Select six of the following: | | 18 |
| **Areas of Specialization** | | |
| Select two of the following: | | 6 |
| **Computer Architecture and Embedded Systems** | | |
| ECE 658 | VLSI Design I | |
| ECE 692 | Embedded Computing Systems | |
| **Intelligent Systems** | | |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 609 | Artificial Neural Networks | |
| **VLSI System Design** | | |
| ECE 658 | VLSI Design I | |
| ECE 758 | VLSI Design II | |
| **Computer Networking** | | |
| ECE 683 | Computer Network Design and Analysis | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| or ECE 783 | Computer Communication Networks | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **33** |

[1] Required for one semester.

## M.S. in Computer Engineering (Master's thesis)

**Bridge Courses (undergraduate degree in computer science)**

| | | |
|---|---|---|
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 395 | Microprocessor Laboratory | 2 |
| ECE 231 | Circuits and Systems I | 3 |
| **Total Credits** | | **8** |

**Bridge Courses (undergraduate degree in electrical engineering)**

| | | |
|---|---|---|
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| or CS 506 | Foundations of Computer Science | |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 395 | Microprocessor Laboratory | 2 |
| **Total Credits** | | **8** |

| | | |
|---|---|---|
| **Core Courses** | | |
| CS 610 | Data Structures and Algorithms | 3 |
| ECE 690 | Computer Systems Architecture | 3 |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Electives** | | |
| Select five of the following: | | 15 |
| **Areas of Specialization** | | |
| Select two of the following: | | 6 |
| **Computer Architecture and Embedded Systems** | | |
| ECE 658 | VLSI Design I | |
| ECE 692 | Embedded Computing Systems | |
| **Intelligent Systems** | | |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 609 | Artificial Neural Networks | |
| **VLSI System Design** | | |
| ECE 658 | VLSI Design I | |
| ECE 758 | VLSI Design II | |
| **Computer Networking** | | |
| ECE 683 | Computer Network Design and Analysis | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **33** |

[1] Required for one semester.

# M.S. in Electrical Engineering

## Degree Requirements

## Bridge Program

Students who have earned a Bachelor of Science in Engineering Technology (B.S.E.T.) degree, or who lack an appropriate background may be admitted and be required to take selected courses in addition to the degree requirements in order to make up deficiencies. They must attain a grade of B or better in each course. At the discretion of the department, students who have taken courses equivalent to these may have their bridge programs reduced accordingly.

## Master's Program

Upon entering the program, students select an area of specialization supervised by the MSEE Program Advisor. The master's program consists of 30 credits. Students who enter the program but who do not receive departmental or research-based awards have three program options: 24 course credits and 6 credits of master's thesis; or 27 course credits and 3 credits of master's project; or 30 course credits not to include either a master's project or thesis. Thesis is required for all those receiving departmental or research-based support. For all others, a project or thesis is optional. Students should consult with the Program Advisor or designee before registering for courses to make sure they are meeting department requirements. As a requirement for graduation, students must achieve a 3.0 cumulative GPA in graduate-level courses, not including the master's thesis or project. The project grade must be B or better.

ECE courses at the 500 level are not acceptable for credit toward a graduate degree in electrical engineering. Only one 500 level course outside the department may be applied for credit toward a graduate degree in electrical engineering.

## Areas of Specialization

Entering students must select an area of specialization during their first semester. Special topics courses and electives are chosen with the approval of the MSEE Program Advisor or designee. Two non-ECE graduate courses may be chosen. Students should contact the MSEE Program Advisor for guidance.

### Focus Area: Communications, Signal Processing and Microwave (courses only)

**Bridge Courses**

| | | |
|---|---|---|
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 640 | Digital Signal Processing | |
| ECE 642 | Communication Systems I | |
| ECE 742 | Communication Systems II | |
| ECE 740 | Advanced Digital Signal Processing | |
| ECE 730 | Theory of Guided Waves | |
| ECE 632 | Antenna Theory | |
| **Suggested Electrical Engineering Electives** | | |
| Select six of the following: | | 18 |
| ECE 609 | Artificial Neural Networks | |
| ECE 622 | Wave Propagation | |
| ECE 623 | Fourier Optics | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 626 | Optoelectronics | |
| ECE 642 | Communication Systems I | |
| ECE 644 | Wireless Communication | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 746 | Adaptive Array Processing and Interference Cancellation | |
| ECE 747 | Signal Decomposition Techniques: Transforms, Sub-bands, and Wavelets | |
| ECE 755 | Advanced Topics in Digital Communications | |
| ECE 757 | Advanced Wireless Communications | |
| ECE 776 | Information Theory | |
| ECE 777 | Statistical Decision Theory in Communications | |
| ECE 778 | Algebraic Coding for Information Transmission | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area: Communications, Signal Processing and Microwave (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 640 | Digital Signal Processing | |
| ECE 642 | Communication Systems I | |
| ECE 742 | Communication Systems II | |
| ECE 740 | Advanced Digital Signal Processing | |
| ECE 730 | Theory of Guided Waves | |
| ECE 632 | Antenna Theory | |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select five of the following: | | 15 |
| ECE 609 | Artificial Neural Networks | |
| ECE 622 | Wave Propagation | |
| ECE 623 | Fourier Optics | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 626 | Optoelectronics | |
| ECE 642 | Communication Systems I | |
| ECE 644 | Wireless Communication | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 746 | Adaptive Array Processing and Interference Cancellation | |
| ECE 747 | Signal Decomposition Techniques: Transforms, Sub-bands, and Wavelets | |
| ECE 755 | Advanced Topics in Digital Communications | |
| ECE 757 | Advanced Wireless Communications | |
| ECE 776 | Information Theory | |
| ECE 777 | Statistical Decision Theory in Communications | |
| ECE 778 | Algebraic Coding for Information Transmission | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area: Communications, Signal Processing and Microwave (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |

| | | |
|---|---|---|
| ECE 640 | Digital Signal Processing | |
| ECE 642 | Communication Systems I | |
| ECE 742 | Communication Systems II | |
| ECE 740 | Advanced Digital Signal Processing | |
| ECE 730 | Theory of Guided Waves | |
| ECE 632 | Antenna Theory | |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Suggested Electrical Engineering Electives** | | |
| Select four of the following: | | 12 |
| ECE 609 | Artificial Neural Networks | |
| ECE 622 | Wave Propagation | |
| ECE 623 | Fourier Optics | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 626 | Optoelectronics | |
| ECE 642 | Communication Systems I | |
| ECE 644 | Wireless Communication | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 746 | Adaptive Array Processing and Interference Cancellation | |
| ECE 747 | Signal Decomposition Techniques: Transforms, Sub-bands, and Wavelets | |
| ECE 755 | Advanced Topics in Digital Communications | |
| ECE 757 | Advanced Wireless Communications | |
| ECE 776 | Information Theory | |
| ECE 777 | Statistical Decision Theory in Communications | |
| ECE 778 | Algebraic Coding for Information Transmission | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

### Focus Area : Computer Networking (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| ECE 683 | Computer Network Design and Analysis | 3 |
| ECE 783 | Computer Communication Networks | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select six of the following: | | 18 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 638 | Network Management and Security | |

| | | |
|---|---|---|
| ECE 639 | Principles of Broadband Networks | |
| ECE 642 | Communication Systems I | |
| ECE 644 | Wireless Communication | |
| ECE 645 | Wireless Networks | |
| ECE 658 | VLSI Design I | |
| ECE 677 | Optimization Techniques | |
| ECE 681 | High Performance Routers and Switches | |
| ECE 690 | Computer Systems Architecture | |
| ECE 742 | Communication Systems II | |
| ECE 785 | Parallel Processing Systems | |
| ECE 685 | Network Interface Design | |
| CS 610 | Data Structures and Algorithms | |
| CS 665 | Algorithmic Graph Theory | |
| MATH 661 | Applied Statistics | |
| MGMT 685 | Operations Research and Decision Making | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

### Focus Area : Computer Networking (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| ECE 683 | Computer Network Design and Analysis | 3 |
| ECE 783 | Computer Communication Networks | 3 |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select five of the following: | | 15 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 638 | Network Management and Security | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 642 | Communication Systems I | |
| ECE 644 | Wireless Communication | |
| ECE 645 | Wireless Networks | |
| ECE 658 | VLSI Design I | |
| ECE 677 | Optimization Techniques | |
| ECE 681 | High Performance Routers and Switches | |
| ECE 690 | Computer Systems Architecture | |

| | | |
|---|---|---|
| ECE 742 | Communication Systems II | |
| ECE 744 | Optimization for Communication Networks | |
| ECE 785 | Parallel Processing Systems | |
| ECE 685 | Network Interface Design | |
| CS 610 | Data Structures and Algorithms | |
| CS 665 | Algorithmic Graph Theory | |
| MATH 661 | Applied Statistics | |
| MGMT 685 | Operations Research and Decision Making | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area : Computer Networking (Master's thesis)

**Bridge Courses**

| | | |
|---|---|---|
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

**Core Courses**

| | | |
|---|---|---|
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| ECE 683 | Computer Network Design and Analysis | 3 |
| ECE 783 | Computer Communication Networks | 3 |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Suggested Electrical Engineering Electives** | | |
| Select four of the following: | | 12 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 638 | Network Management and Security | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 642 | Communication Systems I | |
| ECE 644 | Wireless Communication | |
| ECE 645 | Wireless Networks | |
| ECE 658 | VLSI Design I | |
| ECE 677 | Optimization Techniques | |
| ECE 681 | High Performance Routers and Switches | |
| ECE 690 | Computer Systems Architecture | |
| ECE 742 | Communication Systems II | |
| ECE 744 | Optimization for Communication Networks | |
| ECE 785 | Parallel Processing Systems | |
| ECE 685 | Network Interface Design | |
| CS 610 | Data Structures and Algorithms | |
| CS 665 | Algorithmic Graph Theory | |
| MATH 661 | Applied Statistics | |

| | | |
|---|---|---|
| MGMT 685 | Operations Research and Decision Making | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area : Computer Architecture (courses only)

| **Bridge Courses** | | |
|---|---|---|
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| **Core Courses** | | |
|---|---|---|
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| ECE 689 | Computer Arithmetic Algorithms | 3 |
| ECE 690 | Computer Systems Architecture | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select six of the following: | | 18 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 612 | Computer Methods Applied to Power Systems | |
| ECE 640 | Digital Signal Processing | |
| ECE 643 | Digital Image Processing I | |
| ECE 650 | Electronic Circuits | |
| ECE 660 | Control Systems I | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 686 | Instrumentation Systems and Microprocessors | |
| ECE 687 | Design of Medical Instrumentation | |
| ECE 688 | Microcontrollers in Instrumentation | |
| ECE 785 | Parallel Processing Systems | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area : Computer Architecture (Master's project)

| **Bridge Courses** | | |
|---|---|---|
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| ECE 689 | Computer Arithmetic Algorithms | 3 |
| ECE 690 | Computer Systems Architecture | 3 |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select five of the following: | | 15 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 612 | Computer Methods Applied to Power Systems | |
| ECE 640 | Digital Signal Processing | |
| ECE 643 | Digital Image Processing I | |
| ECE 650 | Electronic Circuits | |
| ECE 660 | Control Systems I | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 686 | Instrumentation Systems and Microprocessors | |
| ECE 687 | Design of Medical Instrumentation | |
| ECE 688 | Microcontrollers in Instrumentation | |
| ECE 785 | Parallel Processing Systems | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area : Computer Architecture (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| ECE 689 | Computer Arithmetic Algorithms | 3 |
| ECE 690 | Computer Systems Architecture | 3 |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Suggested Electrical Engineering Electives** | | |
| Select four of the following: | | 12 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 612 | Computer Methods Applied to Power Systems | |
| ECE 640 | Digital Signal Processing | |

| | | |
|---|---|---|
| ECE 643 | Digital Image Processing I | |
| ECE 650 | Electronic Circuits | |
| ECE 660 | Control Systems I | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 686 | Instrumentation Systems and Microprocessors | |
| ECE 687 | Design of Medical Instrumentation | |
| ECE 688 | Microcontrollers in Instrumentation | |
| ECE 785 | Parallel Processing Systems | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

### Focus Area : Solid State, VLSI and Electro-optics Systems (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 622 | Wave Propagation | |
| ECE 626 | Optoelectronics | |
| ECE 650 | Electronic Circuits | |
| ECE 657 | Semiconductor Devices | |
| ECE 658 | VLSI Design I | |
| ECE 758 | VLSI Design II | |
| **Suggested Electrical Engineering Electives** | | |
| Select six of the following: | | 18 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 623 | Fourier Optics | |
| ECE 624 | Optical Engineering | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 630 | Microwave Engineering | |
| ECE 648 | Digital Microelectronics | |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | |
| ECE 660 | Control Systems I | |
| ECE 677 | Optimization Techniques | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 690 | Computer Systems Architecture | |
| ECE 730 | Theory of Guided Waves | |
| ECE 739 | Laser Systems | |
| ECE 756 | Advanced Topics in Semiconductor Devices | |

| | | |
|---|---|---|
| ECE 785 | Parallel Processing Systems | |
| ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| ECE 677 | Optimization Techniques | |
| ECE 768 | Optimal Control Theory | |
| MTSE 702 | Characterization of Solids | |
| MTSE 650 | Physical Metallurgy | |
| MTSE 765 | Science and Technology of Thin Films | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

### Focus Area : Solid State, VLSI and Electro-optics Systems (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 622 | Wave Propagation | |
| ECE 626 | Optoelectronics | |
| ECE 650 | Electronic Circuits | |
| ECE 657 | Semiconductor Devices | |
| ECE 658 | VLSI Design I | |
| ECE 758 | VLSI Design II | |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select five of the following: | | 15 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 623 | Fourier Optics | |
| ECE 624 | Optical Engineering | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 630 | Microwave Engineering | |
| ECE 648 | Digital Microelectronics | |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | |
| ECE 660 | Control Systems I | |
| ECE 677 | Optimization Techniques | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 690 | Computer Systems Architecture | |
| ECE 730 | Theory of Guided Waves | |
| ECE 739 | Laser Systems | |
| ECE 756 | Advanced Topics in Semiconductor Devices | |

| | | |
|---|---|---|
| ECE 785 | Parallel Processing Systems | |
| ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| ECE 677 | Optimization Techniques | |
| ECE 768 | Optimal Control Theory | |
| MTSE 702 | Characterization of Solids | |
| MTSE 650 | Physical Metallurgy | |
| MTSE 765 | Science and Technology of Thin Films | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

### Focus Area : Solid State, VLSI and Electro-optics Systems (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 622 | Wave Propagation | |
| ECE 626 | Optoelectronics | |
| ECE 650 | Electronic Circuits | |
| ECE 657 | Semiconductor Devices | |
| ECE 658 | VLSI Design I | |
| ECE 758 | VLSI Design II | |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Suggested Electrical Engineering Electives** | | |
| Select four of the following: | | 12 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 623 | Fourier Optics | |
| ECE 624 | Optical Engineering | |
| ECE 625 | Fiber and Integrated Optics | |
| ECE 630 | Microwave Engineering | |
| ECE 648 | Digital Microelectronics | |
| ECE 659 | Fabrication Principles of Electronic and Optoelectronic Devices | |
| ECE 660 | Control Systems I | |
| ECE 677 | Optimization Techniques | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 690 | Computer Systems Architecture | |
| ECE 730 | Theory of Guided Waves | |
| ECE 739 | Laser Systems | |
| ECE 756 | Advanced Topics in Semiconductor Devices | |

| | | |
|---|---|---|
| ECE 785 | Parallel Processing Systems | |
| ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| ECE 677 | Optimization Techniques | |
| ECE 768 | Optimal Control Theory | |
| MTSE 702 | Characterization of Solids | |
| MTSE 650 | Physical Metallurgy | |
| MTSE 765 | Science and Technology of Thin Films | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

### Focus Area : Intelligent Systems (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 610 | Power System Steady-State Analysis | |
| ECE 660 | Control Systems I | |
| **Suggested Electrical Engineering Electives** | | |
| Select six of the following: | | 18 |
| ECE 611 | Transients in Power Systems | |
| ECE 613 | Protection of Power Systems | |
| ECE 616 | Power Electronics | |
| ECE 617 | Economic Control of Interconnected Power Systems | |
| ECE 640 | Digital Signal Processing | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 666 | Control Systems II | |
| ECE 661 | Control System Components | |
| ECE 677 | Optimization Techniques | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 766 | Stability Theory of Nonlinear Systems | |
| ECE 768 | Optimal Control Theory | |
| ECE 769 | Stochastic Estimation and Control | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area : Intelligent Systems (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 610 | Power System Steady-State Analysis | |
| ECE 660 | Control Systems I | |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Suggested Electrical Engineering Electives** | | |
| Select five of the following: | | 15 |
| ECE 611 | Transients in Power Systems | |
| ECE 613 | Protection of Power Systems | |
| ECE 616 | Power Electronics | |
| ECE 617 | Economic Control of Interconnected Power Systems | |
| ECE 640 | Digital Signal Processing | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 666 | Control Systems II | |
| ECE 661 | Control System Components | |
| ECE 677 | Optimization Techniques | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 766 | Stability Theory of Nonlinear Systems | |
| ECE 768 | Optimal Control Theory | |
| ECE 769 | Stochastic Estimation and Control | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

## Focus Area : Intelligent Systems (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 362 | Electromagnetic Fields II | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

**Core Courses**

| | | |
|---|---|---|
| ECE 601 | Linear Systems | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| or ECE 620 | Electromagnetic Field Theory | |
| **Area Requirements** | | |
| Select two of the following: | | 6 |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 610 | Power System Steady-State Analysis | |
| ECE 660 | Control Systems I | |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Suggested Electrical Engineering Electives** | | |
| Select four of the following: | | 12 |
| ECE 611 | Transients in Power Systems | |
| ECE 613 | Protection of Power Systems | |
| ECE 616 | Power Electronics | |
| ECE 617 | Economic Control of Interconnected Power Systems | |
| ECE 640 | Digital Signal Processing | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 666 | Control Systems II | |
| ECE 661 | Control System Components | |
| ECE 677 | Optimization Techniques | |
| ECE 684 | Advanced Microprocessor Systems | |
| ECE 766 | Stability Theory of Nonlinear Systems | |
| ECE 768 | Optimal Control Theory | |
| ECE 769 | Stochastic Estimation and Control | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [1] | 0 |
| **Total Credits** | | **30** |

[1] Two semesters are required.

# M.S. in Internet Engineering

## Degree Requirements

The bridge program curriculum requires a basic knowledge of computer and communications fundamentals.

All master's degree candidates must complete a minimum of 30 credits, 9 in core courses and 21 in elective courses; or 21 credits must be from ECE courses.

The required courses provide the basics of Internet Engineering. Electives are to be chosen from the available course pool to tailor the program to the student's professional needs and interests. This program utilizes graduate courses in Electrical and Computer Engineering, Computer and Information Science, Management Information Systems, and Management Programs at NJIT. They provide the necessary blend of education required for appropriate strength in Internet Engineering.

## M.S. in Internet Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Courses [1]** | | |
| ECE 333 | Signals and Systems | 3 |
| ECE 481 | Digital Communications Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| ECE 251 | Digital Design | 3 |
| **Total Credits** | | **12** |

[1] Bridge courses are usually selected from this list, but some additional bridge courses, appropriate to each student's background, may be required.

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 637 | Internet and Higher-Layer Protocols | 3 |
| ECE 683 | Computer Network Design and Analysis | 3 |
| CS 602 | Java Programming | 3 |
| **Electives** [1] | | |
| Select seven of the following: | | 21 |
| ECE 673 | Random Signal Analysis I | |
| ECE 681 | High Performance Routers and Switches | |
| ECE 685 | Network Interface Design | |
| ECE 638 | Network Management and Security | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 649 | Compression in Multimedia Engineering | |
| ECE 645 | Wireless Networks | |
| ECE 636 | Computer Networking Laboratory | |
| MGMT 620 | Management of Technology | |
| MIS 625 | Management Strategies for E-Commerce | |
| ECE 783 | Computer Communication Networks | |
| ECE 788 | Selected Topics in Electrical and Computer Engineering | |
| or ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [2] | 0 |
| **Total Credits** | | **30** |

[1] Other (new) courses related to Internet Engineering may be selected as electives with approval from the Graduate Advisor

[2] Two semesters are required.

## M.S. in Internet Engineering (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** [1] | | |
| ECE 333 | Signals and Systems | 3 |
| ECE 481 | Digital Communications Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| ECE 251 | Digital Design | 3 |
| **Total Credits** | | **12** |

[1] Bridge courses are usually selected from this list, but some additional bridge courses, appropriate to each student's background, may be required.

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 637 | Internet and Higher-Layer Protocols | 3 |
| ECE 683 | Computer Network Design and Analysis | 3 |
| CS 602 | Java Programming | 3 |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| **Electives** [1] | | |
| Select six of the following: | | 18 |
| ECE 673 | Random Signal Analysis I | |
| ECE 681 | High Performance Routers and Switches | |
| ECE 685 | Network Interface Design | |
| ECE 638 | Network Management and Security | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 649 | Compression in Multimedia Engineering | |
| ECE 645 | Wireless Networks | |
| ECE 636 | Computer Networking Laboratory | |

| | | |
|---|---|---|
| MGMT 620 | Management of Technology | |
| MIS 625 | Management Strategies for E-Commerce | |
| ECE 783 | Computer Communication Networks | |
| ECE 788 | Selected Topics in Electrical and Computer Engineering | |
| or ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [2] | 0 |
| **Total Credits** | | **30** |

1 Other (new) courses related to Internet Engineering may be selected as electives with approval from the Graduate Advisor
2 Two semesters are required.

## M.S. in Internet Engineering (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** [1] | | |
| ECE 333 | Signals and Systems | 3 |
| ECE 481 | Digital Communications Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| ECE 251 | Digital Design | 3 |
| **Total Credits** | | **12** |

1 Bridge courses are usually selected from this list, but some additional bridge courses, appropriate to each student's background, may be required.

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 637 | Internet and Higher-Layer Protocols | 3 |
| ECE 683 | Computer Network Design and Analysis | 3 |
| CS 602 | Java Programming | 3 |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| **Electives** [1] | | |
| Select five of the following: | | 15 |
| ECE 673 | Random Signal Analysis I | |
| ECE 681 | High Performance Routers and Switches | |
| ECE 685 | Network Interface Design | |
| ECE 638 | Network Management and Security | |
| ECE 639 | Principles of Broadband Networks | |
| ECE 649 | Compression in Multimedia Engineering | |
| ECE 645 | Wireless Networks | |
| ECE 636 | Computer Networking Laboratory | |
| MGMT 620 | Management of Technology | |
| MIS 625 | Management Strategies for E-Commerce | |
| ECE 783 | Computer Communication Networks | |
| ECE 788 | Selected Topics in Electrical and Computer Engineering | |
| or ECE 789 | Selected Topics in Electrical and Computer Engineering II | |
| **Seminar** | | |
| ECE 791 | Graduate Seminar [2] | 0 |
| **Total Credits** | | **30** |

1 Other (new) courses related to Internet Engineering may be selected as electives with approval from the Graduate Advisor
2 Two semesters are required.

# M.S. in Power and Energy Systems

## Degree Requirements

### Bridge Program

Students who have earned a Bachelor of Science in Engineering Technology (B.S.E.T.) degree, or who lack an appropriate background may be admitted and be required to take selected courses in addition to the degree requirements in order to make up deficiencies. They must attain a grade of B or better in each course. At the discretion of the department, students who have taken courses equivalent to these may have their bridge programs reduced accordingly.

### Master's Program

This master's program consists of 30 credits. As a requirement for graduation, students must achieve a 3.0 cumulative GPA in graduate-level courses, not including the master's thesis or project. The project grade must be B or better.

### Master's Project/Master's Thesis

If you do a Master’s Project, you need to take in total 9 courses plus ECE 700 Master's Project; and if you do a Master’s thesis, you need to take 8 courses plus ECE 701 Master's Thesis. These options are highly recommended if you like research and plan to pursue for your Ph.D. degree.

#### M.S. in Power and Energy Systems

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 232 | Circuits and Systems II | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 341 | Energy Conversion | 3 |
| ECE 361 | Electromagnetic Fields I | 3 |
| ECE 372 | Electronic Circuits II | 3 |
| **Total Credits** | | **18** |

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 601 | Linear Systems | 3 |
| ECE 610 | Power System Steady-State Analysis | 3 |
| **Specialized Courses/Electives** | | |
| Select three of the following: | | 9 |
| ECE 611 | Transients in Power Systems | |
| ECE 616 | Power Electronics | |
| ECE 618 | Renewable Energy Systems | |
| ECE 698 | Selected Topics in Electrical and Computer Engineering | |
| MGMT 620 | Management of Technology | |
| **Electives** | | |
| ECE 613 | Protection of Power Systems | |
| ECE 617 | Economic Control of Interconnected Power Systems | |
| ECE 698 | Selected Topics in Electrical and Computer Engineering | |
| ECE 698 | Selected Topics in Electrical and Computer Engineering | |
| ECE 605 | Discrete Event Dynamic Systems | |
| ECE 637 | Internet and Higher-Layer Protocols | |
| ECE 661 | Control System Components | |
| ECE 664 | Real-time Computer Control Systems | |
| ECE 673 | Random Signal Analysis I | |
| ME 607 | Advanced Thermodynamics | |
| ME 610 | Applied Heat Transfer | |
| ENE 671 | Environmental Impact Analysis [1] | |
| IE 614 | Safety Engineering Methods | |

| | | |
|---|---|---|
| ARCH 665 | Sustainable Design of Energy Efficient Buildings | |
| **Total Credits** | | **15** |

[1] MGMT 692 Strategic Management and other business and management courses can be included as optional electives based on the student background, instructor approval and advisor approval.

# M.S. in Telecommunications

## Degree Requirements

The curriculum requires a basic knowledge of computer and communications fundamentals such as programming, data structures, computer architecture, signals and systems, and basic communication systems. Bridge courses do not count toward the degree. The bridge courses are selected from the following list depending on individual background in consultation with the graduate advisor. See the **undergraduate catalog** for descriptions of 200- to 400-level courses.

Candidates must complete a minimum of 30 credits: 12 in core courses and 18 in elective courses in an area of specialization with a minimum overall GPA of 3.0. In addition, a minimum average 3.0 GPA is required in the five core courses. Students with an exceptionally strong telecommunications background may be allowed to replace required courses with advanced electives. Permission of the graduate advisor is required.

## M.S. in Telecommunications (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 252 | Microprocessors | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 333 | Introduction to UNIX Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| ECE 501 | Linear Systems and Random Signals [1] | 3 |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 481 | Digital Communications Systems | 3 |

[1] ECE 321 Random Signals and Noise and ECE 333 Signals and Systems may be substituted for ECE 501 Linear Systems and Random Signals.

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 642 | Communication Systems I | 3 |
| ECE 644 | Wireless Communication | 3 |
| CS 652 | Computer Networks-Architectures, Protocols and Standards | 3 |
| or ECE 683 | Computer Network Design and Analysis | |
| ECE 673 | Random Signal Analysis I | 3 |
| **Electives** | | |
| Select five of the following: [1] | | 15 |
| CS 631 | Data Management System Design | |
| CS 633 | Distributed Systems | |
| CS 650 | Computer Architecture | |
| or ECE 690 | Computer Systems Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 665 | Algorithmic Graph Theory | |
| CS 668 | Parallel Algorithms | |
| or ECE 785 | Parallel Processing Systems | |
| IS 679 | | |
| CS 696 | Network Management and Security | |
| or ECE 638 | Network Management and Security | |
| ECE 673 | Random Signal Analysis I | |
| ECE 685 | Network Interface Design | |
| ECE 742 | Communication Systems II | |

| | | |
|---|---|---|
| ECE 755 | Advanced Topics in Digital Communications | |
| ECE 757 | Advanced Wireless Communications | |
| ECE 783 | Computer Communication Networks | |
| **Total Credits** | | **27** |

[1] These courses are to be used in an area of specialization.

## M.S. in Telecommunciations (Master's project)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 252 | Microprocessors | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 333 | Introduction to UNIX Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| ECE 501 | Linear Systems and Random Signals [1] | 3 |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 481 | Digital Communications Systems | 3 |

[1] ECE 321 Random Signals and Noise and ECE 333 Signals and Systems may be substituted for ECE 501 Linear Systems and Random Signals.

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 642 | Communication Systems I | 3 |
| ECE 644 | Wireless Communication | 3 |
| CS 652 | Computer Networks-Architectures, Protocols and Standards | 3 |
| or ECE 683 | Computer Network Design and Analysis | |
| ECE 673 | Random Signal Analysis I | 3 |
| **Project** | | |
| ECE 700 | Master's Project | 3 |
| or CS 700 | Master'S Project | |
| **Electives** | | |
| Select five of the following: [1] | | 15 |
| CS 631 | Data Management System Design | |
| CS 633 | Distributed Systems | |
| CS 650 | Computer Architecture | |
| or ECE 690 | Computer Systems Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 668 | Parallel Algorithms | |
| or ECE 785 | Parallel Processing Systems | |
| IS 679 | | |
| CS 696 | Network Management and Security | |
| or ECE 638 | Network Management and Security | |
| ECE 673 | Random Signal Analysis I | |
| ECE 685 | Network Interface Design | |
| ECE 742 | Communication Systems II | |
| ECE 755 | Advanced Topics in Digital Communications | |
| ECE 757 | Advanced Wireless Communications | |
| ECE 783 | Computer Communication Networks | |
| **Total Credits** | | **30** |

[1] These courses are to be used in an area of specialization.

## M.S. in Telecommunications (Master's thesis)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| ECE 353 | Computer Organization and Architecture | 3 |
| ECE 252 | Microprocessors | 3 |
| CS 332 | Principles of Operating Systems | 3 |
| CS 333 | Introduction to UNIX Operating Systems | 3 |
| CS 505 | Programming, Data Structures, and Algorithms | 3 |
| ECE 501 | Linear Systems and Random Signals [1] | 3 |
| ECE 321 | Random Signals and Noise | 3 |
| ECE 333 | Signals and Systems | 3 |
| ECE 481 | Digital Communications Systems | 3 |

[1] ECE 321 Random Signals and Noise and ECE 333 Signals and Systems may be substituted for ECE 501 Linear Systems and Random Signals.

| | | |
|---|---|---|
| **Core Courses** | | |
| ECE 642 | Communication Systems I | 3 |
| ECE 644 | Wireless Communication | 3 |
| CS 652 | Computer Networks-Architectures, Protocols and Standards | 3 |
| or ECE 683 | Computer Network Design and Analysis | |
| ECE 673 | Random Signal Analysis I | 3 |
| **Thesis** | | |
| ECE 701 | Master's Thesis | 6 |
| or CS 701 | Master's Thesis | |
| **Electives** | | |
| Select four of the following: [1] | | 12 |
| CS 631 | Data Management System Design | |
| CS 633 | Distributed Systems | |
| CS 650 | Computer Architecture | |
| or ECE 690 | Computer Systems Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 668 | Parallel Algorithms | |
| or ECE 785 | Parallel Processing Systems | |
| IS 679 | | |
| CS 696 | Network Management and Security | |
| or ECE 638 | Network Management and Security | |
| ECE 673 | Random Signal Analysis I | |
| ECE 685 | Network Interface Design | |
| ECE 742 | Communication Systems II | |
| ECE 755 | Advanced Topics in Digital Communications | |
| ECE 757 | Advanced Wireless Communications | |
| ECE 783 | Computer Communication Networks | |
| **Total Credits** | | **30** |

[1] These courses are to be used in an area of specialization.

## Area of Specialization

The following are suggested areas of specialization and sample elective courses for each. Students may develop an individual area of specialization in consultation with a graduate advisor.

### Management and Administration

| | | |
|---|---|---|
| CS 696 | Network Management and Security | 3 |
| or ECE 638 | Network Management and Security | |

### Communication Systems

| | | |
|---|---|---|
| ECE 673 | Random Signal Analysis I | 3 |
| ECE 742 | Communication Systems II | 3 |
| ECE 755 | Advanced Topics in Digital Communications | 3 |
| ECE 757 | Advanced Wireless Communications | 3 |

### Networking

| | | |
|---|---|---|
| CS 633 | Distributed Systems | 3 |
| CS 650 | Computer Architecture | 3 |
| or ECE 690 | Computer Systems Architecture | |
| CS 656 | Internet and Higher-Layer Protocols | 3 |
| or ECE 637 | Internet and Higher-Layer Protocols | |
| CS 668 | Parallel Algorithms | 3 |
| or ECE 785 | Parallel Processing Systems | |
| CS 696 | Network Management and Security | 3 |
| or ECE 638 | Network Management and Security | |
| ECE 639 | Principles of Broadband Networks | 3 |
| ECE 673 | Random Signal Analysis I | 3 |
| ECE 685 | Network Interface Design | 3 |
| ECE 783 | Computer Communication Networks | 3 |

### Information Technologies

| | | |
|---|---|---|
| CS 631 | Data Management System Design | 3 |
| ECE 649 | Compression in Multimedia Engineering | 3 |
| CS 696 | Network Management and Security | 3 |
| or ECE 638 | Network Management and Security | |

Other CS and ECE courses related to telecommunications may be selected as elective courses with the written approval of the corresponding graduate advisor.

# Ph.D. in Computer Engineering

## Degree Requirements

Students must attain a minimum overall GPA of 3.0.

### Ph.D. in Computer Engineering (students with master's degree)

| | | |
|---|---|---|
| Graduate course work | | 12 |
| 700-level course work | | 12 |
| ECE 790 | Doctrl Dissrtn & Research [1] | 36 |
| ECE 791 | Graduate Seminar | 0 |
| **Total Credits** | | **60** |

[1] Required for six semesters. Students who complete the 36 credits before research is finished must register for a minimum of 3 credits of ECE 790 Doctrl Dissrtn & Research each semester thereafter until the dissertation is accepted.

### Ph.D. in Computer Engineering (students with baccalaureate degree)

| | | |
|---|---|---|
| Graduate-level course work [1] | | 39 |
| 700-level course work [1] | | 12 |
| ECE 790 | Doctrl Dissrtn & Research [2] | 36 |
| ECE 791 | Graduate Seminar [3] | 0 |
| **Total Credits** | | **87** |

[1] Courses selected in consultation with graduate advisor.

[2] Required for six semesters. Students who complete the 36 credits before research is finished must register for a minimum of 3 credits of ECE 790 Doctrl Dissrtn & Research each semester thereafter until the dissertation is accepted.

[3] Required for six semesters.

Dissertations should demonstrate original research that contributes to the knowledge in the field and should result in the submission of at least one paper for publication in a peer-reviewed journal. Students must provide the department with a written proposal showing that facilities are available and that there is a faculty member willing to supervise dissertation work.

## Residence

Degree-seeking students must spend at least one academic year in full-time residence.

## Qualifying Examination

Contains material related to the student's intended area of specialization. See department for more details.

## Dissertation Defense

An oral defense of the dissertation is required after submission of the final document to the department for approval.

## Pre-Doctoral Research

With department approval, well-qualified students may register for up to a maximum of 9 credits of ECE 792 Pre-Doctoral Research before passing the qualifying examination. A maximum of 6 credits of ECE 792 Pre-Doctoral Research may be applied toward ECE 790 Doctrl Dissrtn & Research. For further information, see **Academic Policies and Procedures** in this catalog and the **Electrical and Computer Engineering department website**.

# Ph.D. in Electrical Engineering

## Degree Requirements

Course selection is determined in consultation with the area faculty.

| | | |
|---|---|---|
| Course work beyond the master's degree | | 24 |
| 700-level courses [1] | | 12 |
| ECE 790 | Doctrl Dissrtn & Research [2] | 36 |
| ECE 791 | Graduate Seminar [3] | 0 |
| **Total Credits** | | **72** |

[1] Courses are normally associated with the area of specialization as listed in the master's degree description. For details, see the department "Handbook for Graduate Students."

[2] Students who complete 36 credits before their research is finished must register for a minimum of 3 credits of ECE 790 Doctrl Dissrtn & Research every semester thereafter until the dissertation has been accepted.

[3] Six semesters are required.

## Dissertation and Defense

The dissertation should demonstrate original research that contributes to the knowledge in the field and should result in the submission of at least one paper for publication in a peer-reviewed journal. Students must provide the department a written proposal showing that facilities are available and that there is a faculty member willing to supervise dissertation work. An oral defense of the dissertation is required after submission of the final document to the dissertation committee for approval.

## Residency

Degree-seeking students must spend at least one academic year in full-time residence.

## Qualifying Examination

The examination contains material related to the student's fundamental knowledge, which includes the area of specialization. Contact the doctoral programs coordinator for more information.

## Pre-Doctoral Research

With department approval, well-qualified students may register for up to a maximum of 9 credits of ECE 792 Pre-Doctoral Research prior to passing the qualifying examination. A maximum of 6 credits of ECE 792 Pre-Doctoral Research may be applied toward the ECE 790 Doctrl Dissrtn & Research requirement.

# Mechanical and Industrial Engineering

## Mechanical Engineering

Mechanical engineering is concerned with the design, development, manufacture, and operation of a wide variety of energy conversion and machine systems. The research and education facilities of the department are housed in the 60,000-square-foot Mechanical Engineering Building. Major research laboratories include Particle Technology, Energetic Materials, Machine Vision and Motion Analysis, Waterjet Machining, Robotics and Intelligent Manufacturing, Bearing Lubrication, and Plastic Processing and Analysis.

### Master of Science in Mechanical Engineering

A program for engineering graduates who want advanced professional preparation and further graduate study in mechanical engineering.

#### Admission Requirements

Applicants are expected to have an undergraduate degree in mechanical engineering or a related field. General admissions requirements for master's programs as described in this catalog apply to applicants to the M.S. in Mechanical Engineering. Sufficient preparation in science and mathematics to complete the course of study is also necessary.

### Doctor of Philosophy in Mechanical Engineering

This is a program for superior students with master's degrees in mechanical engineering or allied fields who wish to do advanced research in an area of mechanical engineering. In exceptional circumstances, highly qualified students with bachelor's degrees in mechanical engineering may be accepted directly into the doctoral program.

#### Admission Requirements

Applicants should have a master's degree from an accredited institution, and have successfully taken courses in applied mathematics and engineering sciences. In addition, applicants must fulfill the admissions requirements for doctoral study as specified in the Admissions section of this catalog. Students who lack an appropriate background will be required to take additional courses before gaining admission to the program. These courses are prescribed by the department on an individual basis and may not be applied as degree credit.

## Industrial Engineering

Industrial Engineering (IE) is a field of study intended for professionals who are interested in managing and analyzing complex systems. IEs typically formulate mathematical and/or digital simulation models of these systems with the intention of improving system and economic performance. Unique and in contrast to other traditional disciplines in engineering IEs focus on information driven human decision making and a broad based systems perspective. IEs consider themselves to be virtually any setting where outcomes are influenced by key decisions.

### Master of Science in Industrial Engineering

Individuals with a diversity of technical background have completed the MSIE degree. These individuals are attracted by the historically strong role played by IEs in modeling and analysis within traditional production and distribution settings, that now extend to healthcare, transportation, and a wide range of service industries. Program provides advanced training in operations research, supply chain, and process modeling and analysis. All courses are offered primarily in evening and weekend sessions at our Newark campus, and ideal for working professionals. Many courses are also offered online in an E-learning mode.

A program for individuals who seek professional advancement in the industrial engineering field.

#### Admission Requirements

A B.S. degree in an engineering, information technology, information technology, operations management, science, or related technical discipline. A bridge program is also available for suitable candidates.

#### Graduate Certificate Program

A 12-credit graduate certificate in Operations Productivity is available as a step toward this degree. Please see **Graduate Certificates** in this catalog for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

### Doctor of Philosophy in Industrial Engineering

The objectives of the Ph.D. in Industrial Engineering program are to provide the knowledge and develop the skills that students need to become leaders of research in academia, industry and government.

This program is intended for highly qualified students who wish to pursue advanced research in industrial engineering and related areas. The program emphasizes two areas: manufacturing systems and assurance sciences, and human factors and occupational safety.

### Admission Requirements

Applicants should have a master's degree in industrial engineering or a related field. In certain circumstances, a qualified student with a bachelor's degree in industrial engineering or related field may be admitted into the program.

## Engineering Management

By drawing on the diverse resources available through the university and surrounding industry, the M.S. in Engineering Management program develops engineers and other technically trained individuals for leadership roles in a technologically-based, project-oriented enterprise.

Focus on interdisciplinary course work and research provides students with an advanced background in both the theoretical and practical aspects of managing technical/engineering projects and programs via case studies, role playing, and course work. The engineering management program faculty bring to the classroom a critical blend of practical and academic experience.

### Master of Science in Engineering Management

The program is particularly valuable to individuals who have a number of years of experience in industry, government, and service organizations, or those who have been entrepreneurs. It provides these professionals with broad-based knowledge and skills to succeed as organizational managers and project managers, from conceptualization through implementation.

#### Admission Requirements

Eligibility for admission requires completion of an undergraduate degree in engineering, the sciences or a closely related area. Students are expected to have achieved an undergraduate GPA of at least 2.8 on a 4.0 scale. Students not satisfying the above requirement will be considered for conditional admission on a case-by-case basis. In some cases, a bridge program will be required to qualify for matriculation.

#### Graduate Certificate Program

A 12-credit graduate certificate in Construction Management, Operations Productivity, Pharmaceutical Management or Project Management is available as a step toward this degree. Please see **Graduate Certificates** in this catalog for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

#### Off-Campus Programs

At extension and corporate sites, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see **Extension Programs** in this catalog. The university's distance learning arm, ACCESS/NJIT, offers this program (as well as part of the bridge program described above) to qualified students who have access to the Internet and a VCR. In addition, distance-based, 12-credit graduate certificates in **Construction Management, Operations Productivity, Pharmaceutical Management or Project Management,** are available as a step toward this degree. See **Graduate Certificates** in this catalog. For further information about extension programs, ACCESS/NJIT programs, and graduate certificates, call the associate vice president of continuing and distance education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; email cpe@njit.edu.

## Healthcare Systems Management

The MS in Healthcare Systems Management will train and educate graduates in the application of systems analysis and quantitative methods in managing the various components of the healthcare delivery system. The program provides graduates with contemporary knowledge and the needed technical expertise for the efficient design, management and operation of healthcare facilities, including hospitals, nursing facilities, clinics, and pharmacies. This expertise will span the subjects of systems engineering, operations management, and advanced information technologies and will present concepts and tools for both reducing healthcare system costs and increasing the quality of healthcare services. Healthcare Systems are defined as the network of physical facilities, equipment, informational technologies, and patient flow processes that are associated with providing and delivering healthcare services. Graduates would find jobs in hospitals and healthcare organizations, serving in progressively more responsible positions in the quality improvement, decision support, information technology, patient accounting, facilities planning, or operations management departments.

### Admission Requirements

A B.S. degree in a technical discipline (e.g., Engineering, Computer Science, Informational Technology, Physics etc.). A bridge program is also available for suitable candidates from other degree majors. Individuals who have been working in a healthcare related organization for two or more years, and are now looking for additional skills to further progress their careers in the healthcare industry would be ideal candidates.

## Manufacturing Systems Engineering

The manufacturing engineering discipline addresses problems and methods of manufacturing systems integration. The M.S. in Manufacturing Systems Engineering program emphasizes the interrelationships between manufacturing equipment, processes and controls, and their integration into production factories.

The curriculum is computer and multimedia intensive and includes the use and understanding of new technologies such as robotics, programmable logic controllers, microprocessors and computer-integrated manufacturing and their application in automated production, assembly, automated inspection, and automated packaging. Focus is on computer-aided design and computer-aided manufacturing. Automation laboratories are used that contain many state-of-the-art devices including several industrial robots, CNC millers, CNC lathes, computer vision systems, and a fully automated flexible manufacturing system.

## Master of Science in Manufacturing Systems Engineering

This is an interdisciplinary program of advanced study for individuals with backgrounds in engineering, focusing on efficient production in technology-intensive manufacturing industries.

### Admission Requirements

Applicants should be graduates of an accredited undergraduate engineering program. Students with degrees in science may also be considered.

# Occupational Safety and Health Engineering

The curriculum has been designed in accordance with the National Institute for Occupational Safety and Health (NIOSH), which sponsors the program. Through course work and research, individuals are exposed to all of the principal areas of concern to the entry-level safety professional, including how technology and hazardous materials affect the safety of the workplace.

NJIT's program is just one of a handful offered in the United States and the only master's-level program in New Jersey. NIOSH offers a limited number of stipends and tuition remission grants to qualified students.

## Master of Science in Occupational Safety and Health Engineering

This program educates engineers in the specialty of occupational safety and health. Upon graduation, students are able to assume both the technical and managerial responsibilities of safety professionals.

### Admission Requirements

An accredited bachelor's degree in an engineering or scientific field is normally required.

# Pharmaceutical Systems Management

The MS program in Pharmaceutical Management (MSPhM) is designed to train and educate professionals for careers in the pharmaceutical industry by providing them with skills in the areas of quantitative systems analysis, planning and design of pharmaceutical process operations, and project management and implementation, relative to all technology intensive operations in this highly sophisticated industry. Application areas will include manufacturing operations, systems automation, packing and distribution, quality control and regulatory compliance, process and product validation, and supply chain management. Offered by the Department of Industrial and Management Systems Engineering in collaboration with the Pharmaceutical Engineering program, degree integrates a strong focus on technical oriented operations management with advanced knowledge of pharmaceutical manufacturing, validation, research and development processes.

## Admission Requirements

A B.S. degree in an engineering, information technology, science, or related technical discipline. A bridge program is also available for suitable candidates from other majors. Individuals who have been working in the pharmaceutical industry for two or more years, and are now looking for additional skills to further progress their careers would be ideal candidates.

# NJIT Faculty

## A

Abdel-Malek, Layek, Professor

Abdou, George, Associate Professor

## B

Bengu, Golgen, Associate Professor

Bladikas, Athanassios, Associate Professor

## C

Cai, Wenbo, Assistant Professor

Caudill, Reggie J, Professor

Chen, Rong-Yaw, Professor Emeritus

Chester, Shawn A., Assistant Professor

## D

Das, Sanchoy K., Professor

Droughton, John V., Professor Emeritus

## F

Fenster, Saul K., Professor Emeritus

Fischer, Ian S., Professor

Florio, Pasquale J., Associate Professor

## H

Harnoy, Avraham, Professor

Hatch, C., Richard, Professor Emeritus

## J

Ji, Zhiming, Associate Professor

## K

Kirchner, Robert P., Professor Emeritus

Koplik, Bernard, Professor

Kountouras, Harry V., Senior University Lecturer

## L

Lee, Eon Soo, Assistant Professor

Linden, Martin J., Professor Emeritus

## M

Mani, Balraj Subra, University Lecturer

McDermott, Kevin J., Associate Professor

## N

Nadimpalli, Siva P.V., Assistant Professor

Narh, Kwabena A., Professor

## R

Rao, I. Joga, Professor

Rosato, Anthony D., Professor

## S

Samardzic, Veljko, University Lecturer

Singh, Pushpendra, Professor

Sodhi, Rajpal Singh, Professor

Surjanhata, Herli, Senior University Lecturer

## T

Tricamo, Stephen J., Professor

### W

Wilson, Charles E., Professor Emeritus

Wolf, Carl, Professor Emeritus

### Z

Zhu, Chao, Professor

## Programs

- Engineering Management - M.S. (p. 972)
- Healthcare Systems Management - M.S. (p. 974)
- Industrial Engineering - M.S. (p. 976)
- Manufacturing Systems Engineering - M.S. (p. 978)
- Mechanical Engineering - M.S. (p. 981)
- Occupational Safety and Health Engineering - M.S. (p. 983)
- Pharmaceutical Systems Management - M.S. (p. 985)

## Programs

- Industrial Engineering - Ph.D. (p. 986)
- Mechanical Engineering - Ph.D. (p. 988)

Supply Chain Engineering - Cert.

Project Management - Cert.

## Mechanical and Industrial Engineering Courses

**IE 501. Fundamentals of Industrial Engineering. 3 credits, 3 contact hours.**
Basic concepts of industrial engineering for students who lack an undergraduate degree in the discipline, including: manufacturing processes, work methods and measurement concepts, basics of human factors, quality control, facilities design, production planning, operations research tools, and simulation models.

**IE 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Restriction: permission from the industrial engineering program director and the Division of Career Development Services. Cooperative education internship providing on-the-job reinforcement of academic programs in industrial engineering. Work assignments and projects are developed by the co-op office in consultation with the industrial engineering program director. Work assignments are related to student's major and are evaluated by faculty coordinators in the IE department. Course cannot be applied toward degree credit.

**IE 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Restriction: permission from the industrial engineering program director and the Division of Career Development Services. Course cannot be applied toward degree credit.

**IE 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Restriction: graduate standing and permission from the industrial engineering program director, and the Division of Career Development Services. Course cannot be applied toward degree credit.

**IE 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**IE 601. Measurement Methods for Performance Analysis of Operations. 3 credits, 3 contact hours.**
Prerequisite: undergraduate mathematics for management science, or EM 602. Quantitative study of various analytical methods for designing and evaluating systems employed in the management of complex enterprises such as decision-making, efficiency measurement, and methods for obtaining optimal system performance.

**IE 603. Behavioral Science in Engineering Organization. 3 credits, 3 contact hours.**
Prerequisite: undergraduate probability and statistics, or EM 503. A study of scientific research on human behavior in organizations. Processes and problems of communication in engineering activities; line-staff and supervisor-subordinate relationships; formal and informal organizations; organization models; and technical and social structure of organizations.

**IE 604. Advanced Engineering Statistics. 3 credits, 3 contact hours.**
Prerequisite: IE 331 (see undergraduate catalog for description) or equivalent. The foundations of modern quality improvement, scientific basis of quality engineering, probability, statistical inference, statistical experimental design issues such as randomized blocks, factorial design at different levels, application to factorial design, building models, and implementation and critique of Taguchi's contributions. Statistical software is used in the data analysis.

**IE 605. Engineering Reliability. 3 credits, 3 contact hours.**
Prerequisite: statistics. Concepts of modern reliability applied to practical industrial problems: statistical concepts, reliability through design, reliability through testing, analysis of reliability data, and the organization and management of a reliability program. Offered alternate years.

**IE 606. Maintainability Engineering. 3 credits, 3 contact hours.**
Prerequisite: statistics. Factors affecting maintainability design applied to military and industrial problems: statistical concepts; maintainability prediction, allocation, and demonstration; availability, system and costeffectiveness; provisioning; optimal maintenance policies; and management of a maintainability program.

**IE 608. Product Liability Control. 3 credits, 3 contact hours.**
Product liability and the effect of legal doctrines on minimizing hazards of design and manufacture. Use of actuarial techniques and legal precedents applicable to design, manufacturing, advertising, and marketing problems: warranties, notices, disclaimers, definition of liability, use of expert witnesses, reliability prediction and analysis methods, safety engineering concepts, and design review. A review of government regulations for safety and protection, as well as mandatory and voluntary standards will also be included.

**IE 609. Advanced Analytical Engineering Statistics. 3 credits, 3 contact hours.**
Prerequisite: IE 604. An extension of the techniques of engineering statistical analysis to industrial applications. Emphasis is placed on the design of experiments and analysis of tests for multivariate level problems.

**IE 610. Transportion Economics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in economics. Principles of engineering economy. Costs of highway and public transportation facilities. Economic comparisons and evaluations. Financing approaches, tax allocation theory. Programming highway and public transit improvements. Same as TRAN 610.

**IE 614. Safety Engineering Methods. 3 credits, 3 contact hours.**
Prerequisites: introductory course in statistics and industrial or construction management. Application of selected safety engineering methods to detect, correct, and prevent unsafe conditions and procedures in future practice. Methods selected are from safety management and programs; loss prevention; fire protection; systems safety; the design of buildings and other facilities; and the design of products, machinery, and equipment. Engineering problems in designing and constructing a hazard-free environment.

**IE 615. Industrial Hygiene and Occupational Health. 3 credits, 3 contact hours.**
Prerequisites: one year of college physics and one semester of college chemistry or biology. Introduction to industrial hygiene. Recognition, evaluation and control of human exposure to noise, heat, bio-hazards, chemicals, radiation, and improper lighting. Government standards, field measurements, work practices, engineering designs, and the effects of excessive exposure on worker health and productivity.

**IE 618. Engineering Cost and Production Economics. 3 credits, 3 contact hours.**
Prerequisite: IE 502 or equivalent. Cost management of operational activities. Focuses on capital investment decision making and efficient resource utilization to achieve cost-effective operations. Topics include alternative investment evaluation, budgeting activity based costing, quality costs, life cycle management and relevant behavioral science. These are considered in the context of manufacturing and service industry application.

**IE 621. Systems Analysis and Simulation. 3 credits, 3 contact hours.**
Prerequisites: IE 331, IE 466 (see undergraduate catalog for descriptions), or equivalent or department approval. The application of well-integrated systems approach, systems and systems engineering in the system life cycle, system design process, mathematical tools and techniques applied to systems analysis, design for operational feasibility, systems engineering management, modeling techniques including simulation, application of discrete simulation techniques to model industrial systems, design of simulation experiments using software, output data analysis.

**IE 622. Simulation and Risk Analysis in Operations Management. 3 credits, 3 contact hours.**
Prerequsites: IE 331 (see undergraduate catalog for description) or equivalent. Introduction to the concepts, methodologies and applictions of simulation in operations management. Foundations of simulation, Monte Carlo approaches, simulation models using spreadsheets, generating probabilistic outcomes using random number generation techniques, applying risk analysis software to spreadsheets for various decisions making. Variety of applications in operations management, finance and marketing. Software to develop models of practical operations management applications, is provided.

**IE 623. Linear Programming. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or introductory course in operations research. Principles, methodology, and practical applications of linear programming to complex problems in production and marketing, simplex techniques, duality theory, parametric analysis, Wolfe and Dantzig's decomposition methods, ellipsoid method, and Karmakar's method.

**IE 624. Heuristic Methods. 3 credits, 3 contact hours.**
Prerequisites: EM 503 or equivalent. Techniques and concepts used to develop intelligent decision support systems. Application of rules called heuristics and models of reasoning to solve problems in engineering design and manufacturing. Topics include set theory, fuzzy subset theory, decision theory, logic, inference expert systems and single and multi-fault diagnostics.

**IE 641. Operations Analysis. 3 credits, 3 contact hours.**
Prerequisites: EM 602 and computer programming experience. Management systems and business behavior using industrial models. Special attention is given to the interaction of individual elements that make up the total system.

**IE 642. Network Flows and Applications. 3 credits, 3 contact hours.**
Prerequisite: EM 602 or equivalent. Theories, algorithms, computation complexity, and application of networks, shortest path, network flow, and minimum cost flow problems. Models of industrial service systems as network problems.

**IE 643. Transportation Finance. 3 credits, 3 contact hours.**
Prerequisite: undergraduate course in economics. Balance sheets and income statements. Asset and liability management, sources and costs of debt and equity financing. Financial performance measures in the private sector (airlines, railroads, trucking and bus companies). Financing issues associated with the public sector (highways and mass transit). Equity and efficiency in pricing. Subsidy allocation formulae. Innovative financing schemes in the public sector. Same as TRAN 643.

**IE 644. Application of Stochastic Modeling in Systems Control. 3 credits, 3 contact hours.**
Stochastic processes applied to control of various types of systems: Markov chains, queueing theory, storage theory applications to measure performance of flexible manufacturing systems, telecommunication and distributions networks and similar service systems. Knowledge of probability theory and linear algebra is essential.

**IE 650. Advanced Topics in Operations Research. 3 credits, 3 contact hours.**
Prerequisite: introductory course in operations research or equivalent. Current topics in deterministic models of operations research: linear programming, large scale decomposition, integer programming, dynamic programming, and nonlinear programming. Emphasis on optimization techniques for solving mathematical programming problems.

**IE 651. Industrial Simulation. 3 credits, 3 contact hours.**
Prerequisite: introductory course in statistics/simulation or instructor's permission. Statistical design and analysis of Monte Carlo simulation experiments from an engineering view. Examples are provided with emphasis on industrial and manufacturing applications of simulation modeling. Markovian processes simulation, random number generation, mathematical programming, heuristics and decision theory.

**IE 652. Facilities Location and Plant Layout. 3 credits, 3 contact hours.**
Prerequisite: introductory course in operations research or instructor's approval. Basic con-cepts of facilities location and plant layout. Quantitative and qualitative tools needed in industrial engineering, including single and multiple facilities location problems, site selections and allocation models, use of Duality theory in location and plant layout problem, and computerized layout planning.

**IE 653. Facility Maintenance. 3 credits, 3 contact hours.**
Prerequisite: EM 501 or equivalent. Intended for those individuals who manage the functioning and maintenance of physical facilities. Emphasis on planning and control of facilities use, maintenance, utility management, managerial control, budgets and costs, personnel administration, legal and safety, flexibility measurement, and design.

**IE 655. Concurrent Engineering. 3 credits, 3 contact hours.**

**IE 659. Supply Chain Engineering. 3 credits, 3 contact hours.**
Coordination of product manufacturing and logistic activities across the global supply chain is studied. Focus is on supply chain design, implementation, and control. Topics include transportation and distribution networks, inventory control, demand planning, materials handling and warehousing, supply chain contracts, manufacturing flexibility, product design for responsiveness, and ERP systems. Supply chain analytics concepts and relevant case studies are introduced.

**IE 661. Man-Machine Systems. 3 credits, 3 contact hours.**
Prerequisite: human factors engineering. Analysis of integrated man-machine systems: physical and psychological effects of systems of deterministic and conditional responses of individuals and groups, and the resulting interaction between individuals, groups, and machine systems; also current research and development pertaining to man-machine systems.

**IE 662. Cognitive Engineering. 3 credits, 3 contact hours.**
Prerequisite: IE 355 or equivalent. The purpose of this course will be to introduce the application of human factors and cognitive psychology principles to the user interface design of information technology, including computer systems, groupware and communications, handheld devices and Internet applications, and automatic speech recognition interfaces. The course will provide grounding in the engineering design processes used to enhance the usability of products and services, and usability testing methods used by user interface designers. Secondly, major areas and design problems in human-computer interaction and Information Technology will be covered, with real world examples. The course would be appropriate for advanced undergraduates in engineering, computer science, and psychology.

**IE 664. Advanced Ergonomics. 3 credits, 3 contact hours.**
Prerequisite: IE 355 or equivalent. The course covers important topics for ergonomics, including functional anatomy of the human body, work physiology and body energy expenditure, and biomechanics for people at work. Commonly used analytical tools for ergonomics will be introduced in the course.

**IE 665. Applied Industrial Ergonomics. 3 credits, 3 contact hours.**
Prerequisites: IE 355 (see undergraduate catalog for description) or IE 699. Introduces the fundamentals and applications of industrial ergonomics for improving equipment, tool, workplace, and job design. Engineers, as well as safety and health professionals, will benefit from the course by understanding the design principles for human operators and current issues in industrial ergonomics, and a variety of evaluating methodologies for the design.

**IE 669. Human Design Factors in Engineering. 3 credits, 3 contact hours.**
Prerequisite: engineering statistics. Human factors research related to workplace and equipment design and development. Capabilities and limitations of the human sensory-motor system. Design of displays and resulting interaction between individuals, groups, environments and machine systems. Current research in engineering pertaining to the man-machine interface. Not for IE students who have had an undergraduate course in human factors.

**IE 670. Industrial Work Physiology. 3 credits, 3 contact hours.**
Prerequisite: IE 669 or equivalent. A study of human physiological responses to industrial environmental factors emphasizing knowledge of human anatomy and physiological tolerances: skeletal, muscle, and neuromuscular systems, evaluation of physical work capacity and performance, changes in circulation and respiration during work. Semester project under the instructor's supervision is also required.

**IE 672. Industrial Quality Control. 3 credits, 3 contact hours.**
Prerequisite: engineering statistics. The management of quality assurance: operational and statistical principles of acceptance sampling and process control; quality problems in production lines, and introduction to total quality management concepts.

**IE 673. Total Quality Management. 3 credits, 3 contact hours.**
Introduces the concept of total quality management as applicable to industrial systems. Presents methods for product quality improvement. Emphasis is on prevention through quality engineering and design, and goes beyond traditional statistical process quality control. Presentation of recent methods in supplier management, quality assurance, process control, and competitor analysis. Includes Taguchi methods and quality function deployment. Description of ISO 9000 and Baldridge Award.

**IE 674. Quality Maintenance and Support Systems. 3 credits, 3 contact hours.**
Prerequisites: probability and statistics, IE 331 (see undergraduate catalog for description) or equivalent. Consideration of factors necessary for cost effective maintenance and support of technical operating systems. Topics discussed include service organization and management, spare parts and logistics, quality assurance, ISO9003 training. Examples from automation, computer systems, clinical engineering, power, and transportation will be used to illustrate application areas.

**IE 675. Safety in Facility and Product Design. 3 credits, 3 contact hours.**
Prerequisite: IE 614 or equivalent. Application of safety principles to minimize the health and safety hazards in the design and manufacture of various products. Practical techniques for, and economic ramifications of, conformance with the many statutes enacted to assure safe workplaces and products.

**IE 677. Applied Statistics and Epidemiology for Hazard Analysis. 3 credits, 3 contact hours.**
Prerequisite: IE 604 or equivalent. Application of statistical concepts to the field of hazard analysis including: investigation of root causes of accidents, their patterns and trends; rules for systematic data analysis; determination of commonality factors; availability and use of customized computer software.

**IE 681. Interdisciplinary Seminar in Occupational Safety and Health. 1 credit, 1 contact hour.**
Restriction: OSHE students, or permission of instructor. This is a required course for students who receive the trainee scholarship from the Occupational Safety and Health Engineering Program sponsored by the National Institute for Occupational Safety and Health (NIOSH). Other graduate students are also welcome and encouraged to take the interdisciplinary seminar course. Students and residents in the ERC programs will be able to participate in an interdisciplinary course with students in industrial hygiene, occupational medicine and occupational safety.

**IE 682. Industrial Safety and Health Evaluation. 3 credits, 3 contact hours.**
Restriction: OSHE students, or permission of instructor. This is a required course for students who receive the trainee scholarship from the Occupational Safety and Health Engineering Program sponsored by the National Institute for Occupational Safety and Health (NIOSH). Other graduate students are also welcome and encouraged to take this site visit course. Upon completion of this course, students will be able to plan and conduct a walk-through evaluation of health and safety hazards in a workplace. Students will also understand the role of occupational health and safety disciplines in the recognition and prevention of occupational injury and illness.

**IE 685. Systems Safety. 3 credits, 3 contact hours.**
Prerequisites: applied probability/statistics and introductory safety. Safety decision making and systems engineering applications to safety, including planning, managing and conducting system safety programs.

**IE 686. Intro to Healthcare Systems. 3 credits, 3 contact hours.**
This course provides a systems analysis view of healthcare services, combining economic, quality, enterprise data and activity costing perspectives. Operations, processes and activities that characterize the US Healthcare system are introduced. System costs, reimbursement methods and financial aspects in the healthcare. Focus on the application of information technologies and system engineering tools to effectively create and deliver value in the care process. Analytical tools for identifying opportunities for systems efficiency and effectiveness.

**IE 687. Healthcare Enterprise Systems. 3 credits, 3 contact hours.**
Prerequisites: IE 686. Provide a thorough understanding of the role of Healthcare Enterprise Systems in healthcare organizations. A detailed study of electronic health records, computerized physician order entry, and meaningful use standards. Design and implementation of enterprise level healthcare information systems, advanced desicion support tools, and process mapping methods for optimal delivery of cost effective care. Analytical and quantitative methods that can be used to evaluate healthcare business processes, determine data requirements, and plan operating procrdures.

**IE 688. Healthcare Sys Perfor Modeling. 3 credits, 3 contact hours.**
Prerequisites: IE 686. Presents advanced techniques and methods for modeling and evaluating the performance of healthcare systems, including operations research, and productivity analysis, and statistical analysis methods. Introduces the performance dynamics of healthcare systems, identifies key decision variables and formulates their effect on systems performance. Develop and optimize healthcare staffing models. Application of operations research methods to a wide range of healthcare scheduling, facility design and patient flow problems.

**IE 699. Special Topics in Industrial Engineering. 3 credits, 3 contact hours.**
Restriction: approval from the industrial engineering graduate advisor. Special course given when interest in a subject area develops. Advanced notice of topics will be given before registration.

**IE 700. Master'S Project. 0 credits, 0 contact hours.**

**IE 700B. Master'S Project. 3 credits, 3 contact hours.**

**IE 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisites: matriculation for the master of science degree, thesis advisor's approval, and adequate graduate courses in the field of the proposed thesis. Candidates for the degree who choose this option must submit an acceptable thesis on an approved subject that contributes to the literature of the field, and preferably aids the candidate's present or potential, career. While original research may not always result, the thesis should provide a new conclusion or application. Approval to register for the thesis must be obtained from the thesis advisor. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**IE 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisites: matriculation for the master of science degree, thesis advisor's approval, and adequate graduate courses in the field of the proposed thesis. Candidates for the degree who choose this option must submit an acceptable thesis on an approved subject that contributes to the literature of the field, and preferably aids the candidate's present or potential, career. While original research may not always result, the thesis should provide a new conclusion or application. Approval to register for the thesis must be obtained from the thesis advisor. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**IE 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisites: matriculation for the master of science degree, thesis advisor's approval, and adequate graduate courses in the field of the proposed thesis. Candidates for the degree who choose this option must submit an acceptable thesis on an approved subject that contributes to the literature of the field, and preferably aids the candidate's present or potential, career. While original research may not always result, the thesis should provide a new conclusion or application. Approval to register for the thesis must be obtained from the thesis advisor. A student must continuously register for a minimum of 3 credits per semester until the thesis is completed. Total credit will be limited, however, to the 6 credits indicated for the thesis.

**IE 704. Sequencing and Scheduling. 3 credits, 3 contact hours.**
Prerequisite: IE 650 or equivalent. Advanced sequencing and scheduling for job shops, flow lines, and other general manufacturing and production systems are discussed in this course. Both deterministic and stochastic scheduling models are covered in detail. Heuristics and worst case analysis for unsolvable hard scheduling problems (NP-C problem) are introduced.

**IE 705. Mathematical Programming in Management Science. 3 credits, 3 contact hours.**
Prerequisites: IE 623 and IE 650. An advanced study of various mathematical programming techniques such as linear and non-linear, parametric, integer, stochastic and dynamic programming. Readings and discussions emphasize mathematical advances and applications in operations research.

**IE 706. A Queueing Approach to Performance Analysis. 3 credits, 3 contact hours.**
Prerequisite: IE 644 or equivalent. Newly developed techniques in the area of queueing networks that play a critical role in studying several aspects of discrete event stochastic systems such as FMS, computer-aided communication systems, transportation systems and service systems.

**IE 725. Independent Research. 3 credits, 3 contact hours.**
Prerequisite: approval from the industrial engineering program director. Program of study prescribed and approved by student's advisor. This special course covers areas in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course.

**IE 726. Independent Research II. 3 credits, 3 contact hours.**

**IE 753. Airport Design and Planning. 3 credits, 3 contact hours.**
Prerequisite or corequisite: TRAN 610 or EM 693. Planning of individual airports and statewide airport systems. Functional decision of air and landside facilities. Orientation, number and length of runways. Concepts of airport capacity. Passenger and freight terminal facility requirements. Airport access systems. FAA operating requirements. Financial, safety and security issues. Same as CE 753 and TRAN 753.

**IE 754. Port Design and Planning. 3 credits, 3 contact hours.**
Prerequisite: TRAN 610 or EM 693. Functional design of the water and landsides for general cargo, liquid and dry bulk, and container operations. Yard and storage systems. Port capacity in an intermodal network. Economic, regulatory, and environmental issues. Same as CE 754 and TRAN 754.

**IE 760. Quantitative Methods in Human Factors. 3 credits, 3 contact hours.**
Prerequisite: IE 661. More advanced human factors engineering concepts analyzed quantitatively: systems modeling, control theory, human error, and decision making. Discussion of human factors, research design and data analysis. Operator/computer interaction is also emphasized.

**IE 761. Advanced Studies in Human Factors. 3 credits, 3 contact hours.**
Prerequisite: one year of graduate work in human factors or the equivalent. The course integrates various areas of graduate studies in human factors such as: work physiology, occupational safety, environment and human-machine systems. Detailed discussion of selected current papers covering theoretical review, experimental design, results, applications, and future research. Completion of semester project under instructor's guidance is mandatory.

**IE 762. Psychophysical Methods in Human Factors. 3 credits, 3 contact hours.**
Prerequisite: one year of graduate work in human factors or instructor's approval. This course considers various classical and modern psychophysical methods, signal detection theory, information theory, and human information processing applicable to advanced human factors/occupational safety research measurement and normative modeling.

**IE 790. Doctoral Dissertation. 0 credits, 0 contact hours.**

**IE 790A. Doctoral Dissertation. 1 credit, 1 contact hour.**

**IE 790B. Doctoral Dissertation. 3 credits, 3 contact hours.**

**IE 790C. Doc Dissertation & Res. 6 credits, 3 contact hours.**

**IE 790D. Doc Dissertation & Res. 9 credits, 3 contact hours.**

**IE 790E. Doc Dissertation & Res. 12 credits, 3 contact hours.**

**IE 790F. Doct Dissertation & Res. 15 credits, 0 contact hours.**

**IE 790G. Doctoral Dissertation. 18 credits, 0 contact hours.**

**IE 791. Graduate Seminar. 0 credits, 0 contact hours.**
A seminar in which faculty or others present summaries of advanced topics suitable for research. Discussion of research procedures, thesis organization, and content. Students engaged in research will present their own research for discussion and criticism.

**ME 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.**
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Cooperative education internship providing on-the-job reinforcement of academic programs in mechanical engineering. Work assignments and projects are developed by the co-op office in consultation with the mechanical engineering department. Work assignments are related to student's major and are evaluated by faculty coordinators in mechanical engineering. Course cannot be used for mechanical engineering degree credit.

**ME 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.**
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Course cannot be used for mechanical engineering degree credit.

**ME 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.**
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Course cannot be used for mechanical engineering degree credit.

**ME 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**ME 607. Advanced Thermodynamics. 3 credits, 3 contact hours.**
Prerequisite: undergraduate thermodynamics. Basic laws of thermodynamics are applied to various thermodynamic systems. Topics include: availability, stability requirements, equation of state, property relations, properties of homogeneous mixtures, optimization applied to power generation and refrigeration cycles, and thermodynamic design of system components.

**ME 608. Non-Equilibrium Thermodynamics. 3 credits, 3 contact hours.**
Prerequisites: undergraduate thermodynamics and heat transfer, and ME 616. (May be taken concurrently.) Principles and mathematical techniques of non-equilibrium thermodynamics applied to mechanical engineering problems. Topics include field theory, energy and entropy balances, variational principles, and applications to fluid flow, heat exchangers and combustion.

**ME 609. Dynamics of Compressible Fluids. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, fluid mechanics, and thermodynamics. One-dimensional reversible and irreversible compressible fluid flow, including effects of variable area, friction, mass addition, heat addition, and normal shock; two-dimensional reversible subsonic and supersonic flows, and an introduction to the method of characteristics and two-dimensional oblique shock.

**ME 610. Applied Heat Transfer. 3 credits, 3 contact hours.**
Prerequisites: undegraduate fluid mechanics, thermodynamics, heat transfer and differential equations. Fundamentals of conduction, convection and radiation heat transfer. Practical engineering applications of heat exchangers including the design approaches by Mean Temperature Difference and Effectiveness-NTU methods, fins, convection fouling factors, and variable property analysis.

**ME 611. Dynamics of Incompressible Fluids. 3 credits, 3 contact hours.**
Prerequisites: undergraduate fluid mechanics and ME 616. (May be taken concurrently.) An introduction to the hydrodynamics of ideal fluids; two-dimensional potential flow and stream functions; conformal mapping; and differential equations of viscous flow. Boundary layer theory and dimensional analysis are introduced.

**ME 612. Gas Dynamics. 3 credits, 3 contact hours.**
Prerequisite: ME 616. (May be taken concurrently.) Physical phenomena of gas dynamics and mathematical methods and techniques needed for analysis. Dynamic and thermodynamic relations for common flow situations are described through vector calculus. The nonlinearity of resulting equations and solutions such as numerical analysis, linearization or small perturbation theory, transformation of variables, and successive approximations are discussed. The method of characteristics is reviewed in detail for shock flows.

**ME 613. Radiation Heat Transfer. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, thermodynamics, heat transfer and ME 616. (May be taken concurrently.) Heat radiation of solid bodies, gases and flames; angle factors; radiative properties of electrical conductors and non-conductors; application of radiative networks to multi-body problems; diffuse specular reflectors: artificial satellites and space vehicles; analogy between heat transfer by radiation and electrical networks; and combined conduction and radiation problems.

**ME 614. Continuum Mechanics. 3 credits, 3 contact hours.**
Prerequisites: Undergraduate courses in mechanics, fluid mechanics, solid mechanics, and mathematics (linear algebra, differential equations, and vector calculus) or approval of the instructor. Fundamentals of the mechanics of continuous media. Specific topics include vector and tensor analysis; kinematics associated with finite deformation; the stress tensor; and the conservation laws of mass, linear momentum, angular momentum, and energy. Constitutive equations for linear and non-linear elastic solids and for inviscid and Newtonian fluids are discussed. The role of material invariance under superimposed rigid body motion and material symmetry in the formulation of appropriate constitutive equations are emphasized.

**ME 615. Advanced Mechanical Vibrations. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and system dynamics. One-, Two- and Multiple degree of freedom systems, Lagrange's equation of motion, Runge-Kutta computation, Finite Element Method and classical methods for normal mode analysis, matrix notation and iteration procedure, and Fourier series representation for the solution of vibration problems.

**ME 616. Matrix Methods in Mechanical Engineering. 3 credits, 3 contact hours.**
Prerequisite: undergraduate differential equations. Applications of matrix algebra and matrix calculus to engineering analysis; matrix methods in solid and fluid mechanics; vibration, elasticity, viscous fluids, and heat transfer. Matrix theory is used to show the basic unity in engineering analysis.

**ME 618. Selected Topics in Mechanical Engineering. 3 credits, 3 contact hours.**
Prerequisite: departmental approval. Given when interest develops. Topics may include analysis and/or design of energy or mechanical systems of current interest to mechanical engineers.

**ME 619. Nano-scale Characterization of Materials. 3 credits, 3 contact hours.**
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy, near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project.

**ME 620. Stress Methods in Mechanical Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and strength of materials. Governing equations and solutions for analysis and design of structural and machine elements; appropriate boundary conditions to investigate pipes and rods subjected to shrink and force fits; rotating disks of uniform and variable thickness; beam and plate elements; and thermal stresses and stress concentrations in mechanical design.

**ME 621. Energy Methods in Mechanical Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and strength of materials. Use of energy methods to design structural and machine elements. Includes approximate solutions for problems using conservation of energy and several variational approaches; the role of energy in failure criteria; combined loads; and the relationship of variational methods to the development of finite element solutions.

**ME 622. Finite Element Methods in Mechanical Engineering. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and strength of materials. Using variational formulation and Ritz approximation, element equations for bar, beam, potential flow, heat transfer, torsion of a solid bar and plane elasticity problems are derived and solved with computer programs.

**ME 624. Microlevel Modeling in Particle Technology. 3 credits, 3 contact hours.**
Presents methodologies for analyzing the macroscopic properties of particulate systems in terms of the underlying microlevel processes. Significant components are the mathematical modeling of particulate systems at the microlevel, analytical and numerical methods for predicting macroscopic properties from microlevel models, and comparison of theoretical predictions with experimental results. Demonstrates the importance of the interaction of these three components in the scientific process. The first part concerns the flow of dry particles where any interstitial fluid can be ignored. The second part considers the flow of particles suspended in an interstitial fluid. Also includes a class project involving development of simulations. Same as CHE 625.

**ME 625. Introduction to Robotics. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, kinematics and demonstrated competence in computer programming and ME 616. (May be taken concurrently.) Introduction to robotics, and computer-controlled programmable robotic manipulators; robot geometries; kinematics of manipulators; differential motion; work space planning and trajectory control; dynamics; robot sensing, and robot programming.

**ME 628. Machine Vision Principles and Applications. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and demonstrated competence in computer programming. Fundamentals of machine vision as applied to inspection, recognition, and guidance in mechanical and manufacturing processes. Emphasis on real-time machine vision algorithms for machine parts inspection and identification. Topics include lighting and optics, camera selection and calibration, image segmentation, edge detection, feature extraction, and pattern classification.

**ME 630. Analytical Methods in Machine Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, machine design, and ME 616. (May be taken concurrently.) Theory and analytical methods used in machine design. Comparisons are made between approximate and exact engineering methods for evaluation of the range of applicability of solutions. Topics include advanced analysis of threaded members; keyed, splined, and shrink fits when subjected to torque; preloaded bearings; surging, presetting and buckling of coiled springs; and accurate analysis of impact stresses and stresses beyond the yield point.

**ME 631. Bearings and Bearing Lubrication. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, machine design and ME 616. (May be taken concurrently.) The theoretical and physical aspects of lubrication: hydrostatic and hydrodynamic problems. Reynold's differential equation for pressure distribution applied to slider bearing and journal bearing problems with and without end leakage.

**ME 632. Mechanical Engineering Measurements. 3 credits, 3 contact hours.**
This course offers extensive mechanical engineering lab experience, including measurement fundamentals, hands-on experiments, uncertainty analysis, technique comparison, and professional engineering reports. It also focuses on the fundamental principles behind each methodology and relevant applications. The topics cover measurement in major mechanical engineering areas including thermodynamics, thermofluids, and control. Specialized experiments include fluidization, CAD/CAM, and NC machining. Comparisons of experimental results against theoretical or computational results are also required.

**ME 633. Dynamics of Machinery. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and matrix analysis. Consideration of kinematics, constraints and Jacobians, linear and angular momentum and potential energy and conservative forces of mechanical systems. Application of principle of virtual work, D?Alembert's principle, method of virtual power and Lagrange's equation to systems of particles and systems of rigid bodies.

**ME 635. Computer-Aided Design. 3 credits, 3 contact hours.**
Prerequisites: undergraduate linear algebra (matrices operation) and differential equations. Adaptation of computer for solving engineering design problems; design morphology; simulation and modeling; algorithms; problem-oriented languages; use of available software; computer graphics, and automated design.

**ME 636. Mechanism Design: Analysis and Synthesis. 3 credits, 3 contact hours.**
Prerequisites: undergraduate kinematics, dynamics and demonstrated competence in computer programming and ME 616. (May be taken concurrently.) Kinematic principles combined with computer-assisted methods for designing mechanisms; complex polar notation; and dynamic and kinetostatic analysis of mechanisms. Kinematic synthesis of planar mechanisms; graphical Burmester theory for plane linkage synthesis; and planar linkage synthesis for function and path generation.

**ME 637. Kinematics of Spatial Mechanisms. 3 credits, 3 contact hours.**
Prerequisites: undergraduate kinematics, dynamics, knowledge of matrices and ME 616. (May be taken concurrently.) Advanced techniques for the dual-number coordinate-transformation matrix modeling to perform the displacement, velocity, static and dynamic force analysis of spatial mechanisms. Applications considered will include shaft couplings, skew four-bars, wobble plates, generalized slider-cranks and robotic manipulators.

**ME 638. Computer-Aided Machining. 3 credits, 3 contact hours.**
Prerequisites: demonstrated competence in computer programming, ME 305, ME 616 and ME 635 or equivalent. Introduction of computer applications to understand integrated computer-aided machining process. Included in the course are the fundamentals of motion control and NC/CNC/DNC machining, part programming and post-processors, and advances in CAM. Student projects are carried out using appropriate manufacturing software.

**ME 641. Refrigeration and Air Conditioning. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations, fluid mechanics and thermodynamics. Refrigeration and air conditioning cycles; comfort analysis, psychometric chart analysis, heat and mass transfer steady and transient processes, heating and cooling design loads, energy loads and standards requirements.

**ME 643. Combustion. 3 credits, 3 contact hours.**
Prerequisites: Undergraduate thermodynamics & fluid mechanics. Chemical & physical process of combustion: ideal combustion, actual combustion, mass balance, energy of reaction, maximum adiabatic combustion temperature, chemical equilibrium, heating values of fuels, combustion in furnaces, internal combustion engines & other heat engines, with emphasis on the analysis & control of the products of combustion in light of environmental considerations.

**ME 644. Building Environmental Control Principles. 3 credits, 3 contact hours.**
Prerequisites: undergraduate thermodynamics, fluid mechanics, heat transfer and differential equations. Control systems for buildings including control of temperature, moisture and air quality. Optimization of systems for control of building energy use. Modern microprocessor-based control systems, including direct digital control, proportional and integral controllers, predictive control, adaptive control, optimum start controllers and optimal control.

**ME 653. Control of Electro-Mechanical Networks. 3 credits, 3 contact hours.**
Prerequisites: undergraduate electrical circuits and mechanical vibrations or equivalent. Electro-mechanical systems; control loops; use of mechanical networks in dynamic systems; and stability and response to various inputs in electro-mechanical networks.

**ME 655. Introduction to Modern Control Methods. 3 credits, 3 contact hours.**
Prerequisites: undergraduate system dynamics and automatic controls. Introduction to modern control methods applied to mechanical and manufacturing systems. Topics include state variable feedback, observer theory, nonlinear control, optimal control, and adaptive control for both continuous and discrete systems.

**ME 660. Noise Control. 3 credits, 3 contact hours.**
Prerequisites: undergraduate differential equations and physics. Engineering methods for reducing noise pollution; reduction of intensity at the source; limitation of transmission paths and absorption; application to structures, machinery, ground transportation, aircraft, and noise measurement.

**ME 670. Introduction to Biomechanical Engineering. 3 credits, 3 contact hours.**
Prerequisites: undergraduate thermodynamics, statics, and dynamics. Introduction to biomechanical engineering of physiological systems; fluid flow, structural, motion, transport, and material aspects; energy balance of the body, and the overall interaction of the body with the environment.

**ME 671. Biomechanics of Human Structure and Motion. 3 credits, 3 contact hours.**
Prerequisites: undergraduate statics, kinematics, and dynamics. Principles of engineering mechanics and materials science applied to human structural and kinematic systems and to the design of prosthetic devices. Topics include anatomy; human force systems; human motion; bioengineering materials; and design of implants, supports, braces, and replacements limbs.

**ME 675. Mechanics of Fiber Composites. 3 credits, 3 contact hours.**
Prerequisites: ME 315 (see undergraduate catalog for course description) and demonstrated competence in computer programming. Introduces various design problems using fiber composites. Analysis of general fiber composite laminate and short fiber composites, fracture mechanics, fatigue, creep and viscoelasticity, thermal stresses, special layups and associated optimization problems.

**ME 676. Applied Plasticity. 3 credits, 3 contact hours.**
Prerequisite: ME 620 or equivalent. Fundamentals of plasticity applied to mechanical and manufacturing engineering problems. Topics include elastic-plastic analysis for beams, rings and plates. Plastic instability and slip-line fields are considered.

**ME 678. Engineering Design of Plastic Products. 3 credits, 3 contact hours.**
Prerequisite: Knowledge of Pro/Engineer (or IDEAS). Structure and properties of plastics including stress-strain behavior and the effect of fillers and reinforcements. Designing for impact, flexure, shear, friction, puncture, creep and fatigue. Case studies of structural, electrical, and optical applications.

**ME 679. Polymer Processing Techniques. 3 credits, 3 contact hours.**
Prerequisites: undergraduate courses in fluid dynamics and heat transfer. Techniques for processing of plastics: extrusion, injection molding, compression molding, thermoforming, casting.

**ME 680. Polymer Processing Equipment. 3 credits, 3 contact hours.**
Prerequisites: CHE 645 or equivalent and undergraduate heat transfer. Application of heat transfer, fluid mechanics, and thermodynamics to the design and control of polymer processing equipment. Detailed consideration of extrusion, collandering, rotational molding, stamping, and injection molding.

**ME 700. Master'S Project. 0 credits, 0 contact hours.**
Prerequisite: department approval. An extensive paper involving design, construction, and analysis, or theoretical investigation. Further information may be obtained from the graduate advisor.

**ME 700B. Master'S Project. 3 credits, 3 contact hours.**
Prerequisite: department approval. An extensive paper involving design, construction, and analysis, or theoretical investigation. Further information may be obtained from the graduate advisor.

**ME 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: department approval. Projects involving design, construction, experimental, or theoretical investigation carried out under the supervision of a designated member of the mechanical engineering faculty. The completed written thesis must be defended in a publicly announced oral defense. A student must register for a minimum of 3 credits per semester until completion, although degree credit will be limited to the 6 credits indicated for the thesis.

**ME 701B. Master'S Thesis. 3 credits, 3 contact hours.**
Prerequisite: department approval. Projects involving design, construction, experimental, or theoretical investigation carried out under the supervision of a designated member of the mechanical engineering faculty. The completed written thesis must be defended in a publicly announced oral defense. A student must register for a minimum of 3 credits per semester until completion, although degree credit will be limited to the 6 credits indicated for the thesis.

**ME 701C. Master'S Thesis. 6 credits, 3 contact hours.**
Prerequisite: department approval. Projects involving design, construction, experimental, or theoretical investigation carried out under the supervision of a designated member of the mechanical engineering faculty. The completed written thesis must be defended in a publicly announced oral defense. A student must register for a minimum of 3 credits per semester until completion, although degree credit will be limited to the 6 credits indicated for the thesis.

**ME 710. Conduction Heat Transfer. 3 credits, 3 contact hours.**
Prerequisite: ME 610 and ME 616 or equivalent. Heat transfer by conduction: differential and integral forms of the energy equation for isotropic and anisotropic material. Analytical and numerical studies of transient and steady one-, two-, and three-dimensional heat transfer problems for a variety of boundary conditions including phase change. In addition, variational and boundary element methods are applied to heat conduction problems.

**ME 711. Convection Heat Transfer. 3 credits, 3 contact hours.**
Prerequisites: ME 610 and ME 616 or equivalent. Development of convective heat transfer theory: currently available methods, analytical and numerical, for predicting heat rates in forced, natural, and mixed convection in laminar and turbulent flow regimes are thoroughly studied. Studied techniques are applied to the thermal design of complex systems.

**ME 712. Mechanics of Viscous Fluids. 3 credits, 3 contact hours.**
Prerequisite: ME 611 and ME 616. (May be taken concurrently.) Properties and behavior of real fluids in laminar and turbulent motion. Review of tensor analysis; current mathematical and empirical laws and methods; flows in ducts; exact solutions of Navier-Stokes equations; boundary layers over surfaces and flow past bodies.

**ME 713. Non-Newtonian Fluid Dynamics. 3 credits, 3 contact hours.**
Prerequisite: ME 611, ME616. Review of Newtonian fluid mechanics. Time dependent response and transport properties of non-Newtonian fluids in simple shear and extensional flows. Experimental techniques for measuring dynamic response and transport properties. Continuum and micromechanical constitutive models; solutions of constitutive equations.

**ME 714. Principles of Particulate Multiphase Flows. 3 credits, 3 contact hours.**
Prerequisite: Courses in fluid mechanics or approval of the instructor. This course provides an introduction to the fundamental principles of mass, momentum and heat transfer in particulate multiphase flows. Theories and governing equations for distinctive responses and motions of each phase and the dynamic interactions among phases are formulated. Typical industrial applications will be illustrated.

**ME 717. Selected Topics in Mechanical Engineering I. 3 credits, 3 contact hours.**
Prerequisite: department approval. Given when interest develops. Topics may include advanced mechanisms, aerodynamics, analysis of ME systems, design optimization, and case studies in design.

**ME 718. ST:. 3 credits, 3 contact hours.**

**ME 721. Thermal Stresses. 3 credits, 3 contact hours.**
Prerequisites: vector analysis or ME 616 or equivalent and theory of elasticity or ME 785. Thermoelasticity; reduction of thermoelastic problems to constant temperature equivalents; fundamentals of heat transfer; and elastic and inelastic stress analysis.

**ME 725. Independent Study I. 3 credits, 3 contact hours.**
Prerequisites: written permission from department chairperson plus prerequisite courses prescribed by a supervising faculty member. Areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering. A maximum of two independent studies courses may be applied to a degree.

**ME 726. Independent Study II. 3 credits, 3 contact hours.**
Prerequisites: written permission from department chairperson plus prerequisite courses prescribed by a supervising faculty member. Areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering. A maximum of two independent studies courses may be applied to a degree.

**ME 727. Independent Study III. 3 credits, 3 contact hours.**
Prerequisites: written permission from department chairperson plus prerequisite courses prescribed by a supervising faculty member. Areas of study in which one or more students may be interested but which is not of sufficiently broad interest to warrant a regular course offering. A maximum of two independent studies courses may be applied to a degree.

**ME 735. Advanced Topics in Robotics. 3 credits, 3 contact hours.**
Prerequisite: ME 625. Introduction to advanced topics and techniques in robotics. Subjects covered include differential kinematics, calibration and accuracy, trajectory control, and compliant motion control as well as an in-depth treatment of topics discussed in ME 625.

**ME 736. Advanced Mechanism Design. 3 credits, 3 contact hours.**
Prerequisite: ME 636 and ME 616. Advanced methods for the synthesis of mechanisms. Topics include synthesis of planar mechanisms for three, four and five positions, multiloop linages, change of branch and order problems, and optimal synthesis of mechanisms. Synthesis of linkages for special types of motion including straight line motion, cusp points on coupler curves and adjustable mechanisms.

**ME 738. Computer Aided Engineering. 3 credits, 3 contact hours.**
Prerequisites: ME 635. This course covers advanced CAD and CAE tools for visual computing simulation and analysis. Topics include modeling, assembly, CAD data exchange by exporting and importing various CAD model formats, computer simulation and analysis of structure, thermal, fluid and animation of the results of analysis. Multi-physics analyses such as thermal-structure, electric-thermal-structure in MEMS and fluid-structure interactions are studied. The laboratory component involves use of most current commercial CAD/CAE software packages.

**ME 752. Design of Plates and Shells. 3 credits, 3 contact hours.**
Prerequisites: ME 616 or equivalent and ME 620. A study of plates and shells. Mechanical engineering design solutions for typical loading and boundary conditions through analytical and numerical methods. Plate and shell interfaces and vibration are also considered.

**ME 754. Pressure Vessel Design. 3 credits, 3 contact hours.**
Prerequisites: ME 616 or equivalent and ME 620. Theories in designing pressure vessels; analysis of circular plates; cylindrical and spherical shells; pressure vessel heads; pipe bends; and attachments. Consideration is also given to pressure vessel materials in fatigue and creep designs.

**ME 755. Adaptive Control Systems. 3 credits, 3 contact hours.**
Prerequisite: ME 655. Theory and application of self-tuning and model reference adaptive control for continuous and discrete-time deterministic systems. Topics include model-based methods for estimation and control, stability of nonlinear systems and adaptive laws. Applications of adaptive control in mechanical systems and manufacturing processes.

**ME 785. Theory of Deformable Solids in Mechanical Engineering I. 3 credits, 3 contact hours.**
Prerequisites: ME 616 or equivalent and ME 620. Measure of strain; strain tensor; stress tensor; equilibrium equations; constitutive relations; compatibility conditions; conditions for and formulation of three-dimensional problems; and the relationship of engineering theories for beams, plates, and shells to the equations of elasticity.

**ME 786. Theory of Deformable Solids in Mechanical Engineering II. 3 credits, 3 contact hours.**
Prerequisite: ME 785. Solutions for problems formulated in ME 785 eigenfunction solutions; operational methods; complex variables theory; three-dimensional problems; contact problems; wave propagation; and non-linear problems.

**ME 790. Doct Dissertation & Res. 0 credits, 0 contact hours.**
Required of all students working toward the Doctor of Philosophy in Mechanical Engineering. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester until 36 credits are reached and for 3 credits each semester thereafter.

**ME 790A. Doc Dissertation & Res. 1 credit, 1 contact hour.**

**ME 790B. Doc Dissertation & Res. 3 credits, 3 contact hours.**

**ME 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.**

**ME 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.**

**ME 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.**

**ME 790F. Doctoral Diss & Research. 15 credits, 3 contact hours.**

**ME 790G. Doctoral Dissertation. 18 credits, 3 contact hours.**

**ME 791. Graduate Seminar and Professional Presentations. 0 credits, 0 contact hours.**
Regular attendance required of all students in the Mechanical Engineering PhD program. Each PhD student is required to make a 15 minute presentation on a topic related to the student's research with an additional 10 minutes to address audience questions. The seminar participants eveluate each speaker.

**ME 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.**

**ME 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.**

**ME 792D. Pre Doctoral Research. 9 credits, 3 contact hours.**

**ME 794. Mechanical Engineering Colloquium. 0 credits, 1 contact hour.**
Prerequisite: graduate standing and major in mechanical engineering. National and international experts in mechanical engineering discuss their recent research. Required of all students enrolled in mechanical engineering graduate degree programs. Students must register in this course for at least two semesters and attend at least four lectures in each semester. All doctoral students and students with assistantships must register in this course each semester and attend regularly.

# M.S. in Engineering Management

## Degree Requirements

Students who lack appropriate academic preparation may be required to take bridge courses in the areas of statistics, cost analysis and engineering economics.

The program requires 30 credits, 18 of which are taken in a required core. A purpose of the core is to provide knowledge in the functional areas that are the cornerstones of the discipline: organization and people management, cost management, and systems management. The remaining 12 credits are elective courses, which may be within an area of specialization to meet the individual's specific professional and personal objectives. A 3-credit project (IE 700 Master'S Project) or a 6-credit thesis (IE 701 Master'S Thesis) are optional electives. In some cases, students may select courses to enhance their technical competency. In other cases, individuals may select courses to prepare for a change in responsibilities or job function. At least half of the elective courses must be selected from those having an IE or EM prefix.

## M.S. in Engineering Management (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| IE 673 | Total Quality Management | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Electives** [1] | | |
| Select four of the following: | | 12 |
| EM 634 | Legal, Ethical and Intellectual Property Issues for Engineering Managers | |
| EM 637 | Project Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| IE 651 | Industrial Simulation | |
| IE 659 | Supply Chain Engineering | |
| EM 632 | Legal Aspects in Construction | |
| IE 618 | Engineering Cost and Production Economics | |

| | | |
|---|---|---|
| IE 621 | Systems Analysis and Simulation | |
| EM 640 | Distribution Logistics | |
| EM 641 | Engineering Procurement and Materials Management | |
| EM 674 | Benchmarking and Quality Function Deployment | |
| IE 605 | Engineering Reliability | |
| IE 672 | Industrial Quality Control | |
| MNE 654 | Design for Manufacturability | |
| EM 632 | Legal Aspects in Construction | |
| IE 653 | Facility Maintenance | |
| MNE 601 | Computerized Manufacturing Systems | |
| MNE 602 | Flexible and Computer Integrated Manufacturing | |
| MNE 655 | Concurrent Engineering | |
| EM 655 | Management Aspects of Information Systems | |
| IE 661 | Man-Machine Systems | |
| EM 635 | Management of Engineering Research and Development | |
| **Total Credits** | | **30** |

[1] School of Management courses with a FIN, MRKT, MIS, HRM or MGMT prefix may be taken as electives

## M.S. in Engineering Management (Master's project)

| | | |
|---|---|---|
| **Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| IE 673 | Total Quality Management | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Project** | | |
| EM 700 | Master's Project | 3 |
| **Electives** [1] | | |
| Select three of the following: | | 9 |
| EM 634 | Legal, Ethical and Intellectual Property Issues for Engineering Managers | |
| EM 637 | Project Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| IE 651 | Industrial Simulation | |
| IE 659 | Supply Chain Engineering | |
| EM 632 | Legal Aspects in Construction | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 621 | Systems Analysis and Simulation | |
| EM 640 | Distribution Logistics | |
| EM 641 | Engineering Procurement and Materials Management | |
| EM 674 | Benchmarking and Quality Function Deployment | |
| IE 605 | Engineering Reliability | |
| IE 672 | Industrial Quality Control | |
| MNE 654 | Design for Manufacturability | |
| EM 632 | Legal Aspects in Construction | |
| IE 653 | Facility Maintenance | |
| MNE 601 | Computerized Manufacturing Systems | |
| MNE 602 | Flexible and Computer Integrated Manufacturing | |
| MNE 655 | Concurrent Engineering | |
| EM 655 | Management Aspects of Information Systems | |
| IE 661 | Man-Machine Systems | |

| | | |
|---|---|---|
| EM 635 | Management of Engineering Research and Development | |
| **Total Credits** | | **30** |

[1] School of Management courses with a FIN, MRKT, MIS, HRM or MGMT prefix may be taken as electives

## M.S. in Engineering Management (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| IE 673 | Total Quality Management | 3 |
| MIS 645 | Information Systems Principles | 3 |
| **Thesis** | | |
| EM 701 | Master'S Thesis | 6 |
| **Electives** [1] | | |
| Select two of the following: | | 6 |
| EM 634 | Legal, Ethical and Intellectual Property Issues for Engineering Managers | |
| EM 637 | Project Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| IE 651 | Industrial Simulation | |
| IE 659 | Supply Chain Engineering | |
| EM 632 | Legal Aspects in Construction | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 621 | Systems Analysis and Simulation | |
| EM 640 | Distribution Logistics | |
| EM 641 | Engineering Procurement and Materials Management | |
| EM 674 | Benchmarking and Quality Function Deployment | |
| IE 605 | Engineering Reliability | |
| IE 672 | Industrial Quality Control | |
| MNE 654 | Design for Manufacturability | |
| EM 632 | Legal Aspects in Construction | |
| IE 653 | Facility Maintenance | |
| MNE 601 | Computerized Manufacturing Systems | |
| MNE 602 | Flexible and Computer Integrated Manufacturing | |
| MNE 655 | Concurrent Engineering | |
| EM 655 | Management Aspects of Information Systems | |
| IE 661 | Man-Machine Systems | |
| EM 635 | Management of Engineering Research and Development | |
| **Total Credits** | | **30** |

[1] School of Management courses with a FIN, MRKT, MIS, HRM or MGMT prefix may be taken as electives

Students may also have graduate courses in their undergraduate engineering degree or other technical discipline.

# M.S. in Healthcare Systems Management

## Degree Requirements

A minimum of 30 credits beyond a baccalaureate degree is required. A master's thesis or independent research is optional.

## M.S. in Healthcare Systems Management (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 699 | Special Topics in Industrial Engineering | 3 |

| | | |
|---|---|---|
| IE 699 | Special Topics in Industrial Engineering | 3 |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| **Electives** | | |
| Select four of the following: | | 12 |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 637 | Project Control | |
| IE 682 | Industrial Safety and Health Evaluation | |
| IE 672 | Industrial Quality Control | |
| IE 650 | Advanced Topics in Operations Research | |
| IE 621 | Systems Analysis and Simulation | |
| IE 673 | Total Quality Management | |
| MIS 648 | Decision Support Systems for Managers | |
| MGMT 620 | Management of Technology | |
| **Total Credits** | | **30** |

## M.S. in Healthcare Systems Management (independent research)

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 699 | Special Topics in Industrial Engineering | 3 |
| IE 699 | Special Topics in Industrial Engineering | 3 |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| **Independent Research** | | |
| IE 725 | Independent Research | 3 |
| **Electives** | | |
| Select three of the following: | | 9 |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 637 | Project Control | |
| IE 682 | Industrial Safety and Health Evaluation | |
| IE 672 | Industrial Quality Control | |
| IE 650 | Advanced Topics in Operations Research | |
| IE 621 | Systems Analysis and Simulation | |
| IE 673 | Total Quality Management | |
| MIS 648 | Decision Support Systems for Managers | |
| MGMT 620 | Management of Technology | |
| **Total Credits** | | **30** |

## M.S. in Healthcare Systems Management (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 699 | Special Topics in Industrial Engineering | 3 |
| IE 699 | Special Topics in Industrial Engineering | 3 |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| HRM 601 | Organizational Behavior | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| **Thesis** | | |
| IE 701 | Master'S Thesis | 6 |
| **Electives** | | |

| | | |
|---|---|---|
| Select two of the following: | | 6 |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 637 | Project Control | |
| IE 682 | Industrial Safety and Health Evaluation | |
| IE 672 | Industrial Quality Control | |
| IE 650 | Advanced Topics in Operations Research | |
| IE 621 | Systems Analysis and Simulation | |
| IE 673 | Total Quality Management | |
| MIS 648 | Decision Support Systems for Managers | |
| MGMT 620 | Management of Technology | |
| **Total Credits** | | **30** |

# M.S. in Industrial Engineering

## Degree Requirements

Students who do not have a bachelor of science degree in industrial engineering may be admitted and required to complete the bridge program. Bridge courses do not count toward degree requirements.

A minimum of 30 credits beyond a baccalaureate degree is required. A master's thesis or independent research is optional. Students select an area of specialization and individually design their programs in consultation with the graduate advisor. Faculty advisor approval must be obtained by students before they are permitted to register for IE 701 Master'S Thesis.

*Seminar:* In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in IE 791 Graduate Seminar.

## M.S. in Industrial Engineering (courses only)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| EM 502 | Engineering Cost Analysis | 3 |
| EM 602 | Management Science | 3 |
| IE 501 | Fundamentals of Industrial Engineering | 3 |
| **Total Credits** | | **9** |

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| IE 621 | Systems Analysis and Simulation | 3 |
| IE 650 | Advanced Topics in Operations Research | 3 |
| **Areas of Specialization** | | |
| Select three of the following: [1] | | 9 |
| **Quality Systems Engineering** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| MNE 654 | Design for Manufacturability | |
| **Operations Research** | | |
| IE 651 | Industrial Simulation | |
| IE 704 | Sequencing and Scheduling | |
| IE 650 | Advanced Topics in Operations Research | |
| **Information Systems Design** | | |
| CS 610 | Data Structures and Algorithms | |
| CS 631 | Data Management System Design | |
| EM 655 | Management Aspects of Information Systems | |
| **Supply Chain & Logistics** | | |
| IE 642 | Network Flows and Applications | |
| IE 699 | Special Topics in Industrial Engineering | |

| | | |
|---|---|---|
| EM 707 | | |
| **Service Systems Engineering** | | |
| IE 651 | Industrial Simulation | |
| IE 636 | | |
| MIS 648 | Decision Support Systems for Managers | |
| **Total Credits** | | **21** |

1 Students may choose to specialize in any one of the following areas. Completion of all three courses in a specialization will qualify the student for a specialization certificate to be issued by the department. This will be awarded in conjunction with successful completion of the MS degree.

## M.S. in Industrial Engineering (independent research)

| | | |
|---|---|---|
| **Bridge Courses** | | |
| EM 502 | Engineering Cost Analysis | 3 |
| EM 602 | Management Science | 3 |
| IE 501 | Fundamentals of Industrial Engineering | 3 |
| **Total Credits** | | **9** |

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| IE 621 | Systems Analysis and Simulation | 3 |
| IE 650 | Advanced Topics in Operations Research | 3 |
| **Independent Research** | | |
| IE 725 | Independent Research | 3 |
| **Areas of Specialization** | | |
| Select three of the following: [1] | | 9 |
| **Quality Systems Engineering** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| MNE 654 | Design for Manufacturability | |
| **Operations Research** | | |
| IE 651 | Industrial Simulation | |
| IE 704 | Sequencing and Scheduling | |
| IE 650 | Advanced Topics in Operations Research | |
| **Information Systems Design** | | |
| CS 610 | Data Structures and Algorithms | |
| CS 611 | Introduction to Computability and Complexity | |
| EM 655 | Management Aspects of Information Systems | |
| **Supply Chain & Logistics** | | |
| IE 642 | Network Flows and Applications | |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 707 | | |
| **Service Systems Engineering** | | |
| IE 651 | Industrial Simulation | |
| IE 636 | | |
| MIS 648 | Decision Support Systems for Managers | |
| **Total Credits** | | **24** |

1 Students may choose to specialize in any one of the following areas. Completion of all three courses in a specialization will qualify the student for a specialization certificate to be issued by the department. This will be awarded in conjunction with successful completion of the MS degree.

## M.S. in Industrial Engineering (Master's thesis)

**Bridge Courses**

| | | |
|---|---|---|
| EM 502 | Engineering Cost Analysis | 3 |
| EM 602 | Management Science | 3 |
| IE 501 | Fundamentals of Industrial Engineering | 3 |
| **Total Credits** | | **9** |

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| IE 621 | Systems Analysis and Simulation | 3 |
| IE 650 | Advanced Topics in Operations Research | 3 |
| **Thesis** | | |
| IE 701 | Master'S Thesis | 6 |
| **Areas of Specialization** | | |
| Select three of the following: [1] | | 9 |
| **Quality Systems Engineering** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| MNE 654 | Design for Manufacturability | |
| **Operations Research** | | |
| IE 651 | Industrial Simulation | |
| IE 704 | Sequencing and Scheduling | |
| IE 650 | Advanced Topics in Operations Research | |
| **Information Systems Design** | | |
| CS 610 | Data Structures and Algorithms | |
| CS 611 | Introduction to Computability and Complexity | |
| EM 655 | Management Aspects of Information Systems | |
| **Supply Chain & Logistics** | | |
| IE 642 | Network Flows and Applications | |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 707 | | |
| **Service Systems Engineering** | | |
| IE 651 | Industrial Simulation | |
| IE 636 | | |
| MIS 648 | Decision Support Systems for Managers | |
| **Total Credits** | | **27** |

1. Students may choose to specialize in any one of the following areas. Completion of all three courses in a specialization will qualify the student for a specialization certificate to be issued by the department. This will be awarded in conjunction with successful completion of the MS degree.

# M.S. in Manufacturing Systems Engineering

## Degree Requirements

Students who lack appropriate undergraduate preparation for the program are required to make up deficiencies by taking a program of bridge courses that are designed in consultation with graduate advisors. These courses are taken in addition to the degree requirements and may include undergraduate courses.

A minimum of 30 credits is required: 12 credits of core courses and 18 in an area of specialization. A master's project or thesis is optional. Students select an area of specialization in consultation with the graduate advisor and must take a set of core, required and elective courses.

*Seminar:* All students who receive departmental or research-based awards must register each semester for MNE 791 Seminar In Manufact Engr.

## M.S. in Manufacturing Systems (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| MNE 601 | Computerized Manufacturing Systems | 3 |

| | | |
|---|---|---|
| MNE 602 | Flexible and Computer Integrated Manufacturing | 3 |
| IE 659 | Supply Chain Engineering | 3 |
| MNE 654 | Design for Manufacturability | 3 |
| **Area of Specialization** | | |
| Students may choose to specialize in any one of the following areas: | | 18 |
| **Process Automation** | | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 655 | Concurrent Engineering | |
| ECE 601 | Linear Systems | |
| Process Automation Electives | | |
| **Design for Manufacturing** | | |
| ME 635 | Computer-Aided Design | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 665 | Applied Industrial Ergonomics | |
| Design for Manufacturing Electives | | |
| **Six Sigma Quality** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| IE 604 | Advanced Engineering Statistics | |
| Six Sigma Quality Electives | | |
| **Total Credits** | | **30** |

## M.S. in Manufacturing Systems (independent study)

| | | |
|---|---|---|
| **Core Courses** | | |
| MNE 601 | Computerized Manufacturing Systems | 3 |
| MNE 602 | Flexible and Computer Integrated Manufacturing | 3 |
| IE 659 | | 3 |
| MNE 654 | Design for Manufacturability | 3 |
| **Independent Study** | | |
| MNE 725 | Independent Study | 3 |
| **Area of Specialization** | | |
| Students may choose to specialize in any one of the following areas: | | 15 |
| **Process Automation** | | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 655 | Concurrent Engineering | |
| ECE 601 | Linear Systems | |
| Process Automation Electives | | |
| **Design for Manufacturing** | | |
| ME 635 | Computer-Aided Design | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 665 | Applied Industrial Ergonomics | |
| Design for Manufacturing Electives | | |
| **Six Sigma Quality** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| IE 604 | Advanced Engineering Statistics | |
| Six Sigma Quality Electives | | |
| **Total Credits** | | **30** |

## M.S. in Manufacturing Systems (Master's project)

| | | |
|---|---|---|
| **Core Courses** | | |
| MNE 601 | Computerized Manufacturing Systems | 3 |

| | | |
|---|---|---|
| MNE 602 | Flexible and Computer Integrated Manufacturing | 3 |
| IE 659 | | 3 |
| MNE 654 | Design for Manufacturability | 3 |
| **Project** | | |
| MNE 700 | Master'S Project | 3 |
| **Area of Specialization** | | |
| Students may choose to specialize in any one of the following areas: | | 15 |
| **Process Automation** | | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 655 | Concurrent Engineering | |
| ECE 601 | Linear Systems | |
| Process Automation Electives | | |
| **Design for Manufacturing** | | |
| ME 635 | Computer-Aided Design | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 665 | Applied Industrial Ergonomics | |
| Design for Manufacturing Electives | | |
| **Six Sigma Quality** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| IE 604 | Advanced Engineering Statistics | |
| Six Sigma Quality Electives | | |
| **Total Credits** | | **30** |

## M.S. in Manufacturing Systems (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| MNE 601 | Computerized Manufacturing Systems | 3 |
| MNE 602 | Flexible and Computer Integrated Manufacturing | 3 |
| IE 659 | | 3 |
| MNE 654 | Design for Manufacturability | 3 |
| **Thesis** | | |
| MNE 701 | Master'S Thesis | 6 |
| **Area of Specialization** | | |
| Students may choose to specialize in any one of the following areas: | | 12 |
| **Process Automation** | | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 655 | Concurrent Engineering | |
| ECE 601 | Linear Systems | |
| Process Automation Electives | | |
| **Design for Manufacturing** | | |
| ME 635 | Computer-Aided Design | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 665 | Applied Industrial Ergonomics | |
| Design for Manufacturing Electives | | |
| **Six Sigma Quality** | | |
| IE 672 | Industrial Quality Control | |
| IE 673 | Total Quality Management | |
| IE 604 | Advanced Engineering Statistics | |
| Six Sigma Quality Electives | | |
| **Total Credits** | | **30** |

# M.S. in Mechanical Engineering

## Degree Requirements

Students who lack appropriate undergraduate preparation may be admitted and are asked to make up deficiencies by taking a program of bridge courses that is designed in consultation with the graduate advisor. These courses are taken in addition to the degree requirements and may include undergraduate courses.

The Master of Science in Mechanical Engineering program offers three areas of specialization.

1. *CAD/CAM, Mechanisms & Control* - computer aided engineering, mechanisms, biomechanical & medical devices, robotics and controls.
2. *Mechanics & Material Processing* - tissues & biomechanics, continuum mechanics, plastics, micro/nano materials, particle technology.
3. *Thermo-Fluid Systems & Energy* - biofluids, computational & multiphase fluid dynamics, granular science, HVAC, energy.

The student consults the graduate advisor to plan and develop an individualized and cohesive sequence of courses that meet program requirements of at least 30 degree credits.The MS degree students opting for the project or thesis option must make an arrangement with a faculty member for supervision and obtain the departmental approval in order to receive permits to register for the proper section. Students opting for a project must register for the M.S. project (ME 700) for 3 credits. Students opting for a thesis must register for the M.S. thesis (ME 701) for 6 credits and successfully defend the thesis before graduation. Thesis option is required of all students who receive departmental or research-based awards.

*Seminar:* In addition to the minimum 30 degree credits required, every student must take a minimum of two semesters of ME 794 Mechanical Engineering Colloquium. Students who receive departmental or research-based awards must enroll every semester in ME 794 Mechanical Engineering Colloquium.

## M.S. in Mechanical Engineering (courses only)

| | | |
|---|---|---|
| **Required Courses** | | |
| ME 616 | Matrix Methods in Mechanical Engineering | 3 |
| or MATH 651 | Methods of Applied Mathematics I | |
| Select three of the following: | | 9 |
| ME 610 | Applied Heat Transfer | |
| ME 611 | Dynamics of Incompressible Fluids | |
| ME 614 | Continuum Mechanics | |
| ME 620 | Stress Methods in Mechanical Design | |
| ME 632 | Mechanical Engineering Measurements | |
| ME 635 | Computer-Aided Design | |
| **Elective ME Graduate Courses** | | |
| Select three or more of the following: | | 9 |
| ME 607 | Advanced Thermodynamics | |
| ME 618 | Selected Topics in Mechanical Engineering | |
| ME 621 | Energy Methods in Mechanical Design | |
| ME 622 | Finite Element Methods in Mechanical Engineering | |
| ME 624 | Microlevel Modeling in Particle Technology | |
| ME 625 | Introduction to Robotics | |
| ME 630 | Analytical Methods in Machine Design | |
| ME 636 | Mechanism Design: Analysis and Synthesis | |
| ME 637 | Kinematics of Spatial Mechanisms | |
| ME 655 | Introduction to Modern Control Methods | |
| ME 670 | Introduction to Biomechanical Engineering | |
| ME 678 | Engineering Design of Plastic Products | |
| ME 679 | Polymer Processing Techniques | |
| ME 712 | Mechanics of Viscous Fluids | |
| ME 713 | Non-Newtonian Fluid Dynamics | |
| ME 714 | Principles of Particulate Multiphase Flows | |
| ME 717 | Selected Topics in Mechanical Engineering I | |
| ME 718 | ST: (Selected Topics in Mechanical Engineering II) | |
| ME 735 | Advanced Topics in Robotics | |

| | | |
|---|---|---|
| ME 736 | Advanced Mechanism Design | |
| ME 738 | Computer Aided Engineering | |
| **General Elective Courses** | | |
| Graduate courses from other departments or programs | | 9 |
| **Seminar** | | |
| ME 794 | Mechanical Engineering Colloquium [1] | 0 |
| **Total Credits** | | **30** |

[1] Required for two semesters.

## M.S. in Mechanical Engineering (Master's project)

| | | |
|---|---|---|
| **Required Courses** | | |
| ME 616 | Matrix Methods in Mechanical Engineering | 3 |
| or MATH 651 | Methods of Applied Mathematics I | |
| Select three of the following: | | 9 |
| ME 610 | Applied Heat Transfer | |
| ME 611 | Dynamics of Incompressible Fluids | |
| ME 614 | Continuum Mechanics | |
| ME 620 | Stress Methods in Mechanical Design | |
| ME 632 | Mechanical Engineering Measurements | |
| ME 635 | Computer-Aided Design | |
| **Project** | | |
| ME 700 | Master'S Project | 3 |
| **Elective ME Graduate Courses** | | |
| Select two or more of the following: | | 6 |
| ME 607 | Advanced Thermodynamics | |
| ME 618 | Selected Topics in Mechanical Engineering | |
| ME 621 | Energy Methods in Mechanical Design | |
| ME 622 | Finite Element Methods in Mechanical Engineering | |
| ME 624 | Microlevel Modeling in Particle Technology | |
| ME 625 | Introduction to Robotics | |
| ME 630 | Analytical Methods in Machine Design | |
| ME 636 | Mechanism Design: Analysis and Synthesis | |
| ME 637 | Kinematics of Spatial Mechanisms | |
| ME 655 | Introduction to Modern Control Methods | |
| ME 670 | Introduction to Biomechanical Engineering | |
| ME 678 | Engineering Design of Plastic Products | |
| ME 679 | Polymer Processing Techniques | |
| ME 712 | Mechanics of Viscous Fluids | |
| ME 713 | Non-Newtonian Fluid Dynamics | |
| ME 714 | Principles of Particulate Multiphase Flows | |
| ME 717 | Selected Topics in Mechanical Engineering I | |
| ME 718 | ST: (Selected Topics in Mechanical Engineering II) | |
| ME 735 | Advanced Topics in Robotics | |
| ME 736 | Advanced Mechanism Design | |
| ME 738 | Computer Aided Engineering | |
| **General Elective Courses** | | |
| Graduate courses from other departments or programs | | 9 |
| **Seminar** | | |
| ME 794 | Mechanical Engineering Colloquium [1] | 0 |
| **Total Credits** | | **30** |

[1] Required for two semesters.

## M.S. in Mechanical Engineering (Master's thesis)

| | | |
|---|---|---|
| **Required Courses** | | |
| ME 616 | Matrix Methods in Mechanical Engineering | 3 |
| or MATH 651 | Methods of Applied Mathematics I | |
| Select three of the following: | | 9 |
| ME 610 | Applied Heat Transfer | |
| ME 611 | Dynamics of Incompressible Fluids | |
| ME 614 | Continuum Mechanics | |
| ME 620 | Stress Methods in Mechanical Design | |
| ME 632 | Mechanical Engineering Measurements | |
| ME 635 | Computer-Aided Design | |
| **Thesis** [1] | | |
| ME 701 | Master'S Thesis | 6 |
| **Elective ME Graduate Courses** | | |
| Select one or more of the following: | | 3 |
| ME 607 | Advanced Thermodynamics | |
| ME 618 | Selected Topics in Mechanical Engineering | |
| ME 621 | Energy Methods in Mechanical Design | |
| ME 622 | Finite Element Methods in Mechanical Engineering | |
| ME 624 | Microlevel Modeling in Particle Technology | |
| ME 625 | Introduction to Robotics | |
| ME 630 | Analytical Methods in Machine Design | |
| ME 636 | Mechanism Design: Analysis and Synthesis | |
| ME 637 | Kinematics of Spatial Mechanisms | |
| ME 655 | Introduction to Modern Control Methods | |
| ME 670 | Introduction to Biomechanical Engineering | |
| ME 678 | Engineering Design of Plastic Products | |
| ME 679 | Polymer Processing Techniques | |
| ME 712 | Mechanics of Viscous Fluids | |
| ME 713 | Non-Newtonian Fluid Dynamics | |
| ME 714 | Principles of Particulate Multiphase Flows | |
| ME 717 | Selected Topics in Mechanical Engineering I | |
| ME 718 | ST: (Selected Topics in Mechanical Engineering II) | |
| ME 735 | Advanced Topics in Robotics | |
| ME 736 | Advanced Mechanism Design | |
| ME 738 | Computer Aided Engineering | |
| **General Elective Courses** | | |
| Graduate courses from other departments or programs | | 9 |
| **Seminar** | | |
| ME 794 | Mechanical Engineering Colloquium [2] | 0 |
| **Total Credits** | | **30** |

[1] Required of all students who receive departmental or research-based awards.
[2] Required every semester.

# M.S. in Occupational Safety and Health Engineering

## Degree Requirements

A minimum of 36 credits is required.

Students who lack an appropriate background may be admitted and required to make up deficiencies by taking a program of bridge courses that is designed in consultation with graduate advisors. These courses are taken in addition to the degree requirements and may include undergraduate courses.

*Seminar:* In addition to the minimum 36 degree credits required, all students who receive departmental or research-based awards must enroll each semester in IE 791 Graduate Seminar.

## M.S. in Occupational Safety and Health (courses only)

| | | |
|---|---|---|
| **Required Courses** | | |
| EM 633 | Legal Aspects of Health and Safety | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 614 | Safety Engineering Methods | 3 |
| IE 615 | Industrial Hygiene and Occupational Health | 3 |
| IE 665 | Applied Industrial Ergonomics | 3 |
| IE 685 | Systems Safety | 3 |
| **Elective Courses** | | |
| Select six of the following: | | 18 |
| BME 670 | Introduction to Biomechanical Engineering | |
| BME 671 | Biomechanics of Human Structure and Motion | |
| EVSC 603 | Hazardous Waste Operations and Emergency Response | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| IE 608 | Product Liability Control | |
| IE 661 | Man-Machine Systems | |
| IE 662 | Cognitive Engineering | |
| IE 664 | Advanced Ergonomics | |
| IE 669 | Human Design Factors in Engineering | |
| IE 675 | Safety in Facility and Product Design | |
| IE 681 | Interdisciplinary Seminar in Occupational Safety and Health | |
| IE 682 | Industrial Safety and Health Evaluation | |
| IE 700 | Master'S Project | |
| IE 725 | Independent Research | |
| ME 660 | Noise Control | |
| **Total Credits** | | **36** |

## M.S. in Occupational Safety and Health (Master's thesis)

| | | |
|---|---|---|
| **Required Courses** | | |
| EM 633 | Legal Aspects of Health and Safety | 3 |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 614 | Safety Engineering Methods | 3 |
| IE 615 | Industrial Hygiene and Occupational Health | 3 |
| IE 665 | Applied Industrial Ergonomics | 3 |
| IE 685 | Systems Safety | 3 |
| **Thesis** [1] | | |
| IE 701 | | 6 |
| **Elective Courses** | | |
| Select four of the following: | | 12 |
| BME 670 | Introduction to Biomechanical Engineering | |
| BME 671 | Biomechanics of Human Structure and Motion | |
| EVSC 603 | Hazardous Waste Operations and Emergency Response | |
| EVSC 614 | Quantitative Environmental Risk Assessment | |
| EVSC 616 | Toxicology for Engineers and Scientists | |
| IE 608 | Product Liability Control | |

| | | |
|---|---|---|
| IE 661 | Man-Machine Systems | |
| IE 662 | Cognitive Engineering | |
| IE 664 | Advanced Ergonomics | |
| IE 669 | Human Design Factors in Engineering | |
| IE 675 | Safety in Facility and Product Design | |
| IE 681 | Interdisciplinary Seminar in Occupational Safety and Health | |
| IE 682 | Industrial Safety and Health Evaluation | |
| IE 700 | Master'S Project | |
| IE 725 | Independent Research | |
| ME 660 | Noise Control | |
| **Total Credits** | | **36** |

[1] Required for NIOSH; trainees; optional for all others.

# M.S. in Pharmaceutical Systems Management

## Degree Requirements

A minimum of 30 credits beyond a B.S. degree is required. A thesis or independent research is optional.

### M.S. in Pharmaceutical Systems Management (courses only)

| | | |
|---|---|---|
| **Core Courses** | | |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| IE 673 | Total Quality Management | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| **Elective Courses** | | |
| Select four of the following: | | 12 |
| EM 634 | Legal, Ethical and Intellectual Property Issues for Engineering Managers | |
| EM 635 | Management of Engineering Research and Development | |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 637 | Project Control | |
| IE 659 | Supply Chain Engineering | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 601 | Computerized Manufacturing Systems | |
| PHEN 605 | Pharmaceutical Packaging Technology | |
| PHEN 602 | Pharmaceutical Facility Design | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

### M.S. in Pharmaceutical Systems Management (independent research)

| | | |
|---|---|---|
| **Core Courses** | | |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| IE 673 | Total Quality Management | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| **Independent Research** | | |
| PHEN 725 | Independent Study | 3 |
| **Elective Courses** | | |

| | | |
|---|---|---|
| Select three of the following: | | 9 |
| EM 634 | Legal, Ethical and Intellectual Property Issues for Engineering Managers | |
| EM 635 | Management of Engineering Research and Development | |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 637 | Project Control | |
| IE 659 | Supply Chain Engineering | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 601 | Computerized Manufacturing Systems | |
| PHEN 605 | Pharmaceutical Packaging Technology | |
| PHEN 602 | Pharmaceutical Facility Design | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

## M.S. in Pharmaceutical Systems Management (Master's thesis)

| | | |
|---|---|---|
| **Core Courses** | | |
| EM 602 | Management Science | 3 |
| EM 636 | Project Management | 3 |
| IE 673 | Total Quality Management | 3 |
| IE 618 | Engineering Cost and Production Economics | 3 |
| PHEN 601 | Principles of Pharmaceutical Engineering | 3 |
| PHEN 604 | Validation and Regulatory Issues in the Pharmaceutical Industry | 3 |
| **Thesis** | | |
| PHEN 701 | Master's Thesis | 6 |
| **Elective Courses** | | |
| Select two of the following: | | 6 |
| EM 634 | Legal, Ethical and Intellectual Property Issues for Engineering Managers | |
| EM 635 | Management of Engineering Research and Development | |
| IE 699 | Special Topics in Industrial Engineering | |
| EM 637 | Project Control | |
| IE 659 | Supply Chain Engineering | |
| IE 621 | Systems Analysis and Simulation | |
| MNE 601 | Computerized Manufacturing Systems | |
| PHEN 605 | Pharmaceutical Packaging Technology | |
| PHEN 602 | Pharmaceutical Facility Design | |
| HRM 601 | Organizational Behavior | |
| **Total Credits** | | **30** |

# Ph.D. in Industrial Engineering

## Degree Requirements

### Ph.D. in Industrial Engineering (students entering with appropriate master's degree)

| | | |
|---|---|---|
| Core courses [1] | | 12 |
| Technical electives [1] | | 12 |
| IE 790 | Doctoral Dissertation [2] | 36 |
| IE 791 | Graduate Seminar [3] | 0 |
| **Total Credits** | | **60** |

1. A total of 12 credits must be at the 700 level. None of the 24 credits may be at the 500 level.
2. If the 36 credits of dissertation are completed before the dissertation is finished, students must register each semester for at least 3 credits of dissertation until the dissertation is accepted.
3. Required each semester.

## Ph.D. in Industrial Engineering (students entering with bachelor's degree)

| | | |
|---|---|---|
| Course work | | 42 |
| IE 790 | Doctoral Dissertation | 36 |
| **Total Credits** | | **78** |

## Areas of Specialization

### Manufacturing Systems and Assurance Sciences

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 704 | Sequencing and Scheduling | 3 |
| IE 651 | Industrial Simulation | 3 |
| IE 706 | A Queueing Approach to Performance Analysis | 3 |
| IE 659 | Supply Chain Engineering | 3 |
| **Electives** | | |
| 700 level course | | 3 |
| Three courses from IE, ME, MnE, CS, and Math [1] | | 9 |
| **Total Credits** | | **24** |

1 None at the 500 level

### Human Factors and Occupational Safety

| | | |
|---|---|---|
| **Core Courses** | | |
| IE 604 | Advanced Engineering Statistics | 3 |
| IE 760 | Quantitative Methods in Human Factors | 3 |
| IE 761 | Advanced Studies in Human Factors | 3 |
| IE 762 | Psychophysical Methods in Human Factors | 3 |
| **Electives** | | |
| 700 level course | | 3 |
| Three courses from IE, ME, MnE, CS, and Math [1] | | 9 |
| **Total Credits** | | **24** |

1 None at the 500 level

Specific degree requirements and dissertation topics are approved by the department on an individual basis. Before being permitted to register for dissertation, students must complete course requirements, pass qualifying examinations, both written and oral, and demonstrate that there are facilities and a faculty member available to supervise the research.

## Qualifying Examinations

All doctoral students are expected to pass both a written and oral qualifying examination. Passing the written qualifying examination is a prerequisite for the oral examination. Students are urged to take these examinations as soon as possible after being admitted into the program.

Students must take a two-part written examination within the first year following admission to the program, and pass within two years. The examination is offered every October. A student will be allowed only two attempts to pass the examination. Both parts must be taken at the same time. It consists of two sections:

- **Section I** General competence in mathematics including calculus, probability and statistics, differential equations, and linear algebra.
- **Section II** Proficiency in fundamentals of industrial engineering including: operations research (deterministic and probabilistic), quality control, reliability, engineering economy, production planning and control, and human factors.

The oral examination should be taken and passed in the semester after the written examination is passed. The dissertation committee assigns a topic for the oral examination from the student's area of specialization. The examination is offered by the dissertation committee. Thorough study and understanding of theoretical, technical and practical aspects of the assigned topic should be demonstrated in the oral examination.

## Formation of a Dissertation Committee

With the approval of the graduate advisor, within two months after passing the written examination, students must form a dissertation committee. The committee should consist of at least four faculty members from the department including the student's advisor. In addition, one member of the committee must be chosen from outside the department.

## Dissertation Proposal

Within three months of passing the oral examination, students must submit, for the approval of their dissertation committee, both in writing and orally, a doctoral proposal on the scope of their proposed research.

The dissertation must represent original research leading to meaningful advances in the industrial engineering profession. The work must be worthy of publication in refereed journals on industrial engineering or related fields. Doctoral students must complete the dissertation in the five years subsequent to passing their written and oral qualifying examinations.

## Dissertation Defense

Each doctoral student must submit to their committee a written dissertation for their approval. After the dissertation committee approves the document, the student must successfully defend the dissertation in front of the committee and other interested faculty and students.

# Ph.D. in Mechanical Engineering

## Degree Requirements

Students who enter with the M.S. degree must complete a course work of 24 credits. Students who enter with the bachelor's degree must complete a course work of 48 credits. Students must also complete sufficient credits of dissertation research (ME 790) and meet the milestone deadlines, as specified by the office of Graduate Studies in the New Ph.D. Credit Requirements (http://www5.njit.edu/graduatestudies/content/new-phd-credit-requirements). Specific dissertation topics are approved by the department on an individual basis An oral defense of the dissertation is required after submission of the final document to the department for approval.

## Qualifying Examination

Once admitted to the program, candidates are expected to pass a qualifying examination. Qualifying in Subject Area will be based on students passing a minimum of 4 Mechanical Engineering graduate courses, one of which must be ME 616 Matrix Methods in Mechanical Engineering, with a cumulative grade point average of not less than 3.6/4.0. Qualifying in Examination of Research Potential will be based on the student's formal research prospectus submitted in written form. After receiving the research prospectus, the department will form a committee to conduct an oral examination concerned with student's research ability and general knowledge of mechanical engineering.

**Note:** Before registering for courses, all students must submit a Graduate Registration Form and all new students must obtain approval from the graduate advisor.

# Interdisciplinary Program in Engineering Science

The M.S. in Engineering Science allows students to study areas not covered by traditional engineering or science discipline graduate programs. For those already in the work force, the program provides the opportunity to develop expertise relevant to their work

## Master of Science in Engineering Science

This is a very flexible program that permits advanced study from numerous disciplines in engineering and the sciences.

## Admission Requirements

Applicants are expected to have an accredited undergraduate degree in science or engineering. Candidates with other appropriate backgrounds may be considered.

- Engineering Science - M.S. (p. 989)

## Interdisciplinary Program in Engineering Science Courses

**ESC 701B. Master'S Thesis. 3 credits, 3 contact hours.**

# M.S. in Engineering Science

## Degree Requirements

To ensure academic success in their graduate studies, students may be required to take additional undergraduate or graduate courses before beginning graduate curricula. This program of bridge courses will be individually-designed in consultation with the student's graduate advisor. Such courses are not counted toward degree requirements.

A minimum of 30 credits is required. A thesis or project may be included.

*Seminar:* In addition to the minimum 30 degree credits, all students who receive departmental or research-based awards must enroll each semester in a graduate seminar. The seminar is selected in consultation with the graduate advisor.

### M.S. in Engineering Science (courses only)

| | | |
|---|---|---|
| **Required** | | |
| MATH 6XX | Two 600-level math courses | 6 |
| One 600-level physics, chemistry, or biology course | | 3 |
| Two 600-level engineering courses | | 6 |
| **Electives** [1] | | |
| Select five courses in consultation with graduate advisor | | 15 |
| **Total Credits** | | **30** |

1 The elective credits must form a meaningful and coherent program integrated with the specialization in science or engineering.

### M.S. in Engineering Science (Master's project)

| | | |
|---|---|---|
| **Required** | | |
| MATH 6XX | Two 600-level math courses | 6 |
| One 600-level physics, chemistry, or biology course | | 3 |
| Two 600-level engineering courses | | 6 |
| **Project** | | |
| Master's project | | 3 |
| **Electives** [1] | | |
| Select five courses in consultation with graduate advisor | | 15 |
| **Total Credits** | | **33** |

1 The elective credits must form a meaningful and coherent program integrated with the specialization in science or engineering.

### M.S. in Engineering Science (Master's thesis)

| | | |
|---|---|---|
| **Required** | | |
| MATH 6XX | Two 600-level math courses | 6 |
| One 600-level physics, chemistry, or biology course | | 3 |
| Two 600-level engineering courses | | 6 |
| **Thesis** | | |
| Master's thesis | | 6 |
| **Electives** [1] | | |
| Select five courses in consultation with graduate advisor | | 15 |
| **Total Credits** | | **36** |

1 The elective credits must form a meaningful and coherent program integrated with the specialization in science or engineering.

# Martin Tuchman School of Management

The School of Management is one of NJIT's six schools and colleges serving as the university's business school. SoM has 25 faculty and approximately 700 students.

NJIT's School of Management is one of 643 business schools across 43 countries to be accredited by AACSB, The Association to Advance Collegiate Schools of Business. AACSB accreditation represents the highest standard of achievement for business schools worldwide. Being AACSB-accredited means a business school is able to continuously pass a strict set of standards that are designed to ensure quality. This is why AACSB-accredited business schools are the best in the world. Of the 643 accredited schools worldwide, only 574 institutions have both their Undergraduate and Graduate programs accredited. All of our undergraduate business specializations and our graduate Management of Science and MBA programs are accredited.

## Programs



## **Executive Program** (http://catalog.njit.edu/graduate/academic-policies-procedures/executive-program)



Business Data Science - Ph.D. (http://catalog.njit.edu/graduate/management/management/business-data-science-phd)

Management Essentials - Cert.

Management of Technology - Cert.

Finance for Managers - Cert.

International Commerce - Cert.

**ACCT 615. Management Accounting. 3 credits, 3 contact hours.**
Builds on traditional concepts of managerial accounting (break-even analysis, alternate choice decisions, profit planning, and transfer pricing) and develops the skills that an executive needs in strategic cost analysis. Explores strategic decisions of value chains and activity-based management. Emphasis on using managerial accounting data in executive planning and control.

**ECON 610. Managerial Economics. 3 credits, 3 contact hours.**
Managerial Economics covers the role of economic theory in management analysis and decisions. The study of demand, cost, and supply theories from a business viewpoint are also covered. This course is about economic principles and their relevance to business decision-making. The course examines the interaction of information, economic incentives and market competition and how these interact to determine prices, products available, profits, and patterns of trade and organization.

**ENTR 725. Independent Study. 3 credits, 3 contact hours.**

**FIN 516. Principles of Financial Management. 3 credits, 3 contact hours.**
Fundamentals of financial management divided into two segments: investment and corporation finance.

**FIN 600. Corporate Finance I. 3 credits, 3 contact hours.**
This course introduces concepts and analytical tools to identify and solve Financial Management problems. After introducing the corporation, the course focuses on how firms invest in real assets (capital budgeting) and how they raise money to pay for assets (financing). Practical problems in valuing bonds, stocks and other investments will be based on the time value of money. The trade-off between risk and return will be introduced with the Capital Asset Pricing Model.

**FIN 610. Global Macro Economics. 3 credits, 3 contact hours.**
FIN 610 is an introductory graduate course for entering master's students that will also be taking other core Master's courses such as accounting. The course introduces various concepts relating to macroenomics and the financial environment from both a theoretical and institutional perspective. Thus fiscal and monetary policy and actions are covered but are taught using a macroeconomic model that helps identify how particular actions affect the money and goods economies as well as specific financial institutions.

**FIN 618. Public and Private Financing of Urban Areas. 3 credits, 3 contact hours.**
Ties government's budget, tax policy, allocation of resources between public and private sectors, with the structure, development, and growth needs of urban metropolitan areas. Focuses on problems of poverty, transportation, land-use, economic base, relation between central cities and suburban areas, and alternative engineering and economic solutions. Same as MIP 618 and Tran 604.

**FIN 624. Corporate Finance II. 3 credits, 3 contact hours.**
Prerequisite:FIN 600. The trade-off between risk and return will be examined in the context of historical analysis, portfolio optimization, the Capital Asset Pricing Model and other alternative models. The course will begin with the understanding of the Modigliani and Miller results and introduce bankruptcy, taxes, information asymmetries and other market imperfections. Financial options, put-call parity and option pricing will be introduces.

**FIN 626. Financial Investment Institutions. 3 credits, 3 contact hours.**
Prerequisite: FIN 600. Introduces the role of banking institutions and investment banks in the domestic and international money market and capital environment to the financial managers. Covers instruments and services of financial intermediaries that are crucial to business management. Discussions range from the financial services and facilities of regional banks to money-center banking institutions. Alternatives of project financing, lending requirements and regulations, project financing, and role of intermediaries in local and international transactions. Focuses on the private placement procedures of all types of securities in the capital market and the unique role undertaken by the investment banking firms. Provides an insight about the public offering process for existing and venture capitalized firms.

**FIN 627. International Finance. 3 credits, 3 contact hours.**
Prerequisite: FIN 600. Examines financing of exports and imports, managing multicurrency working capital, international aspects of capital budgeting, cost of capital and their relationship with political, economic, and financial risk. Explores financial innovations and their impact on the firm's financial strategy and performance of overall productivity. Discusses the tax consequences and principal-subsidiary relationship of the multinational enterprise. Introduces international money and capital markets, instruments, derivatives, and institutions.

**FIN 634. Mergers, Acquisitions, and Restructuring. 3 credits, 3 contact hours.**
Prerequisite: FIN 600. Focuses on identifying and evaluating potential and international companies for mergers and acquisitions as well as structuring of deals. The financial, social and managerial implications of these changes in corporate ownership will be examined. Topics are: financing M&As, deal structuring, tax implications, valuation, broker/finder agreements, merger negotiations, and post-merger integration.

**FIN 641. Derivatives Markets. 3 credits, 3 contact hours.**
Prerequisites: FIN 600. This course introduces students to futures, options, and other derivative securities. Topics include option valuation models, principles of forward and futures pricing, structure of markets for derivative securities, and strategies for hedging and speculation.

**FIN 642. Derivatives and Structured Finance. 3 credits, 3 contact hours.**
Prerequisites: FIN 641. This is a second course in the instruments created by modern financial engineering. It continues the study of derivatives from FIN 641 (Derivatives Markets), covering additional types of options and of underlying assets. The second part of the course is devoted to structured finance, including securities backed by mortgages and other types of assets.

**FIN 643. Term Structure of Interest Rates. 3 credits, 3 contact hours.**
Prerequisites: FIN 642 (Derivatives and Structure Finance), MATH 605 (Stochastic Calculus). This course provides the student with a basic understanding of models of the term-structure of interest rates and the pricing of derivatives on bonds and other interest-rate-based securities. Topics covered include arbitrage-free pricing principles, continuous-time interest-rate models, no-arbitrage term structure models, multifactor models, forward measure approach, market models and model calibration.

**FIN 644. Credit Risk Modeling. 3 credits, 3 contact hours.**
Prerequisites: FIN 643 (Term Structure of Interest Rates), MATH 605 (Stochastic Calculus). This course covers types of credit risk, measurement of credit risk, and methods for changing exposure to credit risk using credit derivatives. Current models for pricing credit derivatives will be analyzed and applied.

**FIN 650. Investment Analysis and Portfolio Theory. 3 credits, 3 contact hours.**
Prerequisite: FIN 600. This is a basic course in the theory and practice of investing. We will study in depth why and how to form portfolios of securities. A significant amount of mathematical and statistical analysis will be used in answering these questions. Theories of asset pricing based on the relationship between risk and return will be included. We will also discuss criteria for selecting specific securities in different asset classes, such as, stocks, bonds, and derivatives.

**FIN 655. Financial Innovations and Market Failures. 3 credits, 3 contact hours.**
Prerequisites: FIN 600. This reading intensive course introduces concepts and problems from derivative markets, entrepreneurial finance, and financial market failures (including financial bubbles). The course focuses on valuation of futures and options (including real options), strategy and incentives for new finance, and information asymmetry and market failures, especially financial market bubbles.

**FIN 700. Seminar in Theory and Research in Financial Management. 3 credits, 3 contact hours.**
Prerequisites: FIN 624 or FIN 626. Only open to those students who do not do a thesis. The theory and applied tools of financial management. Presented in seminar format with several students working as a team to analyze and resolve an issue in financial management.

**FIN 701. Thesis in Financial Management. 3 credits, 3 contact hours.**
Prerequisites: FIN 624 or FIN 626; waived with approval of the assistant dean for graduate programs. Examines:What is research? Why do research? What are the objectives of research? Covers the need for research, criteria for good research and research design, concept of measurement, sampling design, primary data collection, experimentation and simulation, statistical and other types of analysis, and reporting of research findings.

**FIN 725. Independent Study. 3 credits, 3 contact hours.**

**HRM 601. Organizational Behavior. 3 credits, 3 contact hours.**
Analysis of key organizational components; individual perception; learning ability; conflict resolution models; group processes in decision making; motivation; problem diagnosis, and the organization as the mechanism for joining into a coherent productive system. Organizational assessment for innovation, leadership styles, and environmental interaction.

**HRM 606. Human Resource Management. 3 credits, 3 contact hours.**
Management of human resources in business, industry, and government; developing personnel programs including wage and job classification, training, employee and labor relations, and accident prevention. Particular attention is directed to cases and roles involving both line and staff managers.

**HRM 610. Seminar on Leadership Skills. 3 credits, 3 contact hours.**
Leadership theory and research is used to provide a foundation for developing leadership skills in work organizations. This course covers all aspects of leadership properties and processes. Concepts and theory are reinforced with case studies and experiential learning exercises. Topics include charismatic leadership, forming and realizing a vision, motivating and socializing followers, conflict resolution, negotiation, power and authority, and values and ethics.

**HRM 630. Managing Technological and Organizational Change. 3 credits, 3 contact hours.**
Managing planned and unplanned change in organizations. The change process is studied in relation to technology-driven changes in the workplace and to other environmental factors. Focuses on planned and unplanned systemic change, such as downsizing, re-engineering, mergers, and acquisitions.

**HRM 640. Cultures in Organizations. 3 credits, 3 contact hours.**
Prerequisite: HRM 601. Cultures and subcultures in organizations are studied from an ethnographic perspective. Managerial and professional cultures are studied as are engineering and R&D cultures. Organizational cultures are also studied in detail using case studies, with an emphasis on understanding culture as a control mechanism in modern organizations.

**HRM 685. Cross Cultural Management Studies. 3 credits, 3 contact hours.**
Provides insight into the institutional fabric and social and communication behavior of other cultures to better understand problems arising from cultural aspects of managing and doing business in various countries. Focus will be with the manager acting in various cultural environments, not restricted to the traditional human resource function at corporate headquarters. Cultural differences and technologies are also examined.

**MGMT 501. Management Foundations. 3 credits, 3 contact hours.**
This course provides foundation knowledge for MSM and MBA students whose undergraduate coursework does not include coursework in accounting and finance. It therefore, serves as a pre-qualifier for the MSM and MBA programs.

**MGMT 590. Coop Work Experience I. 3 credits, 3 contact hours.**

**MGMT 591. Coop Work Experience II. 3 credits, 3 contact hours.**

**MGMT 592. Coop Work Experience III. 3 credits, 3 contact hours.**

**MGMT 593. Coop Work Experience IV. 0 credits, 0 contact hours.**
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

**MGMT 610. Foundations of Management in Organizations. 3 credits, 3 contact hours.**
Presented during the residence week for the Executive Program. Includes management accounting, managerial economics, statistics, operations research, marketing, MIS, and finance.

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Technology as a main component of an organizational entity. Generation, development, and implementation of technology are outlined. Influence of technology on global competitiveness is also discussed.

**MGMT 625. Distribution Logistics. 3 credits, 3 contact hours.**
Distribution logistics emphasizing techniques used to optimize corporate profit and customer service; transportation modes; inventory policies; warehousing and order processing; and the best logistics gross margin. Same as EM 640 and TRAN 640.

**MGMT 630. Decision Analysis. 3 credits, 3 contact hours.**
Introduction to the methodology of decision analysis using computer based techniques and systems analysis. Introduces concepts of modeling, probability, and choice. Addresses the philosophy and detailed methods involved in decision analysis. Methods are applied to address routine and special business decisions.

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This course provides an introduction to data mining with an emphasis on large scale databases as a source of knowledge generation and competitive advantage. Specific topics include: framing research questions; data modeling; inferential data mining techniques; and evaluation and deployment of data mining systems.

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Prerequisite: FIN 516. For the student who is considering starting or managing a new business. The course combines classroom instruction in business management and a term project involving the analysis of a business case. The course is designed to build upon and integrate the student's previously acquired business knowledge and skills into an understanding of how to start and run a new business.

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The course reviews key elements of project management frameworks with a particular focus on global projects, which include people from various organizations working in different countries across the world, both face-to-face and virtually. Such projects vary in complexity based on the number of organizations, locations, cultures, languages and time-zones involved. It discusses people, technology and processes relevant to managing global projects and virtual teamwork.

**MGMT 645. New Venture Finance. 3 credits, 3 contact hours.**
Prerequisite: FIN 516. This course is designed to provide students with understanding of the problems and opportunities posed by the financing of a new and growing technology-based business. Students will study the financial conditions of new businesses and examine the effect of growth upon cash flow while exploring optimal sources of capital.

**MGMT 648. Distribution Channel Managemnt. 3 credits, 3 contact hours.**
Prerequisites: MRKT 330 Utilizing a strategic perspective, this course augments the understanding of how a firm can effectively manage the distribution system or network of alliances among agents, wholesalers, distributors and retailers to attain a sustainable competitive advantage. This course focuses on developing and implementing strategies for planning, organizing and controlling the various external institutions, agencies as well as in-house units that ultimately deliver products and services to consumer and business-to-business markets. In addition to electronic channels, the topics studied in the distribution process include channel strategy, channel design, channel management, as well as the selection, motivation, and performance assessment of resellers.

**MGMT 649. Convention, Creativity and Innovation. 3 credits, 3 contact hours.**
This course explores the role of creativity and disruptive thinking in relation to the development of new products, processes, technologies and industries. It begins with a focus on the behavioral aspects of creativity and disruptive thinking and includes exercises and tools to challenge conventional thinking. Disruption is them studies through a strategic lens with emphasis on understanding the conditions under which radical change is appropriate and when it is not.

**MGMT 650. Knowledge Management. 3 credits, 3 contact hours.**
Students will learn the principles of the knowledge management process. At the end of the course, students will have a comprehensive framework for designing and implementing a successful knowledge management effort and be able to assist in the development of knowledge.

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Improves knowledge of the issues involved in international business operations and their management. Develops skills in selecting key issues and familiarization with emerging methods for organizing and managing international operations. Emphasis will be on companies with technological, product, production, or design focus.

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**MGMT 670. International Business. 3 credits, 3 contact hours.**
Covers the scope and the essential characteristics of international business in the world economy; MNEs as economic, political, and social institutions; national and international control; functional management and operations; country evaluation; and regional market analysis.

**MGMT 680. Entrepreneurial Strategy. 3 credits, 3 contact hours.**
For the student who is considering starting and/or managing a new business. Integrates knowledge of the different aspects of business that have been learned as separate subjects. Provides an understanding of the decisions that guide the overall operations of an entrepreneurial business organization and how it interacts with its markets, competitors, and suppliers. Combines classroom instruction in business strategy along with case analysis of small firms. Should be taken in the last semester of the program, unless prior arrangement has been made with the instructor or the graduate advisor. Taken in the final semester only.

**MGMT 682. Business Research Methods I. 3 credits, 3 contact hours.**
A comprehensive introduction to business research methods covering the fundamental concepts of problem definition and the research process including quantitative and qualitative research, survey research, observation methods and experimental research methods. The course also covers data analytics, including advanced descriptive and predictive analysis models, involving inferential statistics, regression and correlation analyses and non-parametric methods. The course emphasizes problem solving using advanced quantitative software tools such as SPSS, Munitab, SAS, MathLab, and R. Students will be required to work on business research case studies and projects involving the collection and/or treatment of large data sets, as well as to develop research constructs and hypotheses and to write and present reports documenting research findings and recommendations.

**MGMT 683. Business Research Methods II. 3 credits, 3 contact hours.**
Prerequisites: MGMT 682, MATH 640, MKTG 631 This course develops an understanding and application of multivariate analysis methods for identifying meaningful business relationships from a complex data-set. Depending on the characteristics of the measurement scales employed to draw data and the statement of the research hypotheses, the course offers an understanding of the most appropriate Multivariate Dependence and Interdependence Techniques for data analyses to find support for research problems. The guidelines for application and interpretation of results from multivariate analyses are discussed for providing business solutions.

**MGMT 685. Operations Research and Decision Making. 3 credits, 3 contact hours.**
Introduces the concepts of objective functions and constraints, concepts of value and utilities, optimization algorithms, networks, and game theory. Covers models of linear programming, inventory systems, multi-criteria decision-making, project management, and transportation planning. Topics discussed from probabilistic and deterministic approaches.

**MGMT 686. Corporate Governance. 3 credits, 3 contact hours.**
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**MGMT 691. Legal and Ethical Issues. 3 credits, 3 contact hours.**
Explores the legal and ethical responsibilities of managers. Analyzes extent to which shareholders should be allowed to exercise their legitimate economic, legal, and ethical claims on corporate managers; extent of regulation of a particular industry, individual rights of the employee and various corporate interests, and corporate responsibility to consumers, society, and conservation of natural resources and the environment.

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**MGMT 699. ST:. 3 credits, 3 contact hours.**

**MGMT 701. Master'S Thesis. 0 credits, 0 contact hours.**
Prerequisite: approval of the assistant dean for graduate programs. For students who desire to complete a thesis in management. Students must register every semester until the thesis is completed. Only 6 credits indicated for the thesis is applied to degree credit.

**MGMT 710. Forecasting Methods for Business Decisions. 3 credits, 3 contact hours.**
Covers the application of forecasting techniques to various phases of business and management decision making. Topics include forecasting with cyclical and seasonal series; Box-Jenkins modeling; regression modeling; use of stochastic models; and the linkage of management forecasts to macro forecasts. Actual models in use will be reviewed and evaluated.

**MGMT 725. Independent Study. 3 credits, 3 contact hours.**

**MGMT 726. Independent Study II. 3 credits, 3 contact hours.**

**MIS 620. E-Commerce Technologies. 3 credits, 3 contact hours.**
Intended to develop a basic understanding of the Internet and its underlying technologies as a foundation for e-commerce with an introduction to e-commerce applications. Addresses the technology for MIS managers to effectively manage the launching of e-commerce infrastructures. Covers data communication and networking, EDI, intranets and extranets, bandwidth and security issues.

**MIS 625. Management Strategies for E-Commerce. 3 credits, 3 contact hours.**
Prepares students for effective management of internet-based businesses and electronic commerce and oversight of global business activities in an increasingly competitive environment. Introduces Internet concepts and infrastructure. Examines current and proposed Internet services forming the basis of Internet commerce. Covers corporate intranets and extranets and their applications to corporate computing, seamless e-commerce, and other emerging services such as VPN. Issues are discussed, with special emphasis on security.

**MIS 645. Information Systems Principles. 3 credits, 3 contact hours.**
The management of information processing resources, including: role of information processing, estimates of personnel resources and budgets, integration of corporate and MIS plans, organizational alternatives for MIS departments and support staffs, management of computer operations, equipment and general software acquisitions, intermediate and long-range MIS plans, integration of personal computers, minicomputers, and mainframes, and security and controls.

**MIS 648. Decision Support Systems for Managers. 3 credits, 3 contact hours.**
Prerequisites: MIS 645. Covers the use of decision support systems to support management decision making in a real world environment. Topics include: establishing and measuring decision support systems success criteria, software tools, model management, elements of artificial intelligence, and statistics. Justification, design, and use of decision support systems.

**MIS 680. Management Science. 3 credits, 3 contact hours.**
Introduction to the methodology of decision making applying the techniques of operations research and system analysis to managerial problems. Introduction to the concept of objective functions and constraints, concepts of value and utilities, optimization algorithms, networks and game theories. Elementary mathematical model linear production systems, inventory systems, multi-criteria decision making, project management and transportation planning. Topics will be discussed from the deterministic as well as scholastic points of view.

**MIS 701. Thesis in Information Systems Management. 3 credits, 3 contact hours.**
Prerequisites: MIS 645, MIS 648, CS 675, CS 679 or waived with approval of the Dean. Examines what is research? Why do research? What are the objectives of research? Covers need for research, criteria for good research and research design, concept of measurement, sampling design, primary data collection, experimentation and simulation, statistical and other types of analysis, and reporting of research findings.

**MIS 725. Independent Study. 3 credits, 3 contact hours.**

**MRKT 620. Competing in Global Markets. 3 credits, 3 contact hours.**
Designed to help prepare students to become effective managers overseeing global market activities in an increasingly competitive environment. It will examine the impact of global economic, financial, cultural, political, and legal factors on the development of marketing programs and on the marketing/R&D and marketing/manufacturing interfaces.

**MRKT 630. Models of Consumer Behavior. 3 credits, 3 contact hours.**
Provides students a framework, the buyer decision process model, to analyze how and why products and services are selected and purchased. Impact of consumer decisions on the marketing strategies of organizations is emphasized. Focus on quality management of the marketing function to determine customer needs; provide the appropriate products, prices, distribution systems, and promotion messages; and measure customer satisfaction after purchase and use.

**MRKT 631. Marketing Research. 3 credits, 3 contact hours.**
Provides a research and managerial perspective on advanced marketing research methods and analytical techniques. Topics include problem formulation, research design, data collection and analysis, managerial report writing. Students will acquire experience by developing and executing their own marketing research project using sophisticated computerized analytical techniques.

**MRKT 636. Design and Development of High Technology Products. 3 credits, 3 contact hours.**
Focus on analysis of needs of buyers and consumers for specific product characteristics and the development of appropriate products to satisfy such needs. The process of identifying new product opportunities, screening new product concepts, product testing and test marketing, product positioning, and development of the marketing strategy and implementation plans.

**MRKT 637. Marketing Communications and Promotions. 3 credits, 3 contact hours.**
Communications, sales promotion, and public relations are examined from the perspective of the manager. Topics include advertising and promotion research, media selection, creative production of electronic and print materials, and the budgeting and control of their use. Field research will be stressed as part of the course project requirement.

**MRKT 638. Sales Management for Technical Professionals. 3 credits, 3 contact hours.**
Focuses on the promotion and sales of products in the business-to-organization market. All elements of the marketing communications mix are covered according to their importance in that market: selling, sales promotion, trade advertising, and publicity. The latest techniques are reviewed and discussed using case histories and student projects. Issues of global competitiveness, high technology products, and the role of total quality management in marketing communications are emphasized.

**MRKT 642. International Marketing Management. 3 credits, 3 contact hours.**
Focus on multinational enterprise in the global market, emphasizing special managerial skills required to adapt sound marketing practices to foreign cultural, political, economic and financial environments. Foreign opportunities and marketing strategies are examined. Students prepare a marketing plan for entry into an international market after conducting appropriate research.

**MRKT 645. Internet Marketing Strategy. 3 credits, 3 contact hours.**
Introduction to the use of the Internet and electronic commerce in the development of marketing strategy. Examines the characteristics of electronic markets, the use of Internet for data collection and market research, the Internet as a communication and distribution medium, and the development of Internet-based marketing strategies.

**MRKT 725. Independent Study. 3 credits, 3 contact hours.**

**MRKT 753. Marketing Science. 3 credits, 3 contact hours.**
Prerequisite: MRKT 631. Emphasizes quantitative model building approach to the complex problems of marketing decision making using the principles of quantitative decisions to management problems and econometrics to the understanding of large amounts of data, which lead to improvements in marketing decision effectiveness. Such areas of marketing as buyer behavior, pricing, promotion, advertising, sales force management, and new product planning will be analyzed.

# Management

## Master of Business Administration in Management of Technology

NJIT's MBA in the Management of Technology is designed to prepare a new generation of technology savvy business leaders.The curriculum integrates fundamental business knowledge with applications of technology to business to prepare students to think strategically about business and technology.The program is built upon four themes that are transforming business:

1. the transition to a knowledge based economy;
2. the emergence of the digital firm;
3. the globalization of business; and
4. innovation as the primary source of competitive advantage.

Concentration areas are offered in Management Information Systems, Marketing, and Finance.

### Admission Requirements

Applicants to the MBA must submit complete transcripts of all undergraduate work and scores on the Graduate Management Admissions Test (GMAT). The GMAT is required of all applicants except those holding master's or doctoral degrees from an accredited U.S. university. Up to nine credits of graduate work may be transferred from another school, provided that they are not counted towards a terminal degree at that school.

MBA Pre-Qualifying Requirements : Students are expected to demonstrate competency in the area of accounting, finance, quantitive methods, information systems and economics. Depending on the applicant's undergraduate degree program all or part of the pre-qualifier requirements can be met with prior undergraduate course work. Applicants who do not meet pre-qualifying requirements will be required to complete a bridge course.

# Master of Science in Management

The Master of Science in Management is designed to allow students to build specialized knowledge in one of four concentration areas : Management Information Systems, Organization Management, Management of Technology and Finance. Specialized knowledge is augmented with a 15 credit management core that provides the general knowledge needed to manage technical and specialized units.

## Admission Requirements

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MSM Pre-Qualifying Requirements : Students are expected to demonstrate competency in the area of accounting, finance, quantitive methods, information systems and economics. Depending on the applicant's undergraduate degree program, all or part of the pre-qualifier requirements can be met with prior undergraduate course work. Applicants who do not meet pre-qualifying requirements will be required to complete a bridge course.

# Executive Master of Business Administration

Tailored to the demanding schedules of working professionals, the solution focused 18-month, 48-credit program is customized for career advancement without interruption of professional obligations.  Built upon the hallmarks of Innovation, Immersion, and Integration, this practical and results-oriented option emphasizes the application of advanced management strategies to traditional business challenges.  With the added bonus of Saturdays and on-line flexibility, the EMBA offers both breadth and depth of business experience in an accelerated mode of delivery.  Students are assigned independent and group projects emphasizing the employment of innovative management strategies in traditional corporate settings.  Further, the students represent diverse industries and job functions, providing an enriching experience and balanced perspective.  The curriculum consists of **4 Thematic Areas**: Leadership, Globalization, Creativity and Innovation, and Business and Government Relations.

EMBA candidates have the opportunity to participate in a 7-10 day international study tour.  Meeting with business leaders in their work environments, students learn first-hand the opportunities and issues posed by today’s volatile-yet-exciting international business climate.  Recent tours have included Brazil, France, The Czech Republic, Russia, Estonia, Chile, Argentina, and China.  Students have called the trips “invaluable.” *[I gained] “critical insight….we would never have learned in any classroom or textbook.”*

## Professional Leverage

The program offers the additional benefit of PMP or Risk Management certification training.  This new program feature represents an integration of the EMBA with industry recognized professional qualifications.

## Admission Requirements

These criteria are standard admission guidelines; however, each candidate is evaluated based upon his/her individual profile.

Candidates must have an earned bachelor’s degree (4 year US equivalent) and must take the GMAT (minimum score of 500); the GRE (with a comparable score) is also acceptable.

## GMAT Waivers

- Candidates with an earned Master’s or PhD from a US or Canada based “accredited" program
- Candidates with a minimum GPA of 2.8 from a US based research intensive University
- Candidates [without masters degrees], who have “significant” management experience, may appeal to the EMBA admission committee for a GMAT waiver;  **there is no waiver guarantee**.

# Master of Science in International Business

The Master of Science in International Business is designed for students to gain an understanding of the activities in international business providing a framework for understanding them from the perspective of a company manager. The MSIB is a 30 credit program (which is 10 courses)

## Admission Requirements

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MSIB Pre-Qualifying Requirements: Students are expected to demonstrate competency in the area of accounting, finance, quantitative methods, information systems, and economics. Depending on the applicant's undergraduate degree program all or part of the pre-qualifier requirements can be met with prior undergraduate course work. Applicants who do not meet pre-qualifying requirements will be required to complete up to 6 credits of course work.

# NJIT Faculty

## A

Anandarajan, Asokan, Professor

## B

Bandera, Cesar, Assistant Professor

Bonitsis, Theologos H., Associate Professor

## C

Casal, Jose C., Senior University Lecturer

Chakrabarti, Alok K., Distinguished Professor Emeritus

Chen, Yi, Associate Professor

Chou, Porchiung B., Senior University Lecturer

Cicon, James E., Assistant Professor

Cordero, Rene, Associate Professor Emeritus

## E

Egbelu, Pius J., Distinguished Professor

Ehrlich, Michael A., Associate Professor

## F

Fjermestad, Jerry L, Professor

## G

Gopalakrishnan, Shanthi, Professor

Guilbault, Melodi D., Senior University Lecturer

## K

Kudyba, Stephan P., Associate Professor

## L

Lawrence, Kenneth, D., Professor

## M

Mehta, Rajiv, Professor

## P

Passerini, Katia, Professor

## R

Rapp, William V., Research Professor

Rotter, Naomi G., Professor Emeritus

## S

Schachter, Hindy L., Professor

Schoenebeck, Karen P., Senior University Lecturer

Shi, Junmin, Assistant Professor

Somers, Mark, Professor

Sverdlove, Ronald, Assistant Professor

Sylla, Cheickna, Professor

### T

Thomas, Ellen J., Assistant Professor

### W

Walsh, Diana, Senior University Lecturer

### X

Xu, Wei, Assistant Professor

### Y

Yan, Zhipeng, Associate Professor

## Programs

- Management - M.S. (p. 1003)
- Management of Technology - M.B.A. (p. 1001)

## Executive Program (p. 596)

- Management of Technology - E.M.B.A. (p. 1000)

Business Data Science - Ph.D. (http://catalog.njit.edu/graduate/management/management/business-data-science-phd)

Management Essentials - Cert.

Management of Technology - Cert.

Finance for Managers - Cert.

International Commerce - Cert.

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**MGMT 725. Independent Study. 3 credits, 3 contact hours.**

**MGMT 726. Independent Study II. 3 credits, 3 contact hours.**

# Executive M.B.A. in Technology

(48 credits)

| **Core Courses** | | |
|---|---|---|
| HRM 601 | Organizational Behavior | 3 |
| ACCT 615 | Management Accounting | 3 |
| FIN 600 | Corporate Finance I | 3 |
| MRKT 620 | Competing in Global Markets | 3 |
| ECON 610 | Managerial Economics | 3 |
| MGMT 630 | Decision Analysis | 3 |

| | | |
|---|---|---|
| MIS 645 | Information Systems Principles | 3 |
| MGMT 692 | Strategic Management | 3 |
| **Total Credits** | | **24** |

## Concentration in Business and Government Relations

| | | |
|---|---|---|
| MGMT 656 | Public Policy and Business | 3 |
| MGMT 686 | Corporate Governance | 3 |
| **Total Credits** | | **6** |

## Concentration in Global Business

| | | |
|---|---|---|
| MGMT 641 | Global Project Management | 3 |
| MGMT 670 | International Business | 3 |
| **Total Credits** | | **6** |

## Concentration in Innovation and Business Development

| | | |
|---|---|---|
| MGMT 649 | Convention, Creativity and Innovation | 3 |
| MGMT 640 | New Venture Management | 3 |
| MGMT 650 | Knowledge Management | 3 |
| FIN 655 | Financial Innovations and Market Failures | 3 |
| **Total Credits** | | **12** |

# M.B.A. in Management of Technology

| | | |
|---|---|---|
| **Bridge Course** | | |
| MGMT 501 | Management Foundations | 3 |
| **Total Credits** | | **3** |

| | | |
|---|---|---|
| **Module I** [1] | | |
| ACCT 615 | Management Accounting | 3 |
| FIN 600 | Corporate Finance I | 3 |
| FIN 610 | Global Macro Economics | 3 |
| or ECON 610 | Managerial Economics | |
| HRM 601 | Organizational Behavior | 3 |
| MGMT 691 | Legal and Ethical Issues | 3 |
| MIS 645 | Information Systems Principles | 3 |
| or IS 677 | Information System Principles | |
| MIS 680 | Management Science | 3 |
| or MGMT 630 | Decision Analysis | |
| MRKT 620 | Competing in Global Markets | 3 |
| MGMT 692 | Strategic Management | 3 |
| or MGMT 680 | Entrepreneurial Strategy | |
| **Module II Elective Core Courses** | | |
| Select three of the following: | | 9 |
| MGMT 620 | Management of Technology | |
| MGMT 635 | Data Mining and Analysis | |
| MGMT 640 | New Venture Management | |
| MGMT 650 | Knowledge Management | |
| MGMT 670 | International Business | |
| MGMT 699 | ST: | |
| MIS 648 | Decision Support Systems for Managers | |
| EM 636 | Project Management | |
| HRM 630 | Managing Technological and Organizational Change | |

| | | |
|---|---|---|
| **Module III Concentration Courses** | | |
| Select four courses in one concentration: | | 12 |
| MIS Concentration Courses [1] | | |
| MGMT 630 | Decision Analysis | |
| MGMT 635 | Data Mining and Analysis | |
| MGMT 641 | Global Project Management | |
| MGMT 710 | Forecasting Methods for Business Decisions | |
| MIS 648 | Decision Support Systems for Managers | |
| MIS 650 | | |
| IS 631 | Enterprise Database Management | |
| IS 663 | System Analysis and Design | |
| IS 678 | IT Service Management | |
| IS 684 | Business Process Innovation | |
| IS 688 | Web Mining | |
| Finance Concentration Courses | | |
| FIN 610 | Global Macro Economics | |
| FIN 624 | Corporate Finance II | |
| FIN 626 | Financial Investment Institutions | |
| FIN 627 | International Finance | |
| FIN 634 | Mergers, Acquisitions, and Restructuring | |
| FIN 641 | Derivatives Markets | |
| FIN 642 | Derivatives and Structured Finance | |
| FIN 650 | Investment Analysis and Portfolio Theory | |
| Marketing Concentration Courses | | |
| MRKT 631 | Marketing Research | |
| MRKT 632 | | |
| MRKT 636 | Design and Development of High Technology Products | |
| MRKT 638 | Sales Management for Technical Professionals | |
| MNE 655 | Concurrent Engineering | |
| MGMT 625 | Distribution Logistics | |
| IE 659 | Supply Chain Engineering | |
| IS 664 | Customer Discovery | |
| Healthcare Management Concentration Courses | | |
| MGMT 635 | Data Mining and Analysis | |
| MIS 648 | Decision Support Systems for Managers | |
| CS 631 | Data Management System Design | |
| CS 632 | Advanced Database System Design | |
| CS 634 | Data Mining | |
| CS 639 | Elec. Medical Records: Med Terminologies and Comp. Imp. | |
| BNFO 615 | Data Analysis in Bioinformatics | |
| BNFO 644 | Data Mining and Management in Bioinformatics | |
| MATH 663 | Introduction to Biostatistics | |
| IE 686 | Intro to Healthcare Systems | |
| IE 687 | Healthcare Enterprise Systems | |
| IE 688 | Healthcare Sys Perfor Modeling | |
| MGMT 650 | Knowledge Management | |
| Cooperative Education | | |
| Innovation and Entrepreneurship Concentration Courses | | |
| MGMT 625 | Distribution Logistics | |
| MGMT 631 | | |
| MGMT 640 | New Venture Management | |
| MGMT 645 | New Venture Finance | |

| | | |
|---|---|---|
| MGMT 649 | Convention, Creativity and Innovation | |
| MGMT 688 | Information Technology, Business and the Law | |
| MRKT 636 | Design and Development of High Technology Products | |
| HRM 630 | Managing Technological and Organizational Change | |
| Custom Concentration | | |
| Select 4 elective courses | | |
| STEM-MBA Option Concentration | | |
| Select 4 elective courses | | |
| **Total Credits** | | **48** |

[1] All courses required. No substitutions.

# M.S. in International Business

*Please note that as of Fall 2013 this program is no longer admitting any new students. If you are interested in pursuing graduate studies in international Business, please consider the **MS in Management** program.*

## Degree Requirements

The bridge course is necessary if a candidate has no academic background in finance and accounting.

| | | |
|---|---|---|
| **Bridge Course** | | |
| MGMT 501 | Management Foundations | 3 |
| **Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |
| or FIN 600 | Corporate Finance I | |
| HRM 601 | Organizational Behavior | 3 |
| MGMT 692 | Strategic Management [1] | 3 |
| or MGMT 680 | Entrepreneurial Strategy | |
| **Elective** | | |
| Graduate-level course [2] | | 3 |
| **Specialization Courses** | | |
| Select six of the following: | | 18 |
| FIN 627 | International Finance | |
| EM 636 | Project Management | |
| MGMT 650 | Knowledge Management | |
| MGMT 670 | International Business | |
| MRKT 620 | Competing in Global Markets | |
| MRKT 631 | Marketing Research | |
| MRKT 642 | International Marketing Management | |
| **Total Credits** | | **30** |

[1] Should be taken only in the final semester

[2] May be course outside School of Management.

# M.S. in Management

| | | |
|---|---|---|
| **Bridge Course** | | |
| MGMT 501 | Management Foundations | 3 |
| **Core Courses** | | |
| ACCT 615 | Management Accounting | 3 |
| FIN 600 | Corporate Finance I | 3 |
| HRM 601 | Organizational Behavior | 3 |
| MIS 645 | Information Systems Principles | 3 |

| | | |
|---|---|---|
| MRKT 620 | Competing in Global Markets | 3 |
| Select 15 credits from one area: | | 15 |
| **Global Project Management** [1] | | |
| ECON 610 | Managerial Economics | |
| or FIN 610 | Global Macro Economics | |
| EM 636 | Project Management | |
| EM 637 | Project Control | |
| EM 691 | Cost Estimating for Capital Projects | |
| IE 618 | Engineering Cost and Production Economics | |
| IE 659 | Supply Chain Engineering | |
| IS 614 | Command and Control Systems | |
| IS 684 | Business Process Innovation | |
| MGMT 641 | Global Project Management | |
| **Web Systems and Media** [2] | | |
| IS 661 | User Experience Design | |
| IS 664 | Customer Discovery | |
| IS 688 | Web Mining | |
| IS 690 | Web Services and Middleware | |
| MRKT 637 | Marketing Communications and Promotions [4] | |
| PTC 601 | Advanced Professional and Technical Communication | |
| PTC 605 | Elements of Visual Design | |
| PTC 606 | Advanced Information Design | |
| PTC 650 | ELearning Design for Mobile | |
| **Business Analytics** [3] | | |
| CS 634 | Data Mining | |
| IS 631 | Enterprise Database Management | |
| IS 687 | Transaction Mining and Fraud Detection | |
| IS 688 | Web Mining | |
| MATH 661 | Applied Statistics | |
| MGMT 630 | Decision Analysis | |
| MGMT 625 | Distribution Logistics | |
| MGMT 630<br>or MGMT 662 | Decision Analysis | |
| MGMT 635 | Data Mining and Analysis | |
| MGMT 650 | Knowledge Management | |
| MGMT 710 | Forecasting Methods for Business Decisions | |
| MIS 648 | Decision Support Systems for Managers | |
| MRKT 645 | Internet Marketing Strategy | |
| **Total Credits** | | **30** |

1. One course must be either ECON 610 Managerial Economics or MGMT 641 Global Project Management
2. One course must be MRKT 637 Marketing Communications and Promotions
3. One course must be MGMT 630, MGMT 635, MGMT 710, MGMT 662, MIS 648, or MRKT 645.

# Index

## A



## B

## C

## M