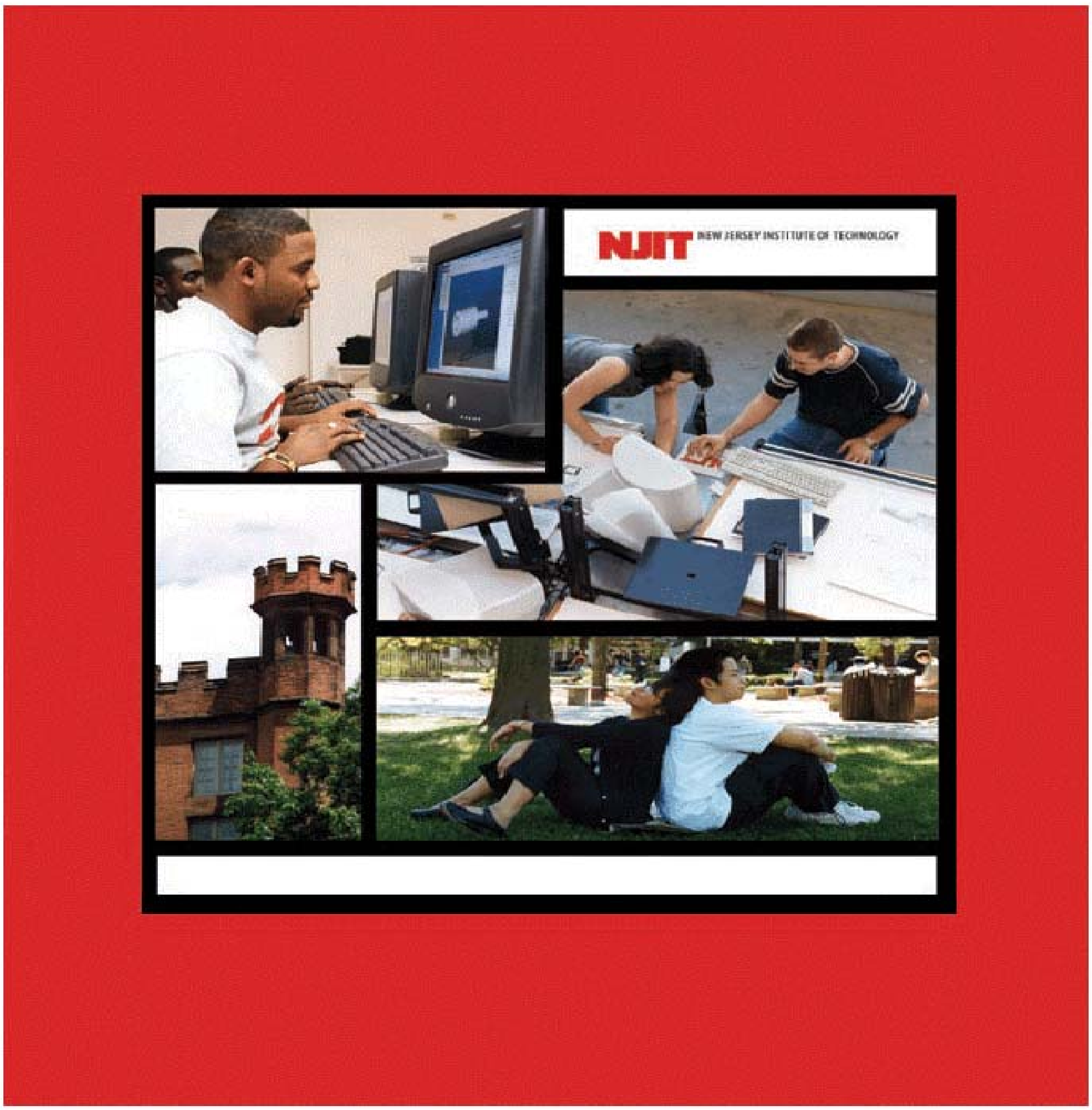
NJIT
NEW JERSEY INSTITUTE OF TECHNOLOGY

2003-2004 Graduate Catalog

About NJIT



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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. 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 fostered 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 technological universities in the nation. With more than 8,800 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 45-acre campus in Newark, and a solar observatory in Big Bear, California. With robust extension and distance education programs, NJIT's degree and non-degree programs are available throughout the state and world.

NJIT's Six Colleges

NJIT's roots are in engineering education. For more than eight decades, 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.

NJIT's New Jersey School of Architecture, established in 1974, is one of the largest architecture schools in the nation and is nationally recognized for the innovative integration of computer technology into the design curriculum.

The College of Science and Liberal Arts (CSLA), established in 1982, is moving into the forefront of many national research activities from solar astronomy to mathematical modeling. CSLA provides students with the skill sets for the professional marketplace, including literacy in the mathematical, physical and biological sciences, as well as traditional liberal arts disciplines.

The School of Management, established in 1988, combines the best of traditional business disciplines (e.g., finance, marketing, accounting, e-commerce) with the power of information and technology management to develop professionals who can manage and communicate effectively.

The Albert Dorman Honors College, established in 1993, 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.

The College of Computing Sciences, established in 2001, has one of the largest educational programs in the nation, with 2,400 students in 13 degree programs.

Computing-Intensive Campus

As one of America's most computing-intensive universities, NJIT is nationally recognized as a pioneer in the use of information technologies from developing algorithms to reduce simulation times on large-scale parallel computers, to advancing the frontiers of visualization technology, to patenting optics-based sensors, to developing computer-based infrastructure management systems, to developing advanced computer-mediated communication systems.

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. Indeed, computing and information technology underpin every facet of the NJIT mission.

NJIT is designated as a "Research Intensive" University by the Carnegie Foundation and ranks in Tier 2 among the "best national universities" by *U.S. News and World Report.* The university expends more than $50 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 the biosciences, manufacturing, microelectronics, multimedia, transportation, computer science, solar astrophysics, environmental engineering and science, and architecture and building science.

NJIT Mission Statement

NJIT is **a public, urban, 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.
- The conduct of **research** in such multidisciplinary areas as environmental engineering, materials science, manufacturing, productivity enhancement, infrastructure systems, communications technologies, and an array of biorelated sciences and technologies.
- Contributing to the state's **economic development** through partnerships and joint ventures with the business community and through the development of intellectual property.
- **Service** to both local communities 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.

Information Services and Technology Resources

NJIT's information services and technology resources provide 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. In 1998 and again in 1999, Yahoo! Internet Life magazine ranked NJIT America's "most wired" public university in the nation for the use of technology as measured by a set of indicators that include academics, student services, communications and technology infrastructure. Students have the opportunity to experience many aspects of a "virtual university." The latest advances in telecommunications and multimedia technology enhance the delivery of courses and overall educational experience for all students. As a member of the Internet2 research consortium, students have the opportunity to work closely with faculty and researchers as new families of advanced networking applications are developed for the new millennium. NJIT operates an on-campus PC store where all students, faculty and staff may purchase PC hardware and software, and a PC maintenance facility for service and support.

Computers and information technology play an important role in virtually every task performed on campus, from cutting-edge research to parking-space reservations. Computers assist in teaching and independent study, campus communications, library research, engineering and architectural designs. Computers allow students to register for classes and choose course schedules and ask questions of academic advisors. 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.

The Newark campus' ATM network backbone connects more than 3,900 nodes in classrooms, laboratories, residence halls, faculty and staff offices, the library, student organization offices and others. The network provides access to a wealth of shared information services. Some of these include high-performance computer servers providing CPU cycles for simulation and computational research, disk arrays for storage of large data sets, communication servers for electronic mail and document exchange, databases, digital journal subscriptions and a virtual "Help Desk." A virtual private network combined with Internet access, plus a large ISDN modem bank, extend access to campus information resources to faculty, staff and students at home, work, any of the university's extension sites, or throughout the world.

Primary academic computing is provided via a distributed computing environment using the Andrew File System (AFS). Students receive a single log-on account that provides access to hundreds of UNIX and NT-based workstations on the campus network for programming, computation, Internet access, graphics and visualization facilities and many other applications. Powerful statistical analysis software is provided on a separate VMS computing system. The Academic Computing lab in the Student Mall has several hundred PCs for student use. Additional PC clusters are available in the Honors Center, the Robert W. Van Houten Library, the University Learning Center and many departmental facilities.

NJIT is home to the EIES/VC Virtual Classroom® conferencing system, one of the first computerized conferencing systems to be used for distance education. Each semester, more than 2,000 students use the Virtual Classroom® system as a meeting place for class group discussion.

The Van Houten Library’s Information Commons provides a convenient and relaxed atmosphere to search the Web, access electronic databases, view videotapes and other electronic archives of class lectures, or retrieve scholarly publications through digital library subscriptions. Reference librarians are available to help students sort through the vast amounts of information resources available and access what they need.

The Office of Instructional Technology and Media Services provides several facilities used for live and taped broadcast of telecourses as well as satellite downlinks for a wide variety of video teleconferences and other educational and public service satellite broadcasts. Several interactive television studio classrooms provide distance learning facilities.

In addition to these extensive resources, several departments have special facilities for the support of individual academic programs, including the 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.

All students and faculty are encouraged to make full use of computing facilities including e-mail and personal Web pages. Students may obtain accounts by following an online tutorial in one of the many computer labs. Once an account is set up, students may take advantage of an online, self-registration system to enroll in courses for subsequent semesters. NJIT alumni are eligible for lifetime e-mail.

Library Services

The university's Robert W. Van Houten Library is located in the Central Avenue Building. Erected in 1992, the Van Houten Library provides a modern facility for individual and group study, research and browsing. The library has a collection of more than 150,000 books, and subscribes to more than 1,000 printed periodicals and about 8,000 electronic journals. These electronic databases are accessible from any computer on NJIT's campus, and any member of the NJIT community (student, faculty or staff) has access to these databases from a remote location via NJIT's Virtual Private Network (VPN). The library's home page provides access to NJNEER, the library's electronic catalog, NJNEER Web, the new Web version of the catalog and links to a wide array of information services.

The library's Information Commons, located on the first floor, is designed to provide a unique variety of services to satisfy student information needs. Commons workstations have computers for searching Web sites, computers for searching the NJNEER online and Web catalogs, and access to a variety of online journal databases, many providing full-text articles. VCRs for viewing videocassettes reserved for courses are also available, as are computers with word processing and other services. A student user manual describing library services is available at the library's circulation and reference desks.

Journal and conference literature in engineering, science, management, architecture and other subject areas is accessible through a variety of indexing and abstracting publications, in both print and electronic format. Frequent review of available electronic databases has resulted in a huge increase in the number of electronic journals available to library users. Among the online databases recently added to the library's collection are Lexis-Nexis Academic Universe (access to the world's leading legal, news, medical and business resources) and JSTOR (a full-text database of more than 100 scholarly journals in economics, ecology, statistics, mathematics, history and philosophy). UnCover, a document delivery service that faxes articles within 48 hours, is available through our Interlibrary Loan/Document Delivery Service.

The librarians provide individualized reference services, literature searches and instruction in the use of information resources. There are five technical reference librarians providing such services, each holding a master's degree in library science and, among the group, degrees in chemistry, industrial engineering, information science, art, mathematics and liberal arts. They also act as liaisons to NJIT academic departments in materials selection and assistance. The Architecture Library, a branch of the Van Houten Library, is located on the fourth floor of Weston Hall, part of the Architecture and Building Sciences Complex. The collection includes more than 13,500 volumes of books and journals, nearly 80,000 slides, and more than 1,000 maps in addition to product catalogs, videotapes, CD-ROMs, models, portfolios and theses. The makeup of the collection is primarily architecture including history, theory, design and practice and secondarily art, design, structures and planning. Access to the architecture journal articles is provided by the Avery Index to Architectural Periodicals and the Art Index on the Web. All online sources are available in the Architecture Library as well as in the main Van Houten Library.

In addition to NJIT's libraries, students have access to nearby Rutgers-Newark's Dana Library, UMDNJ's Smith Library, and Newark Public Library. Students may also borrow from the libraries of Jersey City University, Kean University, Ramapo College, Rowan University, Stockton State College, William Paterson University, College of New Jersey, and Montclair State University.

More information about the library can be found at http://www.njit.edu/Library/Welcome.html or by calling (973) 596-3210 (reference desk), (973) 596-6371 (circulation desk).

Consortium with Rutgers-Newark and UMDNJ

NJIT, Rutgers-Newark and UMDNJ, New Jersey's university of the health sciences, offer 10 joint bachelor's 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, multisponsor 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 and Rutgers-Newark take courses at both institutions. In addition, the two universities cosponsor common seasons of theatrical productions, as well as "World Week," and a variety of other cultural and social activities.

NJIT at Mount Laurel

Students may earn a master’s degree in a variety of degree programs by attending NJIT at Mount Laurel. Centrally located in Burlington County, NJIT at Mount Laurel offers courses at the new state-of-the-art Technology and Engineering Center, one of South Jersey’s finest educational facilities, operated jointly by NJIT and Burlington County College. Students can complete master’s degrees in computer science, electrical engineering and engineering management. Specialized classes via distance learning, graduate certificate programs and continuing professional development courses are also offered at NJIT at Mount Laurel. For additional information about graduate programs at this branch campus, call 1 (800) 222-NJIT.

Continuing Professional Education

NJIT's Division of Continuing Professional Education provides enriching career-long learning opportunities through Extension Programs, ACCESS/NJIT eLearning, Graduate Certificates, and through its non-credit technical programs, Professional Development Training and Corporate Customized Training.

Twelve-credit graduate certificates, which are also applicable to NJIT master's degrees, are available to those seeking a career upgrade and change. Certificates can be acquired in one calendar year by attending classes on campus, at extension sites or via eLearning.

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, one CEU is defined as being equal to classroom hours. Taught throughout the year, individual classes typically last one to five days. Certificates and license review programs can entail a significant number of hours of instruction spanning several months.

NJIT's Division of Continuing Professional Education's non-credit training programs are available via both classroom and instructor-led eLearning virtual classrooms. Typical topics include computer and technology; and safety and environment.

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 non-credit courses that meet technology-based organizations' needs for high-quality, lifelong workforce education. More than 375 courses are available in 17 subject areas.

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

Extension Programs

Students may take courses and earn degrees throughout the state at NJIT's extension sites listed below. Admissions requirements and the quality of instruction are the same for on-campus and extension programs. Registration, advisement and support services are available at each site.

Atlantic County at the FAA Technical Center: courses leading to completion of a Master of Science in Computer Science and in Information Systems.

Burlington County at NJIT's Mount Laurel campus: Master of Science degrees are available in Computer Science, in Engineering Management, and in Information Systems.

Mercer County at the Department of Transportation: courses leading to the completion of a Master of Science in Transportation.

Mercer County at the Department of Environmental Protection: courses leading to the completion of a Master of Science in Environmental Science.

Somerset County at Raritan Valley Community College: courses leading to the completion of a Master of Science in Management.

The Office of Extension Programs also offers graduate courses on-site at technology-based organizations, including Chubb Institute, National Starch and Chemical Company, Stryker Howmedica Osteonics, Telcordia Technologies, Wyeth Pharmaceuticals and others. These courses are available only to the employees of the host corporations.

For more information about these and other off-campus programs, call the Division of Continuing Professional Education at (973) 596-3640.

ACCESS/NJIT eLearning

ACCESS/NJIT provides students the opportunity to earn college credit through enrollment in online electronic-based courses. Each online course combines video media with electronic interaction primarily through Web-based and computerized conferencing under the management of an NJIT course mentor. Online courses are flexible and rigorous educational experiences suited to motivated students.

The program's reach is nationwide and international. Course material is transmitted through the Internet, cablecast, wireless cable, compressed digital teleconferencing, CD Rom and VHS tape distribution. In addition, ACCESS/NJIT originates programming for the National Technology University, a provider of graduate courses for technological professionals.

ACCESS/NJIT offers three graduate degrees (M.S. in Engineering Management, M.S. in Information Systems and M.S. in Professional and Technical Communications), four undergraduate degrees (B.S. and B.A. in Information Systems, B.S. in Computer Science and B.S. in Information Technology), select Graduate Certificates, and courses in many disciplines including the physical sciences, computer science, mathematics, engineering and management. ACCESS/NJIT offerings are listed in the Continuing Professional Education (CPE) Catalog, available upon request from the Division of Continuing Professional Education and via the NJIT Web site, www.njit.edu/dl.

ACCESS/NJIT furnishes a convenient alternative to distance learners and students who have scheduling conflicts.

In addition, any NJIT student needing course review can use ACCESS/NJIT course material. Several campus workstations in the Van Houten Library are set up for viewing.

For more information, contact the Division of Continuing Professional Education at (800) 624-9850.

Graduate Studies

NJIT offers advanced studies in numerous disciplines leading to master's degrees, doctoral degrees and graduate certificates. Programs are available to full-time students and to working professionals who are interested in part-time study. Some programs are offered in cooperation with Rutgers-Newark and with UMDNJ as part of continuing collaborations within The Graduate Center at Newark.

Full-time students are involved in the university's extensive research activities through association with renowned faculty and research centers. Financial support is available through a variety of programs that permit students to become part of the teaching, administrative and research functions of the university. Other non-service-based support is also available.

Graduate Degrees

The doctoral and master's degree programs offered at NJIT are listed below. All doctoral programs lead to the doctor of philosophy; master's programs lead to the master of science with the exception of the Master of Architecture, the Master of Arts in History, the Master of Business Administration in Management of Technology, the Master in Infrastructure Planning, and the Master of Public Health. Dual degree offerings are available for M.Arch./M.S. in Civil Engineering, M.Arch./Master in Infrastructure Planning, and M.Arch./M.S. in Management. Other degree options include the B.S./M.S., the M.S./M.S., the Executive M.B.A. Program, and the Collaborative Doctorate. The degree program descriptions are specified in the NJIT graduate catalog, http://www.njit.edu/catalog.

Applied Chemistry (M.S.)	Applied Mathematics (M.S.)
Applied Physics (M.S., Ph.D.) joint with Rutgers-Newark	Applied Science (M.S.)
Applied Statistics (M.S.)	Architecture (M.Arch.)
Architectural Studies (M.S.)	Biology (M.S., Ph.D.) joint with Rutgers-Newark
Biomedical Engineering (M.S.)	Biomedical Informatics (M.S., Ph.D.) joint with UMDNJ
Business Administration in Management of Technology (M.B.A.)	Chemical Engineering (M.S., Ph.D.)
Civil Engineering (M.S., Ph.D.)	* Computational Biology (M.S.) joint with Rutgers-Newark
Computer Engineering (M.S., Ph.D.)	Computer and Information Science (Ph.D.)
Computer Science (M.S., Ph.D.)	Electrical Engineering (M.S., Ph.D.)
Engineering Management (M.S.)	Engineering Science (M.S.)
Environmental Engineering (M.S., Ph.D.)	Environmental Policy Studies (M.S.)
Environmental Science (M.S., Ph.D.) joint with Rutgers-Newark	History (M.A.) joint with Rutgers-Newark
* Logistics Engineering (M.S.)	Industrial Engineering (M.S., Ph.D.)
Information Systems (M.S., Ph.D.)	Infrastructure Planning (M.I.P.)
Interdisciplinary Studies (M.S.)	* Internet Engineering (M.S.)
Management (M.S.)	Manufacturing Systems Engineering (M.S.)
Materials Science and Engineering (M.S., Ph.D.)	Mathematical Sciences (Ph.D.) joint with Rutgers-Newark
Mechanical Engineering (M.S., Ph.D.)	Occupational Safety and Health Engineering (M.S.)
Occupational Safety and Industrial Hygiene (M.S.)	Pharmaceutical Engineering (M.S.)
Professional and Technical Communication (M.S.)	Public Health (M.P.H.) joint with Rutgers-Newark and

	UMDNJ
Telecommunications (M.S.)	Transportation (M.S., Ph.D.)
* Urban Systems (Ph.D.) joint with Rutgers-Newark and UMDNJ	

* pending approval

Graduate Certificates

Twelve-credit graduate certificates are offered in "fast track" professional fields externally validated with expanding employment opportunities. The following list is the current selection of Graduate Certificates:

Bioinformatics
Business Management Fundamentals
Construction Management
Information Assurance
Information Systems Auditing
Information Systems Design
Information Systems Implementation
Internet Applications Development
Management of Technology
Operations Productivity
Pharmaceutical Management
Pharmaceutical Technology
Practice of Technical Communications
Project Management
Sustainable Architecture
Telecommunications Networking
Virtual Tools for Professional Communities

Graduate Student Association

The Graduate Student Association was founded in 1983 to promote the interests of graduate students, enhance program quality, foster student-faculty communication, and provide for the needs of advanced degree students. All students currently enrolled in NJIT graduate degree programs and paying the Graduate Student Association fee are members of GSA. A current graduate student and an alternate from each degree program are represented on the GSA Council. Students interested in serving on the council or learning more about GSA should contact the GSA office (973) 596-2993 or the Office of Graduate Studies (973) 596-3462. The dean of graduate studies is the GSA advisor.

Graduate Honor and Professional Societies

Alpha Epsilon Lambda Honor Society

The Sigma Chapter of Alpha Epsilon Lambda, the National Honor Society for Graduate and Professional School Students, was established in 1995 at NJIT and is the first chapter in New Jersey. Membership is based on standards of scholarship, leadership and character, and is by invitation. Contact the Dean of Graduate Studies, (973) 596-3462, for more information.

Other Honor and Professional Societies

Each program offering graduate degrees at NJIT will have information about honor and professional societies open to graduate students in particular disciplines. Contact the dean of the appropriate school or college or the dean of graduate studies for further information. NJIT also has active chapters of Omicron Delta Kappa, a service-oriented society, and Sigma Xi, which focuses on research.

Alumni Association

The Alumni association of NJIT is a not-for-profit organization that works in partnership with the university family to promote and support NJIT. The Association maintains a relationship with alumni to provide them with a voice and a means of fellowship and growth.

The association offers numerous programs and services: free and lifetime use of the university's computer network and e-mail service, including the association's home page on the NJIT Web site; seminars and business forums; a variety of annual award programs to recognize the accomplishments of NJIT's constituency, students and faculty members; the annual Financial Aid Scholarship Program that provides needed aid for aspiring NJIT students; grants that provide financial support and recognition to NJIT organizations and departments; development and support of U.S. and international association chapters; free subscription to the association newsletter; free miniature copy of the student's diploma upon graduation; access to the A.J.J.A. Wilson Alumni Center's seminar/conference rooms and lounge, the Robert W. Van Houten Library, and the gymnasium facilities, pool and tennis courts.

The Alumni Association works closely with the Division of Career Development Services to assist alumni faced with unemployment, early retirement, and second careers.

Child Care Center

The NJIT child care center, currently operated by Childtime Children's Centers Inc., is located on the first floor of NJIT's Enterprise Development Center II building, 105 Lock Street. The center is available to children of NJIT employees and students, employees of tenants in the university's incubator program and residents in the neighboring community. The center is licensed by the State of New Jersey.

The center is for children age 6 weeks to 5 years. Programs and activities are divided into levels for infant, young toddler, toddler, young preschooler and preschooler. Developmentally appropriate activities for each age group include hands-on pre- math, science, language and reading activities. An after-school program is also offered to children ages 5 through 13.

The center operates year-round, 6:30 a.m. to 6:30 p.m. Monday through Friday, excluding university holidays. For further information, call Childtime Children's Centers Inc. at (973) 645-0442.

NJIT Campus

Located in the University Heights section of Newark, NJIT's 45-acre campus is adjacent to the campuses of Rutgers-Newark and Essex County College and a short distance from UMDNJ. 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 5 minutes from campus and Newark International Airport is within 5 miles of NJIT.

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. A new student center is under construction.

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 computer and information science, 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 Pub. 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 close to 1,200 students.

A Look at Student Life

NJIT offers a wide range of extracurricular programs from sports to professional societies.

NJIT has an extensive intercollegiate sports program. Men's sports are baseball, basketball, fencing, judo, soccer, swimming, tennis and volleyball. Women's sports include basketball, fencing, judo, swimming, tennis and volleyball. The intramural program includes all sports available at the intercollegiate team level plus track and field, racquetball, flag football, badminton, softball and archery.

There are 15 social fraternities, most with residential facilities, and 9 sororities, 10 honor societies and 27 professional recognition societies. The latter include Tau Alpha Pi, Phi Eta Sigma, Tau Beta Pi, Sigma Xi, Alpha Epsilon Lambda, and the American Chemical Society, the American Institute of Aeronautics and Astronautics, the Society for Technology, the Society of Women Engineers, and the Society for Advancement of Management, to name a few. There is an active professional society for almost every major field of study offered by the university.

The Student Senate administers a wide range of programs through the Student Activities Council, various honor societies, and the Cabinet for Professional Societies and Cultural Organizations. Some of these activities include chess, lacrosse, the Vector newspaper, the Nucleus yearbook, ham radio, photography, theater and radio broadcasting. Graduate students also enjoy participating in the NJIT chapter of Pugwash USA and Computer Club 2 (YACC2).

NJIT is within walking distance of the Newark downtown area and nearby campuses, which, along with NJIT, are located in Newark's University Heights section. Students may take advantage of Newark's nationally ranked museum, library, Symphony Hall, and New Jersey Performing Arts Center (NJPAC) and may enjoy the city's burgeoning art and jazz scene. In addition, students have easy access to the vast cultural resources of the New York/New Jersey metropolitan area. NJIT is only 20 minutes from midtown and downtown Manhattan, and the city is easy to reach by bus, train or car. A joint Rutgers/NJIT shuttle bus provides regular free commuting service to principal transportation centers.

There are frequent distributions of discount tickets to shows, museums, concerts and sports events. The Student Activities Council and many professional and cultural organizations follow their various interests on weekend trips throughout the Northeast United States.

And there's the Hazell Center, where students gather to eat, plan programs and activities, socialize, work on publications, bowl, shoot pool, watch movies, play chess or just relax. NJIT provides an environment in which students may learn not only in the classrooms and labs but on the playing field; not only from their faculty but from each other.

Staff from the Office of the Dean of Student Services are available until 5:45 p.m. Tuesday through Thursday to provide information to evening students. Quarterly throughout the year, evening students are mailed a schedule of special events and academic workshops. The Counseling Center is open weekdays, including evening hours, to provide counseling, psychological services or referral for adult students who face stress from academic, personal or employment responsibilities.

Student Services

The dean of student services administers and coordinates the activities of the Student Services Division, including the Hazell Center, the Counseling Center, Health Services, Residence Life, the University Learning Center and the University Research Experience. Special services for evening and disabled students are provided. The office also is the liaison for Food Services, The Pub and the NJIT Bookstore.

The office is located in Student Services, Campbell Hall. The phone number is (973) 596-3466/3470.

The Hazell Center

The buildings in NJIT's $83 million campus construction program are beginning to take shape as the university community looks forward to the September 2003 completion date. The centerpiece is a new four-story student center with an outdoor roof garden with seating, a two-story student lounge and an expanded woman's center. Additional features will include a bookstore, a convenience store, six-lane bowling alley and computer center.

The Hazell Center is a place for cultural, educational and social activities for the NJIT community. The Hazell Center staff strives to provide students, faculty and staff with a relaxing environment where they can enjoy a meal, study, watch a film, play billiards or a variety of other games, participate in the many activities offered or just socialize with friends. The Offices of Student Activities, Greek Life, Women's Center and Miniversity are located within the building. The center also houses a wide variety of student clubs and organizations including the Student Senate, Graduate Student Association (GSA), Student Activities Council (SAC), university newspaper (Vector), yearbook (Nucleus) and radio station (WJTB). More than 50 student-run cultural, professional, special interest and social clubs and organizations share office space in the Hazell Center.

On the lower level of the center is a recreation area with bowling, billiards, table tennis and video games. A variety of tournaments is offered each semester. The majority of student organization offices, radio station WJTB and The Pub are also located on the lower level. The main level of the center houses the Food Court, Student Dining Room, Information Desk and offices of the director of the Hazell Center, assistant director for Greek Life and the reservation manager. The second floor of the center houses the offices of the associate director for student activities, the Women's Center, Miniversity and several student organizations. This floor also contains the Ballroom, which is used for a variety of large events, several meeting rooms, an art gallery and the Faculty/Staff Dining Room.

The Hazell Center Information Desk personnel provide information about the campus, community events and public transportation. The Information Desk also has a university telephone directory, campus maps, discount tickets for Broadway shows, postage stamps and mail service. Two computers are provided for students to check class schedules, grades and registration information. The Hazell Center Office also provides fax service for a nominal charge. The phone number for the Information Desk is (973) 596-3605.

The Constance A. Murray Women's Center

The Constance A. Murray Women's Center provides a hospitable environment for all women at NJIT. Located on the second floor of the Hazell Center, the women's center offers a wide range of resources, including a multimedia library, computer workstations and access to a World Wide Web database about women in technology. The center contains space for small group meetings, study, tutoring and research. It provides a forum for women to discuss matters of mutual concern, including issues related to the academic and social environment at NJIT. It sponsors programs and events especially designed to facilitate mentoring and career networking among women. The center also supports research about women and technology and fosters efforts to explore the continued integration of gender into the curriculum. The lounge/study area is open to all members of the NJIT community daily, Monday through Friday.

International Students

The Office of International Students and Faculty offers numerous services and programs to aid students in their adjustment to NJIT. Because immigration regulations frequently change, affecting the status of students, all international students holding non-immigrant visas (especially F and J visas) must attend a mandatory orientation program prior to the beginning of their first semester. F-1 and J-1 students must maintain full-time registration (12 credits per semester), except for special cases as defined by immigration regulations. Students on dependent visas (such as F-2, J-2 and H-4) should consult with the Office of International Students and Faculty if change in status or full-time study is contemplated. The office is located in Eberhardt Hall, Room B10. The phone number is (973) 596-2451.

Students with Disabilities

The coordinator of Student Disability Services assists students with disabilities in the NJIT Counseling Center. Assistance services may include: providing general information; counseling; coordinating academic accommodations such as special testing arrangements or adaptive equipment; coordinating the provision of auxiliary services such as note takers, sign language interpreters, readers; and liaison with faculty, staff and other agencies. Services are provided to students with documented disabilities and require meeting with the coordinator, submitting documentation and completing appropriate forms. For further information or to discuss accommodations, please contact the coordinator of student disability services in the Counseling Center. The Counseling Center, located in Student Services, Campbell Hall, is open from 8 a.m. to 6 p.m. Monday through

Thursday and 8 a.m. to 5 p.m. Friday during fall and spring semesters; from 8 a.m. to 5 p.m. Monday through Thursday and 8 a.m. to 4 p.m. Friday during summer sessions. The phone number is (973) 596-3414. Scheduling an appointment is important to ensure availability and make arrangements for appropriate accessibility.

Immunizations

The State of New Jersey and NJIT require all students to submit proof of having two doses of measles vaccine and one dose each of mumps and rubella vaccine. A tuberculin test (PPD) and entrance physical exam also are required. If documentation is unavailable then re-immunization is required. Contact the Office of Health Services for further information.

Health Insurance

The State of New Jersey and NJIT require all students enrolled full-time and all international students to maintain health insurance coverage that provides basic hospital and medical benefits. Coverage must be maintained throughout the student's enrollment. Insurance may be provided by the student or may be purchased through the university. Students may waive participation in the NJIT plan for the full academic year. To waive insurance, the student must complete a waiver form and submit it to Health Services within the 30-day enrollment period at the beginning of the semester. Waiver forms and insurance brochures are available in the Office of Health Services. International students with J-1 visa status must be covered by an insurance package at all times as specified by the U.S. Department of State, which generally exceeds NJIT's plan coverage. Further information about required coverage and/or enrollment can be obtained from the Office of International Students and Faculty. Part-time students also may purchase health insurance through NJIT within the 30-day enrollment period at the beginning of the semester. Insurance also may be purchased for dependents.

Health Services

To function well in a college setting, a student must be physically healthy. To ensure the good health of our students, the Office of Health Services provides primary health care to all enrolled students who have submitted a complete medical examination form. Services offered to eligible students include the assessment and treatment of health problems and injuries, laboratory tests, health counseling and education. Referrals are made to area hospitals, physicians and other resources when necessary. The office also coordinates mandatory immunization requirements, which apply to all students. Information on immunization requirements is available at the Office of Health Services. The office is open 8:30 a.m. to 4:30 p.m., Monday, Wednesday and Thursday, and 8:30 a.m. to 6 p.m. Tuesday and Friday during fall and spring semesters. Physicians are available for consultation in the Office of Health Services by appointment during the academic year. Summer hours are 9 a.m. to 4 p.m., Monday through Friday. Health services staff may be reached at (973) 596-3621.

Counseling Center

The Counseling Center, staffed by experienced psychologists and professional counselors, provides services for students seeking psychological, academic and substance abuse counseling. In addition to the professional counseling staff, a psychiatrist is available for consultation as needed. The Counseling Center also offers workshops on different topics, maintains a library of career and graduate school information, coordinates services for students with disabilities and administers supportive testing. Students are welcome to come in and browse through the informational materials or call for an appointment with a counselor. Office hours are scheduled so that services are also accessible to adult evening students.The Counseling Center is open from 8 a.m. to 6 p.m. Monday through Thursday and 8 a.m. to 5 p.m. Friday during fall and spring semesters; from 8 a.m. to 5 p.m. Monday through Thursday and 8 a.m. to 4 p.m. Friday during summer sessions. The Counseling Center offers professional counseling to adult students facing stress from academic, personal, family or employment responsibilities. Counseling services are confidential, with limited exceptions. Call us at (973) 596-3414 for an appointment. The center is located in Student Services, Campbell Hall.

Stop-In Center

The Stop-In Center, staffed by trained student peers, provides on-the-spot information and assistance about all aspects of college life. Peer counselors are prepared to talk with fellow students about a wide range of questions or concerns — academic or personal — as well as provide relevant information. If they are unable to resolve a problem directly, they refer students to the person or office that can. No appointment is necessary and students are invited to stop by (downstairs in the Hazell Center, Room 021) and become familiar with the staff and services available. The phone number is (973) 596-3422 and the Stop-In Center is open weekdays during the fall and spring semesters.

Residence Life

NJIT provides on-campus housing for undergraduate and graduate students. The residence halls have 24-hour security at the front desk. Full-time professionals and student staff maintain the residence halls.

Redwood Hall is a coed facility that houses 210 freshmen and some sophomores in double rooms. There are two large bathrooms on each floor and a microwave in the kitchen located on the first floor.

Cypress Hall is a coed facility that houses 420 sophomore, junior, senior and graduate students in two-room suites and single rooms. Single rooms are reserved for students with disabilities. Each suite has a shared bath, and single rooms have private baths. There are common lounges and kitchenette facilities on each floor. Each lounge has a microwave that is always accessible.

Oak Hall is a coed facility that houses 238 junior, senior and graduate students in furnished double and triple rooms and five-person apartments. Each apartment has a kitchen and bath. A floor has been designated for graduate students. The five-person apartment consists of a bathroom, a lounge that includes a kitchen and two bedrooms to be shared by the five students (two in one bedroom and three in the other). The double and triple rooms include a kitchen and a bathroom to be shared with the adjacent room.

Laurel Hall is a coed facility that houses 298 sophomore, junior, senior and graduate students in two-room suites of various combinations. Single rooms are reserved for upper division and graduate students. Each suite has a shared bath. There are common lounges and kitchenette facilities on each floor. Each lounge has a microwave oven.

Each residence hall provides PC connectivity to on-campus academic computing resources and the Internet.

Students may apply for on-campus housing after being accepted for admission. Residence hall contracts are for the entire academic year. A number of spaces are reserved for new students each year.

Students who are accepted for admission to NJIT will receive information from the Office of Residence Life describing the procedure for applying for space in the residence halls.

Evening Students

Office of the Dean of Student Services staff members are available until 5:45 p.m., Tuesday through Thursday, to provide advisement and needed information to evening students. The Counseling Center is open to evening students until 6 p.m., Monday through Thursday and until 5 p.m. Friday during fall and spring semesters, offering confidential professional counseling to adult students who face stress from academic, personal or employment responsibilities. Many other offices, including the Registrar's Office, remain open after regular hours to assist students taking evening courses. Students should contact individual offices to determine availability.The Hazell Center features weekly films and activities in the evening. All forums are held in the evening to allow evening students' participation.

Food Services

Three student-dining facilities are located in the Hazell Center. NJIT's private food services vendor, Gourmet Dining Services, operates the Student Dining Room and the Food Court. Students who choose to purchase a meal plan can sign up for one of five options at the Gourmet Dining Services office. The Student Dining Room offers breakfast 7:30 a.m. to 9:30 a.m., lunch 11:30 a.m. to 1:30 p.m., and dinner 4:30 p.m. to 6:30 p.m., Monday through Friday, and brunch 11 a.m. to 1 p.m. and dinner 4:30 p.m. to 6 p.m. on Saturday, Sunday and holidays. Students dining here are permitted to eat as much as they want for one price. Payment is either by cash or through the meal plan. Food cannot be taken out. The Food Court is open 7:30 a.m. to 10 p.m., Monday through Friday, 8:30 a.m. to 8:30 p.m. on Saturday and is closed on Sunday. The Food Court is open to the entire community. Cash or the student meal plan can be used for payment. Students choose from a variety of dining options: Taco Bell, Nathan's Finest, gourmet pizza bar, and a made-to-order pasta station and deli section. A full salad bar also is available. Food may be eaten at the Food Court or carried out. The Pub, located in the lower level of the Hazell Center, is operated by a non-profit corporation. The Pub offers sandwiches and snacks, and, to those 21 years of age or older, beer and wine. Student meal cards are not accepted at The Pub.

Physical Education and Athletics

The Division of Physical Education and Athletics encourages students to develop individual physical skills that can be used throughout life, and provides a variety of programs that will meet the diverse needs and interests of the

NJIT community. These include programs of skills instruction, intramural and intercollegiate competition, sports clubs and open recreation. The Estelle and Zoom Fleisher Athletic Center houses a swimming pool; locker rooms; Fleisher fitness center with a 1/16-mile indoor track; an athletic training room; dance, exercise and fencing areas; conference and audio/visual rooms; four racquet sport courts; and three gymnasia. Lubetkin Field is a multipurpose, lighted recreational area with a regulation soccer field, softball and baseball fields and a jogging area. There are four lighted tennis courts behind the athletic center. Recreational areas are open from 7 a.m. to 11 p.m. Monday through Friday, from 9 a.m. to 7 p.m. on Saturday, and from noon to 9 p.m. on Sunday. For information, contact the division office in the Physical Education Building. The phone number is (973) 596-3636.

Division of Career Development Services

The Division of Career Development Services (CDS) is responsible for Career Planning and Placement, Cooperative Education and Internships, Student Employment, Community and Public Service, and Alumni Career Services. Students may utilize these services by calling CDS at (973) 596-3100 to schedule an appointment, or stop by to find out if a career counselor is available. Several services are available online at *www.njit.edu/CDS.* After registering for this free service, students can connect to several career-related hyperlinks to browse job openings in several majors and concentrations. Online help is available for those who need assistance.

Community and Public Service

See the Academic Programs section in this catalog for more information.

Cooperative Education and Internships

See the Academic Programs section in this catalog for more information.

Career Planning and Placement

The Division of Career Development Services offers students a broad range of career investigation and preparation services. Included are career advising, career development workshops led by staff and industry representatives, job fairs, access to the Career Resource Center, career counseling, and on-campus recruitment by a wide range of prospective employers. Access to information is provided on site and remotely through the CDS Online Internet service. In addition, the office maintains full-time job listings. SIGI+, a computerized career assessment instrument, and company information are located in the Career Resource Center. The center is open Monday through Thursday, 8:30 a.m. to 6 p.m., and Fridays, 8:30 a.m. to 4:30 p.m.

For more information, contact the Division of Career Development Services, (973) 596-3100 or *www.njit.edu/CDS.*

Student Employment

The Office of Student Employment offers services and programs to help NJIT students earn money to finance college expenses and acquire practical work experiences through part-time and summer employment. Opportunities are provided for on-campus and off-campus employment for eligible students in all academic disciplines. Through the student employee training and development service, students are helped to succeed on the job. Students may participate in the following programs.

Federal Work Study (FWS)

Students who are U.S. citizens or permanent residents and have received a FWS allocation as a part of their Financial Aid award are eligible to participate. Students may earn up to the amount specified on the award letter from the Financial Aid Office. FWS jobs are available both on- and off-campus.

University Work Study (UWS)

UWS provides on-campus employment opportunities for NJIT students not eligible for the FWS program. Students must be enrolled full- or half-time, accepted into a degree-granting academic program and attending classes to apply for UWS jobs. Eligible international students must also have on-campus employment clearance from the Office of International Students and Faculty.

Grant/Contract Hourly Employment

NJIT's faculty and staff are often awarded grants or contracts from governmental agencies, foundations or private corporations to conduct research projects or special programs. Eligible NJIT students may be hired for on-campus jobs funded by these grants or contracts. Students should contact their academic departments and/or professors about available positions.

Job Location and Development Services (JLDS)

JLDS provides assistance for any NJIT student seeking part-time or summer employment off-campus. Private and public employers in the New Jersey/New York area send numerous job announcements daily to NJIT. Students may view job postings in the Career Resource Center or access the part-time job listings on the Internet via CDS Online. Also, a six-week Summer Job Search Club is offered each spring semester to help students find off-campus summer jobs related to their academic major.

For additional information, contact the Division of Career Development Services, (973) 596-6590.

Alumni Career Services

Alumni of NJIT graduate or undergraduate programs have access to a variety of career assistance services and programs provided by the Division of Career Development Services. Whether interested in changing careers or currently out of work, NJIT connections are valuable and offer a good place to begin a personal career search. Alumni can take advantage of these services: individual career counseling, the Career Resource Center, full- and part-time employment listings, support groups, a computerized bulletin board listing experienced-level job openings, direct access to job postings on the Internet, alumni mentors offering career advice and employment leads, and career-related workshops such as resume writing, interviewing skills, networking and job search strategies.

Alumni Association

The Alumni Association of NJIT is a not-for-profit organization that works in partnership with the university family to promote and support NJIT. The association maintains a relationship with alumni to provide them with a voice and a means of fellowship and growth.

The association offers numerous programs and services: free and lifetime use of the university's computer network and e-mail service, including the association's home page on the NJIT Web site; seminars and business forums; a variety of annual award programs to recognize the accomplishments of NJIT's constituency, students and faculty members; the annual Financial Aid Scholarship Program that provides needed aid for aspiring NJIT students; grants that provide financial support and recognition to NJIT organizations and departments; development and support of U.S. and international association chapters; free subscription to the association newsletter; free miniature copy of the student's diploma upon graduation; access to the A.J.J.A. Wilson Alumni Center's seminar/conference rooms and lounge, the Robert W. Van Houten Library, and the gymnasium facilities, pool and tennis courts.

The Alumni Association works closely with the Division of Career Development Services to assist alumni faced with unemployment, early retirement and second careers.

Accreditation

NJIT is accredited by the Middle States Association of Colleges and Schools (MSACS) Commission on Higher Education.

All of NJIT's eligible professional programs, both graduate and undergraduate, are accredited by the respective accrediting agency for their field:

- **AACSB** American Assembly of Collegiate Schools of Business
- **CSAC/CSAB** Computer Science Accreditation Commission of the Computing Sciences Accreditation Board
- **EAC of ABET** Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology
- **NLNAC** National League for Nursing Accrediting Commission
- **TAC of ABET** Technology Accreditation Commission of the Accreditation Board for Engineering and Technology

NAAB National Architectural Accrediting Board

In the United States, most 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 two types of degrees: the Bachelor of Architecture and the Master of Architecture. A program may be granted a five-year, three-year or two-year term of accreditation, depending on its degree of conformity with established educational standards.

Masters degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree which, when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

The New Jersey School of Architecture received a successful accreditation review in 2002.

Addresses and telephone numbers for all of these accrediting agencies are listed below.

Accreditation Board for Engineering and Technology, Inc. (ABET)
111 Market Place, Suite 1050
Baltimore, MD 21202
Tel. (410) 347-7700

The Associaton to Advance Collegiate Schools of Business (AACSB)---The International Association for Management Education
600 Emerson Road, Suite 300
St. Louis, MO 63141-6762
Tel. (314) 872-8481

Computing Sciences Accreditation Board, Inc.
Suite 209, Two Landmark Square
Stamford, CN 06901
Tel. (203) 975-1117

Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (EAC of ABET)
111 Market Place, Suite 1050
Baltimore, MD 21202
Tel. (410) 347-7700

Middle States Association of Colleges and Schools
3624 Market Street
Philadelphia, PA 19104
Tel. (215) 662-5606

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

National League for Nursing Accrediting Commission
New York, NY 10006
Tel. 1 (800) 669-1656

Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC of ABET)
111 Market Place, Suite 1050
Baltimore, MD 21202
Tel. (410) 347-7700

The Foundation at NJIT

The foundation is a privately incorporated resource development organization that supports excellence in teaching, research and public service programs at NJIT. The NJIT Board of Overseers has leadership and fiduciary responsibility for the foundation. The foundation's mission includes fund-raising and, through the Board of Overseers, soliciting private philanthropy on behalf of the university.

Major Research and Public Service Centers

Engineering and Applied Science

Associated Institutions for Material Sciences (AIMS)[1]

AIMS is a consortium with Princeton, Rutgers, David Sarnoff Research Center and UMDNJ. Associated centers include the New Jersey Center for Biomaterials and Medical Devices, which works to initiate major research programs and transfer technologies to New Jersey companies regarding implant design improvement and a better understanding of the relationship between living tissue and artificial implants. (732) 445-0488

Center for Applied Mathematics and Statistics (CAMS)

Fosters and supports the application of advanced mathematical and statistical methods to scientific, engineering and management problems. The statistical consulting facility assists internal and external clients with problems in data analysis, time series, design of experiments and estimation and reliability theory. (973) 596-8545

Center for Membrane Technologies[1]

The center focuses on research in new membrane structures, materials and devices, novel membrane-based processes and techniques and applications, development of membrane technologies for separations and other applications. NJIT leads an academic consortium whose other members include Rowan, Rutgers-New Brunswick and Stevens. Training of professionals, graduate and undergraduate students, developing new membrane technologies and their applications and transferring them to corporate partners are prime objectives of the center. (973) 596-8479

Center for Solar Research

The center focuses on observational and theoretical astrophysics and operates the Big Bear Solar Observatory, at Big Bear Lake, California, and a dedicated array of solar radio telescopes at Owens Valley Radio Observatory, in Owens Valley, California. The facilities at both locations have the unique capacity to study the sun and its extended magnetic atmosphere simultaneously. (973) 596-3565

Multi-lifecycle Engineering Research Center (MERC)[1]

The center is dedicated to the research and development of innovative engineering methodologies and technologies incorporating re-use as a primary consideration in the design of new products and recovering and re-engineering of components and materials for next-generation feedstocks; and to the education of new engineers and professionals with a broad knowledge of these systems. It targets cross-disciplinary thrust areas in multi-lifecycle product and process design, re-engineered materials from the waste stream, manufacturing and materials processing, demanufacturing systems technology, application, demonstration and integration. (973) 642-7198

New Jersey Center for Engineered Particolates[1]

The center focuses on fundamental and applied research in particle technology for industry and promotes technology development and transfer to industrial partners. The research thrust areas include particle storage and transport, particle and surface property modification (engineered particulate materials), particle segregation, mixing and separations, simulations and modeling. Undergraduate and graduate education and professional training complement the research. (973) 596-8479

New Jersey Center for Wireless Technology

New approaches and new software tools for integrated wireless and wired network management, including data and network security, are the goals of the newly established New Jersey Center for Wireless Networking and Internet Security. A partnership between NJIT's Department of Electrical and Computer Engineering and Princeton University, the center is supported by a $2.6 million R&D Excellence Grant from New Jersey Commission on Science and Technology. Its main objective is to provide optimized efficiency and security in the multimedia environment. Led by Atam Dhawan, professor and chair of electrical and computer engineering, the new center builds on NJIT's established strengths in wireless communication, signal processing, multimedia and networking. Other NJIT members of the center team include Associate Professors Constantine Manikopoulos and Yun-Qing Shi and Assistant Professors Symeon Papavassiliou and Sirin Tekinay, all of electrical and computer engineering. Center researchers are collaborating with leading organizations, including Panasonic, Prediction Systems, AT&T, the U.S. Army and Mitre Corp.

New Jersey Center for Microflow Control

Research at the New Jersey Center for Micro-Flow Control (MFC), an increasingly important technology, involves the manipulation of fluid --- gas or liquid --- flow fields by creating small disturbances in the flow.

The New Jersey Commission on Science and Technology R&D excellence program partially builds upon the work of the W.M. Keck Foundation Laboratory for Electro-Hydrodynamics of Suspensions, headed at NJIT by Nadine Aubry, F. Leslie and Mildred Jacobus Professor of mechanical engineering, professor of mathematics and chair of the Mechanical Engineering Department, and Boris Khusid, associate professor of mechanical engineering. The laboratory is funded by a $500,000 grant from the W.M. Keck Foundation. The New Jersey MFC Center is led by professor Aubry.

MFC technology has a wide range of applications, including devices for medical diagnosis and treatment, telecommunications, environmental remediation, chemical and materials processing. In collaboration with researchers from Princeton University and industrial partners, the NJIT center will focus on the development of new technologies such as miniaturized systems on a microchip for the characterization and manipulation of cells, bacteria, spores or other microscopic particles, and high-precision microprocessing tools using microjets.

With their collaborators from the City University of New York, the research team has also received funding from the U.S. Office of Naval Research to develop an electro-hydrodynamic technology for monitoring and cleaning contaminants from oils, lubricants and coolants and other fluids used in shipboard equipment. Many machine failures are caused by contamination of hydraulic fluids, coolants and other liquids with micron- or sub-micron-sized particles due to corrosion or aging of fluids, but mechanical filtering is ineffective for such fine debris. In contrast, a strong high-gradient AC electric field can be used to control and manipulate the motion and aggregation of particles in flowing liquids. The team is developing a field prototype of online filtering hardware and will test it aboard a naval ship.

Environmental Engineering and Science

Otto H. York Center for Environmental Engineering and Science (CEES)

CEES is the home for many of NJIT’s environmental centers, programs and initiatives. The $11 million center, containing $2.4 million in state-of-the-art laboratory equipment, is the first building in the nation especially constructed for cooperative public and private research in hazardous waste management. (973) 596-3233

Manufacturing

Center for Manufacturing Systems (CMS)[1]

CMS is NJIT’s focal point for industrial interaction in research, technology extension, education and training pertinent to manufacturing. Project work spans aspects of materials production, component part fabrication and automated assembly. (973) 596-3616

Polymer Engineering Center (PEC)

PEC seeks to advance the foundations of design and control of polymer production and part-fabrication technologies with facilities that include a production scale, multilayer co-extrusion line with thermoforming unit and extruders, injection molding machines, and test and characterization equipment. (973) 642-4582

Polymer Processing Institute (PPI)

PPI is a not-for-profit institute with special areas of expertise in the development of high-performance products and processes for advanced compounding, property characterization and computer modeling. PPI includes the professionally managed Characterization Lab, Computer Center and Process Lab, which contains a number of single- and twin-screw extruders and several injection machines along with downstream equipment. (973) 642-

4582

Transportation

International Intermodal Transportation Center

The institute conducts interdisciplinary research on the transportation needs of the public and private sectors. Affiliated centers include the National Center for Transportation and Industrial Productivity, which investigates methods for increasing productivity through transportation improvements and provides technical, administrative and fiscal management necessary to conduct research projects in the field of transportation (973) 596-3355; and the New Jersey Center for Transportation Information and Decision Engineering (TIDE) Center, a partnership of NJIT, Princeton and Rutgers that develops and markets technologies that will help individuals and commercial enterprises make better transportation-related decisions. (973) 596-8493

Electronics and Communications

Center for Communications and Signal Processing Research

The center promotes research on the theoretical and practical aspects of communications and signal processing in collaboration with government organizations and local industry with emphasis on wireless and personal communications. (973) 596-3520

Electronic Imaging Center

The center’s research emphasizes novel diffractive methods in spectral filtering, which are combined with visible and infrared imaging systems. Of particular interest are applications of infrared imaging and radiometry with industrial and commercial partners. (973) 596-3538

Microelectronics Research Center

Research focuses on advanced semiconductor and micromachined device design, simulation and fabrication. The center features a complete Class 10 cleanroom with 6-inch silicon wafer processing capability, one of only a few such university cleanrooms in the nation. Recent state-of-the-art equipment additions include wafer bonding and deep reactive etching tools. The center provides industry and university clients with technical support and prototype development in MEMS and/or CMOS technologies. (973) 596-5736

New Jersey Center for Wireless Telecommunications

NJIT is the lead institution in a research partnership with Princeton, Stevens and Rutgers that focuses on enabling technologies for digital wireless communication systems to enhance the competitive position of those companies and institutions in New Jersey in the wireless arena. (973) 596-3516

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1 Supported by the N.J. Commission on Science and Technology

2 A National Science Foundation Industry/University Cooperative Research Center

3 Supported by the U.S. Environmental Protection Agency

4 Supported by the U.S. Department of Transportation

5 Supported by the N.J. Department of Environmental Protection

Architecture

Center for Architecture and Building Science Research

This applied research group investigates the building environment within a social and economic context. Major areas of study include housing, learning environments, healthcare and aging, disabilities, preservation technologies and the utilization of waste materials for construction and infrastructure. (973) 596-3097

Public Policy

Small Business Assistance

Center for Information Age Technology (CIAT)

CIAT provides impartial, professional computer-related assistance to government, education, non-profit and business organizations. The center assists with a wide range of projects such as assessment of current hardware and software, identification of systems requirements, vendor and package evaluation, implementation, training and Web site development. (973) 596-3035

Defense Procurement Technical Assistance Center

The center provides individualized marketing, contractual and technical assistance to businesses currently selling or seeking to sell goods/services to the federal, state or local government and prime contractors. (973) 596-5807

Enterprise Development Centers (EDC I, II & III)

EDC I,II and III operate technology-oriented small business incubators committed to the long-term economic vitality and growth of entrepreneurial ventures in New Jersey. EDC addresses problems inherent to these businesses and helps to commercialize companies' new products, processes and services. (973) 596-5864

New Jersey Manufacturing Extension Program, Inc. (MEP)

MEP is a not-for-profit organization headquartered at NJIT that serves as a gateway for small to medium-sized manufacturers to access statewide services in the public and private sectors that address business, financial and technical issues essential to forming high-performance firms. (973) 642-7900

NJIT Faculty Research

NJIT faculty conduct extensive research in the university's research centers and laboratories, and in partnership with other universities, industry and government laboratories. Highlights of major research areas are presented here. Additional information about NJIT research centers mentioned is available and a list of center directors is located at www.njit.edu/research.

ARCHITECTURE

In addition to independent research, architecture faculty are involved in a wide array of interdisciplinary research, mainly through the Center for Architecture and Building Materials Research and the Multi-lifecycle Engineering Research Center.

Areas of Research

Building Technologies and Sciences — Moisture in buildings, building materials, energy transfer through building envelopes, conservation and passive solar heating, building systems integration and building economics.

Computer-Aided Architecture — Use of computers in architectural practice, modeling and simulation, computer application in architectural design, and data structures and graphic representation.

History and Theory of Architecture — Architectural theory and criticism, history of architecture since 1750, urban history and cultural geography, literary themes in architecture, and contemporary art and architectural criticism.

Housing Studies and Urban Design — Housing for new household types, public policies in design arts, technology and architectural design, social meaning of building form, housing environments, community revitalization and economic development.

Urban Infrastructure Planning — Interdisciplinary project planning and design, infrastructure technology and design principles, public space infrastructure, history and theory of urban infrastructure, and financing and implementation of infrastructure projects.

BIOMEDICAL ENGINEERING

NJIT's interdisciplinary biomedical engineering faculty are involved in research and development in collaboration with the following institutions:

Columbia College of Physicians and Surgeons
Hershey Medical Center
Kessler Institute for Rehabilitation
Saint Barnabas Medical Center
UMDNJ-New Jersey Medical School
UMDNJ-New Jersey Dental School
Veterans Administration Medical Center in East Orange

Areas of Research

Mechanical Engineering — In the area of biomechanics, research is ongoing in knee joints, heart valves, spinal disks, spinal fixation devices and a quantification device for lower back pain. Biomaterials research focuses on artificial ligaments and resorbable fracture fixation materials.

Electrical Engineering — Researchers in biomedical signal processing are developing electrocardiogram analysis as a tool for diagnosing and treating stroke disorders and neuromuscular disorders. Other signal processing research involves electroencephalogram analysis in treating epilepsy and electromyogram analysis in fatigue studies.

Chemical Engineering/Chemistry — Studies involve use of membranes for controlled-release of pharmaceuticals, protein separation using affinity chromatography, molecular modeling of drug-receptor interactions, mixing and mass transfer phenomena in bioreactors and reactor analysis and solvent minimization.

CHEMICAL ENGINEERING, CHEMISTRY AND ENVIRONMENTAL SCIENCE

The chemical engineering, chemistry and environmental science research programs are closely associated with these centers;
Center for Membrane Technologies
Multi-lifecycle Engineering Research Center
Otto York Center for Environmental Engineering and Science
Polymer Engineering Center

Areas of Research

Hazardous Waste Treatment and Waste Minimization — Dynamic modeling of biological reactors, anaerobic/aerobic biotreatment processes, in-situ bioremediation, biofiltration of VOCs, kinetic and thermodynamic analysis of combustion and pyrolysis processes, catalytic combustion, acid gas treatment, sampling and analysis of organic and inorganic pollutants, supercritical extraction, treatment of gaseous pollutants by corona discharge, novel routes for solvent-less chemical synthesis, ultrasonic enhancement of in-situ remediation and process design for waste minimization.

Biochemical Processing — Reactor analysis, mixing phenomena, chromatographic separations, molecular modeling of enzyme mimics and drug-receptor interactions.

Materials Processing — Polymer characterization and process engineering, plastics recycling and particle flow systems.

Membrane Separations — Excellent facilities exist for conducting research on membrane separation processes, particularly hollow-fiber membranes. Applications include gas-gas, gas-liquid, and solute-liquid separations, as well as combined reaction/separation processes. Support for these activities comes from industrial and federal research grants, the environmental research centers at NJIT and NJIT's Sponsored Chair in Membrane Separations and Biotechnology.

Research in civil and environmental engineering is conducted within the department and in these NJIT centers:

Center for Manufacturing Systems
Hazardous Substance Management Research Center
Institute for Transportation
Multi-lifecycle Engineering Research Center
Northeast Hazardous Substance Research Center

Areas of Research

Geoenvironmental Engineering Laboratory — This state-of-the-art facility was established with support from a $1 million National Science Foundation (NSF) grant, which was matched with more than $2 million from NJIT. The laboratory provides research support for geoenvironmental projects such as soil decontamination using biological, chemical and/or physical means; modeling of contaminant transformation and transport; and the testing of waste treatment, solidification, and stabilization and containment systems. The equipment includes an environmental scanning electron microscope (ESEM), X-ray fluorescence and X-ray diffraction spectrometers (XRF/XRD), GC/MS and SFE, capillary electrophoresis (CE), UV-VIS, FT/IR, respirometers, particle size analyzer (PSA) and hydraulic conductivity apparatus.

High Performance Concrete Laboratory — Equipped with funds from NSF, this laboratory is capable of testing very high strength concretes under uniaxial as well as triaxial states of stress. The primary testing system is capable of applying up to 1 million pounds of axial load on a specimen in a computer-controlled closed-loop environment. The materials processing component includes two computer-controlled micro-sizers, and fractionators for particle size analysis and categorization of industrial by-product additives to concrete, such as fly-ash, microsilica and blast furnace slags.

Smart Sensors and Nondestructive Testing Laboratory — This laboratory provides means for studying self-sensing systems built into structures to monitor excessive strains, deflections, load distributions, temperature variations and corrosion.

Recycled Plastics Laboratory — This research facility concentrates on developing innovative uses for recycled plastics. In addition to material tests, the lab develops constitutive models and analysis techniques required by the nonlinear characteristics of the material and its variation through the cross section. Computer simulations are used to analyze the barriers during a crash by modifying current programs to include recycled plastic models. Experimental studies include wind and acoustic tests of noise barriers and in-situ implementation of the proposed designs.

COMPUTER SCIENCE AND INFORMATION SYSTEMS

Computer and information science research is conducted in the following laboratories: advanced computer architecture and parallel processing, artificial intelligence, computer communications and networking, data and knowledge engineering, knowledge representation and artificial intelligence, dependable real-time systems, collaborative systems, computer vision, computing education, cognition and learning, hypermedia information systems, neurological computation and robotics, simulation and modeling and software engineering.

Areas of Research

The departments provide research laboratories with infrastructure and coordination for conducting multidisciplinary research and development. Some key areas that the department focuses on are the technology, health care and financial industries, which require research in software engineering, telecommunications, computing systems, artificial intelligence, database, algorithms, and biomedical and information systems. In addition, the department sustains an interdisciplinary research support environment for biomedical and neuroscience applications, computer engineering, computer-mediated communication, enterprise engineering, health care information systems, manufacturing systems, medical imaging and information systems, microelectronics, as well as other disciplines.

ELECTRICAL AND COMPUTER ENGINEERING

In addition to independent research, Department of Electrical and Computer Engineering faculty participate in research at the:
Center for Communications and Signal Processing Research
Electronic Imaging Center
Microelectronics Research Center
Multi-lifecycle Engineering Research Center
New Jersey Center for Wireless Telecommunications

Areas of Research

Ion Beam and Thin Film Laboratory — Studies focus on processing and properties of materials and structures in the form of thin films. The laboratory has a number of thin film deposition systems, including a state-of-the-art ultrahigh vacuum chamber that permits deposition on atomically clean surfaces. Thin film structures, basic elements of modern microelectronic and optoelectronic devices, are increasingly important in almost all areas of technology. Current research includes metal epitaxy on silicon, modification of surfaces with atomic and cluster ions, and development of novel dielectrics with properties controlled by light beams.

Microwave and Lightwave Engineering Laboratory — Research is ongoing in the areas of microwave device modeling and measurement, computer-aided design (CAD) of microwave components and systems, characterization of RF/microwave/optical systems, monolithic microwave integrated circuit design and testing, numerical electomagnetic codes, analysis design and wire antenna multiscattering in vegetation, experimental and theoretical study of linear and semiconductor surfaces, integrated optics, fabrication and characterization.

Multimedia — Research projects are in the areas of multimedia signal processing and compression, multimedia communications, digital content security and data hiding, Internet delivery of multimedia and many others. The multimedia production and Internet delivery studio, with its state-of-the-art webcasting and DVD authoring platforms, facilitates the use of emerging Internet multimedia technologies for education and learning purposes. More than 30 faculty members and about 40 doctoral students are involved in multimedia research.

Communications and Signal Processing — Recent emphasis on wireless and personal communication systems includes multiuser detection and interference cancellation algorithms, smart antennas and space-time processing. Other areas include adaptive systems and arrays, blind signal separation and equalization, synthetic aperture, radar processing and calibration, source encoding and synchronization, detection and estimation and ATM networking. Signal processing research covers wide areas of nonlinear and adaptive signal processing and algorithms, one- and multidimensional signal processing, image-video coding, subband and wavelet transforms, QMF-wavelet filters, and advanced DCT algorithms.

Computer Engineering — Computer engineering faculty members are conducting research in these areas: test generation; fault simulation; design for testability; built-in self-test; data compression; CAD; computer architecture; design verification; computer reliability; fault tolerance; interconnection in high speed digital circuits; microprocessing; Internet-based computer-aided instruction; interconnection networks; multiprocessor systems; nonlinear optimization techniques; genetic algorithms; neural networks; infrared imaging; computer networks; routing in ATM networks; LANs; CEBus; BACnet; parallel computing systems; parallel algorithms; computer vision; Petri nets; discrete event systems; embedded control; computer integrated manufacturing and networking intelligent automation; information display; robotics; ATM switches; and VLSI.

Electronic Imaging — Special filters are widely used in the characterization of chemical or biological systems. Much information on these systems can be deduced from spectral analysis of transmission and reflection of the samples, especially in the infrared (IR) spectral region. Researchers examine tunable filter systems, such as wavefront division interferometers (WDI), together with a two-dimensional IR imager. Such systems are based on multiplexing procedure, which minimizes optical loss. The resolution and the extent of the filtering process is determined by novel electronic processing methods. The goal is to develop a hand-held instrument to monitor harmful molecules in a remote or a nearby environment.

Nonlinear Nanostructures Laboratory — Nanotechnology is a fast-growing interdisciplinary area. While many thin film and granular technologies are within the nano scale, nanotechnology is related to the “added value,” i.e., the functionality, of nanostructures. The basic “building block,” the nanocluster, is an ultrafine-grained solid with a high percentage of atoms at the grain boundaries. The nonlinear optical properties of nanoclusters are of intense interest for use in optical switching and IR sensing. The confinement of the electronic wave function to small dimensions results in an enormous refractive index change. Experiments are under way on Si nanoclusters grown by either laser ablation or ion implantation.

Wireless Telecommunications — Research activities are distributed among four focus areas: wave propagation models for delivery of advanced broadband services and R.F. engineering of novel devices and systems for wireless digital communications technologies; wideband multiple access systems, and multiuser technologies including adaptive equalization and space-time adaptive processing; wireless networking including architectures, wireless ATM, geolocation, teletraffic modeling, resources allocation; and services, applications and wireless technology transfer.

HISTORY

The Federated History Department of NJIT and Rutgers-Newark conducts research in a wide variety of historical fields, regions and periods. Faculty in the department have obtained many grants from government and private foundations such as the National Endowment for the Humanities; the National Science Foundation; the John Simon Guggenheim Memorial Foundation; Fulbright Fellowships; and the Spencer Foundation. The department produces two periodicals:
Eighteenth-Century Scotland
Horn of Africa

Areas of Research

History of Technology, Environment and Medicine — American environmental history; urban environmental history; the social and cultural history of medicine and technology (including gender issues); military medicine; history of mental health; history of print culture; film, television and history; and technology and warfare.

American History — Social, cultural and diplomatic history; the history of women and the family; African-American history; legal history; public history.

World History — Comparative history; economic history; intellectual, cultural, and political history; modern Africa; modern China; Latin America and the Caribbean; Russia and eastern Europe; medieval Europe and Eurasia; modern France, Spain and Britain.

HUMANITIES AND SOCIAL SCIENCES

The department integrates the humanities and social sciences for the purpose of understanding the cultural, social and scientific contexts informing contemporary culture. Special emphasis is given to research in the study of science, technology and society; the study of communication; the study of environmental and health policy; professional ethics; the study of environmental and health economics; and the study of multicultural and international literature. The department is committed to using the humanities and the social sciences as a coherent model for examining human society. Research is conducted in these centers:
Center for Architecture and Building Science Research
Center for Policy Studies
Institute for Transportation
Multi-lifecycle Engineering Research Center

Areas of Research

Environmental Studies — Research is ongoing in policy studies, health, coastal geomorphology, economics, ethics, history, communications and education. The department hosts the nationally acclaimed environmental publication, Terra Nova.

Professional and Technical Writing — Multimedia design, distance learning, writing assessment and environmental communications are areas that faculty currently pursue. The department hosts a new journal, Newark Review.

Contemporary Literature — This research area includes modern poetry, multicultural and international studies, and the relationship between literature and the natural world.

INDUSTRIAL AND MANUFACTURING ENGINEERING

The Department of Industrial and Manufacturing Engineering has a significant and diverse research program that includes areas such as industrial and operations research, design for manufacturing, quality, assembly and concurrent engineering, robotics, global networking, logistics and simulation issues of small and medium-sized companies, multimedia, environmental and health/safety and medical engineering. Research also is affiliated with these major NJIT research centers:
Center for Manufacturing Systems
Multi-lifecycle Engineering Research Center

Areas of Research

Industrial Engineering, Systems and Operations — Research includes the development of control and scheduling algorithms for the optimization of container terminal operations, global networking and logistics operations for small, medium and large corporations, the impact of telecommuting strategies on traffic flow, engineering system modeling and design tools, distributed virtual laboratory networks between research groups, the R&D of quality systems, quality control and management systems.

Manufacturing Systems and Mechatronics Engineering — Focus is on robotics, robot cell design, flexible computer-integrated manufacturing, system integration of automation systems, flexible assembly system modeling, integration, implementation, non-contact sensing and inspection, CAD/CAM integration, servo pneumatic positioning and sensor technology.

Concurrent/Simultaneous and Total Lifecycle Engineering — This new research field includes the development of new methods and toolsets for small batch luxury automobile manufacturers (such as Rolls-Royce Motor Cars), and general methods, tools and technologies for design for manufacturing, design for quality manufacturing, and assembly and maintenance systems.

Medical, Environmental, Health and Safety Engineering — Activity in this area is increasing. Main areas include the assessment of the realistic impact of environmental factors on productivity, devices and methods for the prevention of repetitive motion injuries, microrobotic manipulators for human artery cleaning, and new medical devices coupled with simulators and expert systems that can be used for interacting with the human body and other medical applications.

Multimedia, Simulation and Virtual Reality Modeling — Research activities are spread between discrete event and continuous system modeling and simulation and areas such as graphical modeling of workcells, object-oriented simulation coupled with AI, engineering multimedia developments for the study of servopneumatic positioning, multimedia for total quality management and the ISO9001 standard, flexible automation, concurrent engineering and the virtual reality simulation (and rapid prototyping) of complex electromechanical products and their manufacturing/assembly processes.

MANAGEMENT

In addition to independent research, School of Management faculty are pursuing research conducted in affiliation with these centers:
Center for Manufacturing Systems
International Intermodal Transportation Center
Multi-lifecycle Engineering Research Center

Areas of Research

Entrepreneurship and Small Business — Assessment of emerging technologies, economics, employment growth, theories and practice in relation to entrepreneurship and private enterprise.

Building Production and Management — Building efficiencies, organization of international construction, environmental technology management, and industrial ecology systems.

Behavioral Science and Organizational Theory — Organizational design and development, organizational behavior, occupational and organizational socialization, legal and ethical issues, public administration, social perception, leadership, attachment and commitment processes in organizations, and transportation behavior.

Economics and Finance — Mathematical programming and multicriteria decision making in financial management, portfolio analysis, emerging international capital markets, applied corporate finance, financial economics, public finance, international competitiveness of U.S. economy, and international economic/financial relationships.

Human Resources Management — Managing new technology, labor management relations, public policy and technological change, and tasks and unit level technologies.

Information Systems Management — Policy analysis, computer auditing, control and security, interface design, systems evaluation, technological forecasting and assessment, management information systems, management and social impacts of computer and information systems, group decision support systems and database analysis.

Information Systems Auditing — Operational auditing, internal auditing.

Marketing Management — Marketing research, new product management, consumer behavior, international marketing, marketing technological innovation, mathematical programming and multicriteria decision making, strategic management, sales management, enhancing global competitiveness and technology transfer.

Operations Management — Project management, industrial quality control, production planning, management of manufacturing systems, and mathematical programming and multicriteria decision making.

Corporate Law and Ethics — Employment law, legal and ethical issues in business, international legal environment of business, job security and unlawful discharge/unjust dismissal.

MATHEMATICAL SCIENCES

The research interests of the faculty focus on the development and use of mathematical and computational tools for solving scientific, technological and industrial problems. The Center for Applied Mathematics and Statistics promotes and represents the research interests of all NJIT mathematical sciences faculty.

Areas of Research

Acoustics and Signal Processing — Faculty involved in acoustics study both the forward and inverse problem of sound propagation in the ocean. Work on the forward problem aims for accurate and computationally efficient solutions of the wave equation for complex oceanic environments. Research on the inverse problem addresses the development of algorithms for source localization and geoacoustic inversion, combining array and statistical signal processing concepts and waveguide physics.

Electromagnetics — The electromagnetics group is concerned with the scattering of electromagnetic waves by complex structures and materials. Methods used include modeling, asymptotics and numerical analysis. Applications to material processing are an important aspect of this work. Current and recent projects include the analysis of microwave sintering of ceramics, including thermal runaway and hot-spot dynamics, electron beam welding of ceramics, nonlinear pulses in optical fibers and the development of numerical methods for Maxwell's equations in free-space and in complex, dispersive media.

Fluid Dynamics and Materials Science — Several faculty are involved in the development of analytical and computational methods and their application to problems arising in fluid dynamics and materials science. A particular area of emphasis is the study of the dynamics of interfaces between two fluids or a fluid and a solid. Research in this area includes liquid jet breakup, bubble dynamics, crystal growth, and flame front propagation as well as related problems in combustion and detonation. Other research areas include stability theory, particulate flows, viscoplastic flows, thin films and physiological fluid mechanics (e.g., blood flow in arteries).

Mathematical Biology — This group is involved in two major research projects. First, the development of strategies to promote improved medical and therapeutic techniques, including use of coupled-oscillator theory for optimal walking strategies, use of elasticity theory for wound suturing and use of virtual reality in studies of epilepsy. Second, the development of testable mathematical models of neuronal networks including modeling the bistability of vertebrate motoneurons, modeling motor patterns in crustacea and modeling of hippocampal place cell dynamics in connection to memory recollection.

Statistics — Faculty research areas and interests include applied probability modeling, statistical inference, statistical reliability theory and applications, survival analysis and applications in biostatistics, time series analysis and forecasting, signal processing, design and analysis of industrial experiments.

MECHANICAL ENGINEERING

The scope of research in the Department of Mechanical Engineering is broad. Projects are carried out within the department's laboratories as well as in collaboration with the following centers:
Center for Manufacturing Systems
Hazardous Substance Management Research Center
Multi-lifecycle Engineering Research Center
Particle Processing Research Center
Polymer Engineering Center

Areas of Research

Bearings and Bearing Lubrication — Research areas include design of hydrodynamic, hydrostatic, rolling element bearings and novel designs of unique bearings, such as composite bearings. Also, the role of bearings in rotor dynamics is investigated. Students are engaged in the design and development of testing machines, which include computer data acquisition, for friction and wear, and for testing bearing materials and lubricant additives. Research is conducted in modeling and compensation of friction in control systems for precise motion control, stick-slip friction, friction-induced vibrations and antilock brakes. Work is conducted in modeling and measurement of dynamic friction in bearings, clutches, vehicle breaks and tires. Other research interests are rheology of lubricants, including viscoelastic and synthetic lubricants.

Computational Fluid Dynamics —- The laboratory for computational fluid dynamics is equipped with state-of-the-art computer equipment consisting of an SGI compute server (Origin 2000), four SGI 02 workstations and PCs. The purpose of the laboratory is the understanding, prediction and control of many fluid flows in the laminar, transitional and turbulent regimes. High performance computing, advanced data analysis, hydrodynamic stability theory and control theory are used for this purpose. Research includes boundary layer and channel flows, wake flows, film flows, ocean water waves and propagating flames. Another thrust area is the numerical simulation of multiphase flows such as particulate and bubbly flows.

Electro-Hydrodynamics Research — The research aims at developing a fundamental theory of the synergism of electric- and shear-induced phenomena in suspensions and to examine the accuracy of predictions regarding the effects of high-gradient strong fields on the particle motions and aggregation. Understanding of these phenomena is used toward the control and manipulation of suspension flows. Applications include the development of a novel filtering technology for online cleaning of in-service fluids in shipboard equipment.

Granular Flow — The goal of this research is to develop predictive models of flowing granular materials critical to the design of efficient and reliable solids handling systems prevalent in the industrial sector (chemicals, food, agriculture, pharmaceuticals, minerals, energy, materials, munitions, and electronics), as particulates are universally found in most products either as raw materials or as the final product. Investigations aimed at understanding observable bulk behavior are carried out as part of the Particle Technology Center and made through realistic dynamic computer simulations, analytical modeling and physical experiments. Paramount is the connection between microstructure evolution and transport properties. Phenomena of interest include hopper flows, vibrated beds, shearing, percolation in packed beds, and segregation.

Multiphase Flow Research — Research objectives are to develop a fundamental knowledge of hydrodynamic and interfacial interactions of phases in multiphase flows as well as develop advanced technologies related to particulate multiphase flows. Projects include drag forces and collisions of interacting particles in viscous flows, fibrous filtration of particulate-laden flows, membrane separation, wet scrubbing, liquid jet evaporation in gas-solid suspension flows, and filtration applications using rotating fluidized beds.

Non-Newtonian Fluid Dynamics — A knowledge of non-Newtonian fluid dynamics is essential in many industries, including those involving plastics, paints, suspensions, oils, lubricants, rubber and detergents. Projects include theoretical and computational analyses of the popular constitutive equations for a range of flow problems, e.g., injection molding, porous media flows, viscoelastic particulate flows, free-surface flows as well as the modeling of non-Newtonian fluids. Both finite element and finite difference methods are used to solve the governing equations in two and three dimensions.

Particle Technology Research — Research includes fundamental and applied projects including modeling and development of novel techniques for dry particle coating and manufacturing of engineered particles; ultrafine particle mixing using dry methods, discrete element modeling (DEM) and numerical simulations of particle flows and processes; granulation with minimal use of liquids; particle transport; and handling/flow and delivery from hoppers. Some past projects were development of non-intrusive particle tracing technique for granular flow experiments; development of motion analysis algorithms for high-speed optical imaging of three-dimensional particle collisions; and pattern recognition and cluster analysis techniques to detect micro-structure in granular flows.

Pattern Recognition/Cluster Analysis/Image Processing Research — This research focuses on the use of “soft computing” methods for various applications: fuzzy clustering algorithms, robust clustering, clustering of relational data, application of robust statistical techniques in cluster analysis, shape detection in noisy data, generalization of fuzzy clustering algorithms for multicharacteristic shape detection, such as hyper-spherical/ellipsoidal shells as cluster prototypes, or adaptive clustering and cluster validity issues. Clustering methods and evidence collection techniques are used for lines, curves and arc detection in digital images. These algorithms are also used in reverse engineering through development of CAD models from image sensor data. Machine vision applications are also studied.

Plastics Engineering — The New Jersey Bell Plastics Laboratory is well equipped with a wide range of state-of-the-art plastics processing and forming equipment, supported by analytical testing capabilities. The laboratory is used for a wide range of research and development activities. Activities include re-engineering of commingled waste plastics, studies on self-reinforced composites, and combined parametric and experimental studies to develop models to explain the interrelationships between product properties and process parameters for injection molding processes. As part of the research activities, students use CAD and computer-aided engineering (CAE) tools in the design, analysis and manufacture of plastics products.

Rapid Intelligent Manufacturing and Prototyping — The research aims to generate fundamental knowledge and develop advanced technologies to enable the design and manufacture of products to be done more quickly and cost-effectively. Research projects include next-generation CAD/CAM system with virtual reality, rapid tooling and manufacturing, rapid freezing prototyping, and environmental performance analysis of solid freeform fabrication processes.

System Integration and Robotic — The research applies theoretical analyses, simulations and experiments to the design and control of mechanical and electromechanical systems (mechatronics). Kinematic and dynamic modeling, system calibration and optimization techniques are used to enhance system performance. Projects include development of design, planning, and control methodologies for effective use of parallel kinematics machines and development of ultrafine motion technologies to enable fast, flexible automated assembly of optoelectronics systems.

Waterjet Technology Research — The Waterjet Research facility develops technologies for the use of high- and super high-speed fluid jets for manufacturing complex components from hard-to-machine materials, cleaning and grinding of sensitive surfaces, and bio-medical applications. Projects include numerical modeling of fluid jets, developing expert systems for jet-based processing, precision cleaning of complex surfaces, using ice for machining applications, and using impact and explosion to form jets.

PHYSICS

Interdisciplinary applied physics research is conducted in collaboration with faculties of NJIT, Rutgers-Newark, Rutgers-New Brunswick, and UMDNJ in areas such as electrical engineering, chemistry and chemical engineering, materials science, industrial and manufacturing engineering, biological sciences and geological sciences. Cooperative research efforts are under way with the National Solar Observatory, Bell Labs-Lucent Technologies, U.S. Army Research Lab, and other industrial and federal research laboratories. Research also is conducted at these major NJIT centers and NJIT-maintained facilities:
Microelectronics Research Center
Center for Solar Research
Big Bear Solar Observatory
Owens Valley Radio Observatory

Areas of Research

Device Physics — Research at NJIT is under way in silicon microfabrication, micromachining and fusion bonding for conventional and novel microelectromechanical (MEMS) device applications, metal-insulator-semiconductor device structures and rapid thermal processes in silicon integrated circuits. Studies at Rutgers-Newark involve sensors for biophysics applications. Facilities for this work include state-of-the-art metrology electrical characterization equipment, cryostats for very low temperature measurements and access to NJIT's Class 10 cleanroom with full process capabilities for 6-inch silicon wafers.

Materials Research — Molecular beam epitaxy (MBE) of III-V semiconductors is used to fabricate various photonic devices, digital integrated circuits and optoelectronic integrated circuits. Research on the synthesis and characterization of chemical vapor deposited (CVD) and physical vapor deposited (PVD) silicon-based dielectric films is ongoing. Optical characterization of materials includes visible and far-infrared spectroscopy, photoconductivity, photoluminescence, spectral emissometry and thermal modulation spectroscopy. Materials studies include photoinduced superconductivity in High-Tc materials (i.e., YBCO) and optical properties of SiC, GaN and porous silicon.

Ultrafast Optical and Optoelectronic Phenomena — Terahertz spectroscopy is used to study ultrafast carrier dynamics in semiconductors. Other areas include ultrafast photodetectors, ultrashort nonlinear pulse propagation in optical fibers and planar waveguides, ultrafast photophysics of semiconductor and quantum well devices, and ultrafast optical switching in novel nonlinear materials. The Ultrafast Optics and Optoelectronics Laboratory is capable of producing ultrashort laser pulses of 100 femtosecond duration over a tuning range of 230-nm (ultraviolet) to 2300-nm (infrared).

Optical Science and Engineering Education — The National Science Foundation (NSF) is supporting the development of an optical science and engineering curriculum with optics research collaboration among NJIT's physics, electrical and computer engineering, and chemical engineering, chemistry and environmental science departments.

Solar Physics — The Center for Solar Research operates two world-class observation facilities: Big Bear Solar Observatory (BBSO) and a dedicated array of solar radio telescopes at Owens Valley Radio Observatory (OVRO), both in California and both formerly managed by Caltech. Research focuses on the development of state-of-the-art instruments for solar observations; the study of solar magnetic fields and extended atmosphere; and the study of solar activities and their terrestrial effects. Solar physics interacts closely with other research areas at NJIT, including device physics, image processing and atmospheric chemistry. With the acquisition of BBSO and OVRO, the NJIT physics department has one of the best-known university-based research efforts in solar physics in the world.

Imaging Technology — A developing initiative builds upon NJIT's nationally recognized work in infrared imaging technology, applying it to the promising area of infrared solar physics. State-of-the-art infrared imaging devices are being developed and tested as part of an IR telescope system to be installed at Big Bear Solar Observatory.

Free Electron Laser Physics — The free electron laser (FEL) on the Rutgers-Newark campus generates short tunable far infrared (FIR) pulses allowing a new class of experiments to be carried out at wavelengths of 150--400 microns. The unique time dependence of the Rutgers' FEL will be used to develop an important class of transient FIR experiments with 50 picosecond resolution. Photon echo techniques using the Rutgers' FEL will be applied to obtain significantly improved resolution for the FIR spectra of DNA. Similar techniques will be used to study quantum wells in semiconductors.

Surface Physics — This area focuses on research on laser-induced physical processes on surfaces. One area of current interest is laser-stimulated hydrogen ion desorption from a hydrogenated Si (100) surface. Another area is the interaction of spin polarized atoms with surfaces.

Discharge Physics — Research on glow discharges for plasma processing of semiconductors and other materials is being carried out under an NSF-sponsored program. Related studies on VUV (vacuum ultraviolet) light sources and unique laser pumping schemes are also under way.

Applied Laser Physics — With industry funding, research is being carried out at Rutgers-Newark on laser processing of materials with low thermal conductivity. The physics involves heat transport, laser properties and material properties. New instrumentation to resolve variations in temperature in time and space is being developed. This work is in collaboration with the Department of Ceramics and Engineering in the Rutgers College of Engineering in New Brunswick.

Biophysics — An NSF-funded research training group program in collaboration with the Rutgers-Newark's chemistry department, the federated biological sciences department and Rutgers-Newark's Center for Molecular and Behavioral Neuroscience provides training and research opportunities in frontier interdisciplinary biophysics areas including spectroscopy, signal processing and biomedical instrumentation. One area of great current interest involves the use of stable isotope tracers for medical diagnostics. Another is the development of microsensors to probe nonlinear auditory response in mammals.

TRANSPORTATION

The interdisciplinary program in transportation through the Institute for Transportation involves about 30 NJIT faculty and 25 NJIT graduate students in its research program activities. Congressional legislation requires that TELUS (Transportation Economic and Land Use System) be customized and deployed for use throughout the United States. TELUS is a computerized system for tracking the progress of transportation projects and assessing their economic and land use impacts and interrelationships. Institute research activities are associated with the following centers at NJIT:
National Center for Transportation and Industrial Productivity (NCTIP)
New Jersey Center for Transportation Information and Decision Engineering (TIDE)

Areas of Research

Mitigation of Increased Highway Congestion — resulting in reduced productivity, increased gridlock, pollution and fuel consumption.

Advanced Traffic Control and Engineering — are requiring new systems for traffic management and new engineering and management techniques to expand the capacity of the transportation infrastructure.

Intelligent Transportation Systems — resulting in more efficient use and increased safety for the existing transportation infrastructure.

Increased Competition — for railroad, truck and air carriers because of deregulation. Carriers must further reduce costs while providing high-quality service and consider that a smaller number of large companies may dominate the market.

Globalization — of markets requiring the ability to efficiently move goods over long distances often using multiple carriers. Several large transportation consortia are likely to establish themselves in world markets in the next decade.

Reduction in Public Assistance to Transportation — and the high social and political costs of building new transportation systems placing a tremendous emphasis on improved management of existing facilities, thereby requiring the introduction of innovative financing practices and larger participation from the private sector.

Increase in Social Awareness — demonstrated by society's concern with the energy consumption of scarce fossil fuels and the negative by-products of transportation such as noise, air and water pollution.

Streamlining the Logistics Process — to reduce transportation and inventory costs through the expedition of raw materials from origins to production plants, semi-finished products between plants and finished products to consumers.

Intermodalism — to combine the best of two or more modes of transportation for the coordinated movement of people or freight. The economy of line haul with the flexibility of another mode for local collection and distribution is an example.

Aircraft Routing — to reduce aircraft noise and to improve air traffic operation.

Parking on Campus

All vehicles parked in NJIT lots and the parking deck must be registered with the Department of Public Safety and must display a valid parking permit. Access to NJIT parking lots is controlled by using a validated student ID card. The cards are obtained at the Department of Public Safety, which is located in the parking facility. A separate fee is required for on-campus parking. Vehicle registration materials are mailed to all NJIT students who are registered for classes prior to the start of each semester. Registration materials also are available at the Department of Public Safety front desk. For more information, refer to the Parking and Traffic Regulations pamphlet, available at the Department of Public Safety at 154 Summit Street, Newark, NJ..

The Collaborative Doctorate

This doctoral student option is designed to meet the workforce needs of the knowledge-dependent global economy of the 21st century recognizing the particular requirements of the practitioner. This option can meet the needs of engineers, managers, scientists, military personnel and educators who wish to pursue doctoral studies while employed full-time in the private, public and non-profit sectors.

Academic requirements are the same as for other 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. The program includes significant flexibility with opportunities for distance learning and independent study that are integrated with face-to-face classes.

To participate in this Ph.D. program, students should first confer with their employer. Employees should seek a commitment from their employer that will facilitate participation and commitment to an area of research at an appropriate time. A senior researcher or manager may wish to serve on the student's dissertation committee.

Students must meet university requirements for admission to doctoral programs. Prior work, related research activity, publications, and honors will be evaluated in addition to traditional academic criteria.

Doctoral students are expected to have been employed in their field for at least five years, and to have completed a related master's degree. They are expected to continue employment until they complete all degree requirements. Annual reviews of progress will be conducted. Students may perform dissertation research at their employer's facilities. Dissertation research can be derived from interests of the student and may be related to their professional activity.

Dissertation research must satisfy university policies. The student's dissertation committee defines 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. Credit requirements must meet university standards for the doctorate. Course selection is based on previous activities and the current state of knowledge of the student. 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.

Employers who have a proprietary interest in dissertation research including patent, copyright and technology transfer rights are expected to execute formal agreements with the university before research begins.

Graduate Studies

NJIT offers advanced studies in numerous disciplines leading to master's degrees, doctoral degrees and graduate certificates. Programs are available to full-time students and to working professionals who are interested in part-time study. Some programs are offered in cooperation with Rutgers-Newark and with UMDNJ as part of continuing collaborations within The Graduate Center at Newark.

Full-time students are involved in the university's extensive research activities through association with renowned faculty and research centers. Financial support is available through a variety of programs that permit students to become part of the teaching, administrative and research functions of the university. Other non-service-based support is also available.

Graduate Degrees

The doctoral and master's degree programs offered at NJIT are listed below. All doctoral programs lead to the doctor of philosophy; master's programs lead to the master of science with the exception of the Master of Architecture, the Master of Arts in History, the Master of Business Administration in Management of Technology, the Master in Infrastructure Planning, and the Master of Public Health. Dual degree offerings are available for M.Arch./M.S. in Civil Engineering, M.Arch./Master in Infrastructure Planning, and M.Arch./M.S. in Management. Other degree options include the B.S./M.S., the M.S./M.S., the Executive M.B.A. Program, and the Collaborative Doctorate. The degree program descriptions are specified in the NJIT graduate catalog, http://www.njit.edu/catalog.

Applied Chemistry (M.S.)	Applied Mathematics (M.S.)
Applied Physics (M.S., Ph.D.) joint with Rutgers-Newark	Applied Science (M.S.)
Applied Statistics (M.S.)	Architecture (M.Arch.)
Architectural Studies (M.S.)	Biology (M.S., Ph.D.) joint with Rutgers-Newark
Biomedical Engineering (M.S.)	Biomedical Informatics (M.S., Ph.D.) joint with UMDNJ
Business Administration in Management of Technology (M.B.A.)	Chemical Engineering (M.S., Ph.D.)
Civil Engineering (M.S., Ph.D.)	* Computational Biology (M.S.) joint with Rutgers-Newark
Computer Engineering (M.S., Ph.D.)	Computer and Information Science (Ph.D.)
Computer Science (M.S., Ph.D.)	Electrical Engineering (M.S., Ph.D.)
Engineering Management (M.S.)	Engineering Science (M.S.)
Environmental Engineering (M.S., Ph.D.)	Environmental Policy Studies (M.S.)
Environmental Science (M.S., Ph.D.) joint with Rutgers-Newark	History (M.A.) joint with Rutgers-Newark
* Logistics Engineering (M.S.)	Industrial Engineering (M.S., Ph.D.)
Information Systems (M.S., Ph.D.)	Infrastructure Planning (M.I.P.)
Interdisciplinary Studies (M.S.)	* Internet Engineering (M.S.)
Management (M.S.)	Manufacturing Systems Engineering (M.S.)
Materials Science and Engineering (M.S., Ph.D.)	Mathematical Sciences (Ph.D.) joint with Rutgers-Newark
Mechanical Engineering (M.S., Ph.D.)	Occupational Safety and Health Engineering (M.S.)
Occupational Safety and Industrial Hygiene (M.S.)	Pharmaceutical Engineering (M.S.)
Professional and Technical Communication (M.S.)	Public Health (M.P.H.) joint with Rutgers-Newark and UMDNJ
Telecommunications (M.S.)	Transportation (M.S., Ph.D.)
* Urban Systems (Ph.D.) joint with Rutgers-Newark and	

UMDNJ	

* pending approval

Academic Calender

http://www.njit.edu/old/Calendar/

Academic Policies and Procedures

Registration

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 through Thursday, from 8:30 a.m. to 6 p.m., and Friday 8:30 a.m. to 4:30 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 Web site at www.njit.edu/Registrar.

Responsibility for Registration

NJIT mails notices in advance, but cannot guarantee postal delivery. Regardless, students 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 and must register in-person. Students who receive financial support must be in attendance at NJIT and will not be permitted to have other persons register for them.

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 the student. Currently enrolled extension and distance-learning students are informed of registration procedures for fall, spring and summer semesters by the Division of Continuing Professional Education.

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.

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 often available for international students during the international student orientation program.

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; however, any flat rate (12--19 credits) may still apply. If, within the first five class days of the semester, students change their schedule, they must fill out a schedule change form, present it to the registrar, and pay a schedule change fee.

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

Continuous Registration Requirement, Programs

Once admitted to a degree program, students must be continuously registered for credit each semester until they complete degree requirements, unless they have been approved for a leave of absence by the Office of Graduate Studies.

Continuous Registration Requirement, Project/Thesis/Dissertation

Once a project, thesis, or dissertation has begun, students must register in these each semester until completion. MR (maintaining registration) is not permitted in place of a credit registration for project, thesis, or dissertation. The grade of I is not permitted for project, thesis, or dissertation.

Students who complete work for projects, 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.

Multiple Registration

A student generally cannot be matriculated in more than one graduate degree program at a time. Special circumstances may require the approval of the dean of graduate studies and the director of graduate admissions. This also applies to programs run cooperatively with Rutgers-Newark and UMDNJ. 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 in both a degree and a non-degree graduate program or as an undergraduate and graduate student simultaneously.

Students should consult the Office of University Admissions when contemplating a change in program enrollment. Students should refer to “Change of Major” under Admissions in this catalog.

Cross-Registration Procedures

Students may take courses at UMDNJ and Rutgers-Newark College of Arts and Sciences 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 and UMDNJ must be matriculated in graduate programs at their home institution to cross-register for NJIT courses. Students from Rutgers-Newark and UMDNJ 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 and UMDNJ, are determined by the registrar. In general, students enroll as non-matriculated students at the other institution for summer courses.

Registration at Another College

To take graduate courses at colleges other than those in the cross-registration program, students must obtain prior approval from their advisor and the dean of graduate studies. Students should review the section on “Transfer of Credit” 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.

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. 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.

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 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 a 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 dean of graduate studies and 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 dean of graduate studies or 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.

Transfer of Credits from Outside NJIT

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 U.S. 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. On a case by case basis, up to 9 transfer credits may be considered for non-collegiate-based instruction after evaluation by the dean of graduate studies. The university does not grant transfer credit for work experience or other non-instructional activities.

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 consulation with The Office of Graduate Studies but does not require completion of a transfer credit form or submittal of NJIT transcripts.

B.S./M.S. Program

For information about this program, see the B.S./M.S. page.

M.S./M.S. and Dual Master's Programs

The M.S./M.S. 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. The Office of Graduate Studies will direct the registrar on transfer of the two dual-use courses to the second program. The M.S./M.S. program option is not intended for students who have left the doctoral programs without completion of the degree. Up to 6 credits may be transferred to the second master's degree from outside NJIT. Thesis, project, predoctoral research, independent research and similar courses may not be used.

Several other master's degree combinations involving the Master of Architecture, the Master in Infrastructure Planning and the M.S. in Management allow dual use of courses from the first degree to the second. The number of dual use credits for these combinations may exceed 6 credits in accordance with specific program arrangements.

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 cancelled 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 at www.njit.edu/Registrar. Changes are posted adjacent to doors of originally scheduled rooms.

Enrollment Status

Full-time Students/and Full-time Certification Students registered for 12 credits or more throughout an entire semester are considered full-time. International students must be in full-time status every semester. Full-time certification for allowable situations of less than 12 credits is discussed below. Students who are not registered for 12 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 12 credits, under any of the following circumstances:

- Students have fewer than 12 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 students preparing for qualifying examinations or research proposal presentations and are registered for at least 9 credits.
- Doctoral candidates who completed all required course work, and accumulated the required dissertation credits but have yet to complete the dissertation and defense, are registered in Dissertation Research (and seminar if required) for at least 3 credits each semester.
- Students originally registered for 12 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.

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. Until the Office of Graduate Studies verifies that all tuition bills and fees have been paid, and that master's thesis or doctoral dissertation have been completed in the appropriate format, degrees will not be certified. 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 or program office. At least three program approval signatures are required for master's theses; at least five are required for doctoral dissertations. Fees that must be paid include, but are not limited to, the binding fee, publishing fee, copyright fee, and graduation 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 project, master's thesis or doctoral dissertation. All 500-level or higher courses are included in the cumulative GPA, regardless of applicability to a specific degree. Only the initial grades for graduate courses that have been repeated 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 project, master's thesis or doctoral dissertation, must be 3.0 or better. Grades for master's project or thesis must be a B or better. Completion of the doctoral dissertation and its defense will be assigned a grade of P for passing. The P grade is for dissertation credits taken in the student's final semester. Some types of courses are graded S or U and have no impact on the GPA. Unresolved U's, with the exception of a U in a co-op course, will prevent degree certification.

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 completed within seven consecutive years of original admission. Approved leaves of absence do not count against the seven-year limit for completion of the degree although the validity of individual courses may still expire during this time. Requests for waivers of the seven-year limit for extenuating circumstances, other than mere failure to register, are made to the dean of graduate studies. The technical content and remaining currency of courses is considered in evaluating these requests. The majority of courses in rapidly changing fields (such as computer science) are not likely to be accepted after seven years.

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 and is available in the NJIT Bookstore. 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.

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 in areas in which courses are not normally available. 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 satisfy the 700-level course requirements.

Awarding of Degrees

Degrees are awarded three times each academic year: August, January and 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. 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.

Master of Infrastructure Planning

See the Master of Infrastructure Planning (MIP) page.

Master of Arts

See the Master of Arts in History and Master of Arts in Teaching (History) pages.

Master of Business Administration in Management

See the Master of Business Administration in Management page.

Master of Science

Master of science degrees require a minimum of 30 credits: 18 credits in an area of specialization, which may include a 6-credit thesis or 3-credit project, and 12 credits of electives. Some programs may require students to take more than 30 credits to fulfill degree requirements. The particular programs and departments establish the necessity and requirements for a master's project or thesis and defense.

The 18 credits in an area of specialization must be courses numbered 600 or above, depending on program requirements. Some programs may permit up to 6 of these credits for courses numbered 500 to 599.

The 12 credits of electives are subject to advisor approval. Typically, students are permitted to take at least 6 elective credits outside the department of major study. The departments may set limits on allowing students from outside the department's programs to take their courses.

More detailed descriptions of individual degree requirements may be found in the Degree Programs section of this catalog.

Bridge Program: Students who seek graduate degrees in an academic discipline different from the discipline in which they received their baccalaureate degree may be required to take additional courses. The program of courses will be individually designed in consultation with their graduate advisor. Such courses must be taken before beginning graduate curricula. They may include undergraduate courses. These courses are not counted toward degree requirements but if they are numbered 500 (500 G for architecture) or higher, they are included in the cumulative GPA calculation.

Master's Degrees Offered by The School of Architecture

A full description of these requirements may be found under "Architecture" in the Degree Programs section of this catalog.

Doctor of Philosophy

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.

Doctoral program credit requirements for joint programs, with both university names to appear on the diploma, are to follow the requirements of the program as approved by the two universities, generally a minimum of 72 credits beyond the bachelor's degree. Similarly, joint programs with UMDNJ are to follow requirements established jointly by the two universities.

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.
- For both entry levels, 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 by Newark College of Engineering or by the College of Science and Liberal Arts.
- 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 by the College of Science and Liberal Arts, jointly with Rutgers-Newark, or jointly with UMDNJ.
- 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 dean of 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. Exceptional students, only having bachelor's degrees, who are admitted into doctoral programs must take the qualifying examination within one and one-half years of admission and must pass it within two years. Students are only permitted to take the examination twice. The passage of qualifying examinations is reported to the Office of Graduate Studies. 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

Students 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.

Department chairpersons or doctoral program directors are responsible for approving formation of dissertation committees. Most dissertation committee members are faculty from the student's program or department. The dissertation committee chairperson typically is the doctoral candidate's dissertation advisor, but other faculty may be selected, provided that they are from the student's program or department. The committee consists of a minimum of five members, one of whom is external to the program, or to NJIT. For candidates whose program is interdisciplinary and in more than one department, the external member must not be connected to the student's program or discipline. Two committee members, including an external member, may serve as co-advisors for the dissertation. Changes in advisor or committee membership requires the approval of the dean of graduate studies.

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 criteria 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 dean of 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 commencement 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. 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 these 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 matriculated graduate program making use of any certificate credits. Students who may have completed the course requirements for a certificate in a matriculated degree program are not permitted to receive a certificate until completion of the matriculated program. Only one certificate can be received within any one graduate program.

Academic Standing

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
AUD		Audited (no academic credit)

S or U		Satisfactory or Unsatisfactory
P		Passing for Doctoral Dissertation and Defense

(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 matriculition level of the student in the course.)

Grade Reports

The registrar issues a grade report to each student at the end of each semester. Grades also 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 dean of graduate studies may be consulted.

In all cases, final authority to award grades rests with the instructor.

Special Circumstances

Students should bring to the attention of the dean of graduate studies any special circumstances that may adversely affect academic standing. This action must be taken as soon as such circumstances develop.

Thesis, Project or Dissertation Grades

Grades for these are S or U until completion. Students who do not complete a thesis, project or dissertation in a semester, regardless of accumulated credits, must register again for these in the following semester. Grades of S or U cannot be changed after a semester is over to show retroactive completion or to avoid the additional registration(s).

Incomplete

A grade of I (Incomplete) is given when courses cannot be completed because of special circumstances. Students on academic probation are not permitted incompletes 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 courses in a 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. This grade cannot be changed.

A grade of I cannot be given for thesis, project, dissertation, seminar, pre-doctoral research, co-op or English as a Second Language (ESL) courses. Students in joint programs or cross-registered from or with 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.

Withdrawal from Course(s)

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 their advisor or the Office of Graduate Studies in advance. Withdrawals are done by completing and submitting a Schedule Change Form to the Registrar's Office by the end of the ninth week of the semester. This form requires the signature of the instructor(s). It is available from the Registrar's Office. Failure to submit this form to the registrar 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.

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.

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.

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 graduate studies. Students may not repeat a course without prior approval from the department and the Office of Graduate Studies. Students who receive an F in a course will be required to repeat that course. The dean of graduate studies should be consulted if the course is no longer offered or not applicable to the student's current program or other extenuating circumstances are believed to exist.

Final Grades in Project, Thesis, Dissertation and Research

Letter grades are given for satisfactory completion of project, thesis or independent study. Projects and theses must be submitted first, before a grade can be given. The final grade for a completed and approved dissertation and defense is P. Theses and dissertations are submitted to the Office of Graduate Studies. Projects are submitted to the project graduate advisor. Independent study requirements are established by the departments.

Semester and cumulative GPA calculations by the registrar only include courses for which a letter grade is given. For the purpose of the GPA, 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 an unfinished project or thesis, nor for work not submitted. Receipt of two U grades for project, thesis, dissertation, or pre-doctoral research can result in a letter grade of F in place of the second U and dismissal from the program.

Transcript of Grades

Students who wish to obtain a transcript issued on their behalf must submit a request in writing to the registrar. A fee for each copy must accompany written transcript requests. Allow 10 days to process the request. Transcripts will not be issued to or on behalf of a student with outstanding financial obligations to the university. Official transcripts bearing the university's raised seal will be issued only to other educational institutions, government agencies, or employers. Under no circumstances will official transcripts be issued to students.

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. Students are responsible for checking regularly with the office of the department of major study or the Office of Graduate Studies to determine if they are fulfilling degree requirements.

The Office of Graduate Studies, along with academic departments, reviews 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 satisfactorily 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 semester (or its equivalent of 12 credits) and do not have satisfactory academic standing may be asked by the Office of Graduate Studies to visit in-person to review their academic record and also meet with their graduate advisor. This is not noted on the permanent academic record.

Academic Probation

Students who have completed two or more semesters, or more than 12 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 students to determine approaches toward successful program completion. Course repetition or the taking of up to 6 additional credits are typical recommendations for students whose GPA is below 3.0 and have the ability to raise the GPA to 3.0 with appropriate grades.

Students on academic probation may not maintain registration without the approval of the Office of Graduate Studies. Academic probation may be noted on the permanent academic record.

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 12 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 Student Handbook.
- 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.

Appeals

Decisions relating to a graduate student's academic status are made in accordance with regulations approved by the faculty and its standing committees. Committees include, but are not limited to, the Graduate Council and the Committee on Academic Affairs.

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. At any time, the student may request that the dean of graduate studies be consulted.

A graduate student who remains dissatisfied may appeal the decision to the Committee on Graduate Appeals through the Office of Graduate Studies. The committee's decision, made in writing, is final. Student requests for review or appeal must be in writing and state accurately and completely the decision being appealed, when it was made, by whom, and the reason for the request. Requests should be sent to the dean of graduate studies. A copy of the request together with transcripts, test scores, and other information that form the student's record are distributed to the committee members for their consideration.

Readmission if Dismissed

Students dismissed from NJIT 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 statement by the applicant. A non-refundable fee of $60 must accompany applications.

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, but should seek approval for a leave of absence at which time maintaining registration may be authorized. Students who have discontinued must follow procedures defined by the offices of University Admissions and Graduate Studies to resume their studies.

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 $60 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 and Faculty.

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 Web site.

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.

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 Office of Health Services 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 seven-year period 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.

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 of $60 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 are:

For the fall semester	June 5
For the spring semester	October 15

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, project or dissertation credits will be allowed as long as the advisor grades the work to show that there is satisfactory progress. Credits for which a U (unsatisfactory) grade is given are not counted as degree credits toward completion of the thesis, project or dissertation. Doctoral dissertation registration may be 3 credits during a summer session.

Master's project or master's thesis registration must be at least 3 credits during a semester or summer session. Doctoral dissertation registration must be at least 6 credits during a semester until the total dissertation credit requirement is reached, at which time 3 credit registrations are permitted.

All students must have their advisor's signature and section identification each time they register for project or thesis. Students must register for thesis, project or dissertation work within the deadlines established by the registrar.

Maximum credit registration each semester is 12 credits for the doctoral dissertation, 6 credits for the master's thesis and 3 credits for the master's project. Additional credit registrations, beyond 12, for doctoral dissertations, will require approval of the dean of graduate studies.

Once a student has begun a master's project, master's thesis or doctoral dissertation, the student must register for these courses each semester until the project, thesis or dissertation is completed. Unapproved interruptions in project, thesis or dissertation 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 a final grade 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 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, 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.

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 F, and may result in dismissal.

No more than six years of registration for doctoral dissertation is permitted. Failure to complete a doctoral dissertation in this period will result in a final grade of F, and dismissal from the program.

Students who require additional time to complete a project, thesis or dissertation should appeal for an extension, in writing, to the graduate program advisor, the academic department, and the Office of Graduate Studies.

Deadline Waiver

Applicants for January or May graduation 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 Office 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. 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 obtain a final grade.

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. A copy of the handbook may be obtained from the Office of the Dean of Students.

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 Hazell 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 Hazell 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

The Federal Family Educational Rights and Privacy Act of 1974 gives students the right to inspect any educational records about them maintained by NJIT. Students have the right to a hearing to challenge the contents of these records, and also have the right to add to their records an explanation of information they challenge. Unless specifically exempted by the public law, NJIT is mandated to keep student records strictly confidential.

The university registrar is responsible for student records. Educational records are defined as transcripts, admission files and registration forms. To review their files, students must contact the registrar, in writing, to specify the items they want to see. Student health records are maintained by the Director of Health Services and may only be examined by a health professional chosen by the student.

Educational records defined by the public law must be made available within 45 days after a student requests to see them. A catalog of educational records kept by NJIT is available from the registrar. Exceptions to the right of inspection include financial aid records and records of institutional, supervisory, and administrative personnel, and ancillary educational personnel.

For a nominal service fee, copies of these records may be made for students.

Only those at NJIT acting in the student's interest are allowed access to student files, including personnel in the registrar's, admissions, student services, and finance offices; and academic personnel within the limitations of their need to know.

With the exceptions stated in the law, no one outside NJIT shall have access to a particular student's educational record without the written consent of the student, except in extraordinary circumstances such as emergencies.

Accrediting agencies carrying out their accrediting function and certain state and federal officials are permitted access. A record of, and reasons for, granting access will be kept by the university and will be available to the student.

The university, 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 who desire directory information to be withheld should notify the registrar in writing within the first two weeks of initial registration.

Request for non-disclosure will be honored by the university for ONLY ONE ACADEMIC YEAR AT A TIME. Authorization to withhold directory information must be filed annually in the Office of the Registrar.

Students who disagree with an entry may challenge its accuracy with the Office of the Registrar. If this remedy fails, either NJIT or the student may request a formal appeal hearing. The law mandates that such hearings be held within 30 days of requests, and be conducted by a university official or other person with no direct interest in the outcome. Students will be given a full and fair opportunity to present relevant evidence and be represented by their own counsel.

Students may include a written statement in their file explaining a disputed entry following an unfavorable determination of an appeal. A written decision will be rendered within 15 working days after the hearing of an appeal.

Students who believe that they are treated unfairly or improperly and contrary to the provisions of the law may request, in writing, assistance from the provost of the university or the provost's designee. Students who believe that their rights have been abridged may file complaints with the appropriate federal agency.

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 that its role as an educational institution is best served by disclosing to the public all academic research, dissertations and theses 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

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 students who are attending or are employed by the university.

To protect against premature disclosure or publication of a proprietary nature, students must immediately report the same to the Office of Intellectual Property. Students must neither publish nor discuss proprietary information with anyone other than the director of the office of intellectual property or members of the University Patent Committee. When a project, thesis or dissertation covers such material, the student or the advisor must report the existence of such material to the Office of Graduate Studies and the Office of Intellectual Property; the university will expedite its review. If necessary, the Office of Graduate Studies and the Office of Intellectual Property 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 agreement specifying royalties, licensing and sale. All income derived from intellectual property will be shared between NJIT and the student. The size of the share is determined by university policy and/or special agreement.

For further information, call the Office of Intellectual Property, (973) 596-5820.

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, the City of Newark, the City of Mount Laurel, and the County of Burlington. 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.

Academic Programs

B.S./M.S. and Dual Degree Programs

This accelerated dual degree program permits undergraduates to earn credits toward a master’s degree. Students take 6 credits of graduate course work in their senior year. These may be counted towards 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 after they complete at least five courses in their major, and have maintained a GPA of 3.0 or better. Students must submit the application for admission to the B.S./M.S. program to the Office of Graduate Studies no later than one year prior to graduation. Applicants must fulfill all university requirements for admission to graduate programs. Some programs will require submittal of GRE or GMAT scores. For all others, these are highly recommended.

Information and applications can be obtained from the Office of Graduate Studies, (973) 596-3462.

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./M.S. in Management program, which allows 12 dual-use credits.

M.S./M.S. and Dual Master’s Programs

The M.S./M.S. 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. The Office of Graduate Studies will direct the registrar on transfer of the two dual-use courses to the second program. The M.S./M.S. program option is not intended for students who have left the doctoral programs without completion of the degree. Up to 6 credits may be transferred to the second master’s degree from outside NJIT. Thesis, project, predoctoral research, independent research and similar courses may not be used.

Several other master’s degree combinations involving the Master of Architecture, the Master in Infrastructure Planning and the M.S. in Management allow dual use of courses from the first degree to the second. The number of dual use credits for these combinations may exceed 6 credits in accordance with specific program arrangements.

The Executive Program: Master of Science in Management

The Executive Program, operated by the School of Management, is an accelerated 14-month M.S. in Management degree program for rising executives, specifically designed to meet the needs of business professionals and the demands of corporate life. The curriculum emphasizes the use of information systems, strategic planning and the integration of business functions. The program addresses competition in the global marketplace, the deployment and use of technology, environmental issues, and ethical standards for business leaders. The Executive Program is accredited by AACSB.

The program begins with a five-day residential session. A second residential session involving an international study tour is held approximately nine months later. The remainder of the program is taught on campus, Fridays and Saturdays, every other week. Classroom meetings are separated by 12 days or more to accommodate business travel. The Executive Program is offered three times a year. Classes at the Newark campus start in February and August and in October at the NJIT at Mount Laurel campus.

Interest from the business community has been enthusiastic. For more information, contact the Executive Program, (973) 596-6378.

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 support 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.

Cooperative Education

The Cooperative Education Program provides students with an experiential and applications approach to education. Through cooperative education, students gain academically integrated work experience that is related to their degree. Qualified graduate students gain salaried professional experience while they earn their degrees.

Co-op work experiences are concurrent or alternate with full- or part-time graduate study. During placement periods students are enrolled in the graduate co-op work experience course. Graduate co-op work experience periods are not limited to academic semesters. Students may begin work in the second semester of attendance at NJIT (except for international students).

All co-op student participants must be able to produce U.S. employment authorization. Bureau of Citizenship and Immigration Services(BCIS) regulations require students with F-1 visas to be in valid status for nine consecutive months before they can be placed in co-op employment. International students become eligible to apply during their second semester of study. They must secure employment authorization from the Office of International Students and Faculty before beginning a co-op work experience. There are additional restrictions on co-op employment for students on financial support or involved with research activity and thesis or dissertation work. The Office of Graduate Studies may be consulted about policy issues.

Community and Public Service

Graduate students may also receive financial support through participation in the NJIT Service Corps. Through experiential learning activities, students link classroom theory and concepts with practical application, contribute their expertise and develop leadership, decision-making and interpersonal skills through involvement with non-profit and governmental agencies and community-based organizations.

- **Community Service Work Study:** Off-campus employment that is course- and major-related in non-profit and governmental agencies and community-based organizations for eligible Federal Work Study graduate students.
- **Housing Scholars:** Merit-based, competitive full-time summer employment in community-based organizations that design and develop plans for affordable housing projects around the state. Students pursuing graduate degrees in civil engineering, management, computer science and computer engineering who are U.S. citizens or permanent residents, have completed 6 credits of graduate study, are in good academic standing, have satisfied all other university requirements for financial support, and are approved by their department’s co-op advisor are eligible to apply. Architecture students may apply after completing 14 credits of first-year required graduate courses

and if they have an overall cumulative 3.2 GPA or above. However, participation cannot begin until 28 credits are completed.
- **Service Learning:** Course-based, students can register for classes that include a community Service Learning option or register for faculty-monitored independent study that includes a community Service Learning component.

For more information, contact the Division of Career Development Services, Community and Public Service, (973) 596-3100.

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

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, infrastructure planning, and materials science and engineering 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.

Graduate Management Admission Test (GMAT) The GMAT is required for all applicants for the M.B.A. in Management of Technology and the M.S. in Management programs. 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.gmac.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

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 www.aamc.org/stuapps/admiss/mcat/start.htm. 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).

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.

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.

Admissions Requirements for Master's Study

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 the bachelor's degree may be admitted to a master's degree program and 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 the Internet, www.njit.edu. A non-refundable fee of $60 must accompany the application. Applications may be deferred for one semester for a delay in admission without incurring another $60 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; for spring (January) admission by October 15. Applications for financial support for fall (September) must be received by January 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 an application for admission to the new program and provide appropriate supporting materials. 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 UMDNJ 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 UMDNJ.

M.S./M.S. Program For information about this program, see the B.S./M.S. page.

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. International applicants must show a TOEFL score of at least 550(Paper-based)/213(Computer-based). 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 Academic Programs 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 UMDNJ. Students may apply and be admitted through either university. Programs that lead to joint degrees are applied physics, biology and mathematical sciences with Rutgers-Newark and urban systems with Rutgers-Newark and UMDNJ. NJIT coordinates the computer and information systems specialization of 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 Major

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 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 B.S./M.S. program are required to take 6 graduate-level credits while undergraduates to satisfy 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 Test of English as a Foreign Language (TOEFL) 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 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.

Students with TOEFL scores of 550(Paper-based)/213(Computer-based) 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 12 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). 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.

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 the equivalent
Chile	Bachillerato, 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	Diplomgrad, Staatsexamen or Magister Artium
Greece	Ptychion
Guatemala	Licenciatura
Haiti	Diplome d’Etudes Superieures 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 subjects
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.
Pakistan	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 Profesor from a four-year university program
Philippines	Bachelor’s degree
Saudi Arabia	Bachelor’s degree
Singapore	Honors bachelor’s degree
Sweden	Filosofie Kandidatexamen or Ekonoexamen
Switzerland	Licence or Diplom of at least a four-year duration
Syria	Licentiate or bachelor’s degree
Rep. of China (Taiwan)	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.

Directory

University Mailing Address

New Jersey Institute of Technology
University Heights
Newark, New Jersey 07102-1982

University Switchboard

(973) 596-3000
In New Jersey: 1 (800) 925-NJIT or
1 (800) 222-NJIT (Mount Laurel)

NJIT on the Internet: http://www.njit.edu

Many academic and administrative departments have home pages on NJIT's Web site and are accessible from the address above.

Main Offices	Extension
Admissions: Graduate and Undergraduate	3300
Alumni Affairs, Office of	3441
Biological Sciences, Federated Department of NJIT and Rutgers-Newark	6597
Biomedical Engineering, Department of	3584
Bookstore	3200
Bursar, Office of the	3148
Career Development Services, Division of	3100
Chemical Engineering, Department of	3568
Civil and Environmental Engineering, Department of	2444
College of Computing Sciences, Dean	5488
College of Science and Liberal Arts, Dean	3677
Computer and Information Science, Department of	3366
Computing Help Desk	2900
Continuing Professional Education, Division of	3060
Cooperative Education and Internships, Office of	3100
Electrical and Computer Engineering, Department of	3512
Employment, Student	3474
Engineering Science Program	3584
Engineering Technology, Department of	3228
Chemistry and Environmental Science Program	3595
Financial Aid, Office of	3479
Graduate Studies, Office of	3462
Information Technology Program	3366
History, Federated Department of NJIT	5344
History Federated Department of Rutgers-Newark	353-5410

Honors College, Albert Dorman	4448
Human Resources, Office of	3140
Humanities and Social Sciences, Department of	3266
Industrial and Manufacturing Engineering, Department of	3655, 3660
Intellectual Property, Office of	5825
International Students and Faculty, Office of	2451
Library, Architecture	3083
Library, Robert W. Van Houten	3206
Mathematical Sciences, Department of	5782
Mechanical Engineering, Department of	3331
Microelectronics Research Center	5714
Newark College of Engineering, Dean	3222
New Jersey School of Architecture, Dean	3080
Physical Education and Athletics	3636
Physics, Department of	3562
Public Safety	3111
Registrar, Office of the	3236
Research Office	3429
Residence Life	3039
School of Management, Dean	3248
Student Center, Hazell	3605
University Advancement	3400
University Communications	3433

Campus Map and Travel Directions

http://www.njit.edu/about/visiting/

Course Code Explanation

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

Code	Department
Acct	Accounting
Arch	Architecture
BINF	Biomedical Informatics
BME	Biomedical Engineering
CE	Civil Engineering
ChE	Chemical Engineering
Chem	Chemistry
CIS	Computer and Information Science
ECE	Electrical and Computer Engineering (formerly CoE, EE)
Econ	Economics
EM	Engineering Management
EnE	Environmental Engineering
Eng	English
EPS	Environmental Policy Studies
EvSc	Environmental Science
Fin	Financial Management
Hist	History
HRM	Human Resource Management
IE	Industrial Engineering
Math	Mathematics
ME	Mechanical Engineering
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
OSIH	Occupational Safety and Industrial Hygiene

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 intermediate-level graduate courses normally associated with master's-level study.

Numbers from 700 to 799 indicate advanced-level graduate courses normally associated with doctoral-level study.

Rutgers-Newark Courses

The number preceding each course title is divided into three parts. The first two digits are the administrative code (standing for a faculty or a school), the next three digits are the subject code, and the final three digits are the course code.

ADMINISTRATIVE CODES

The following administrative codes are used in this catalog.

Code	Department
16	Graduate School-New Brunswick
25	College of Nursing
26	Graduate School-Newark

SUBJECT CODES

The following subject codes are used in this catalog.

Code	Department
120	Biology
198	Information Systems
215	Ecology and Evolution
460	Geology
510	History
620	Management
630	Marketing
705	Nursing
711	Operations Management
755	Physics, Applied
790	Political Science
834	Public Administration

960	Statistics

COURSE CODES

Two course codes separated by a comma indicate that each term course may be taken independently of the other, e.g., 26:70:537,538.

Courses numbered in the 500s and 600s are for graduate students in advanced-degree programs. Courses numbered in the 700s are ordinarily intended for students preparing individual research theses for advanced degrees.

UMDNJ Courses

NUMERICAL CODE

The UMDNJ School of Health Related Professions courses listed in this catalog are at the 5000 and 6000 level and correspond to NJIT's 600-level courses, those normally associated with master's-level study; those at the 7000 level correspond to NJIT's 700-level courses, those normally associated with doctoral-level study. The UMDNJ's New Jersey Medical School courses listed in this catalog numbered in the 600s correspond to NJIT's 600-level courses, those normally associated with master's-level study.

ALPHABETICAL CODE

Code	Department
BINF	Biomedical Informatics
BIO	Biostatistics
EPI	Epidemiology
QM	Quantitative Methods

The Executive Program

The Executive Program, operated by the School of Management, is an accelerated 14-month M.S. in Management degree program for rising executives, specifically designed to meet the needs of business professionals and the demands of corporate life. The curriculum emphasizes the use of information systems, strategic planning and the integration of business functions. The program addresses competition in the global marketplace, the deployment and use of technology, environmental issues, and ethical standards for business leaders. The Executive Program is accredited by AACSB.

The program begins with a five-day residential session. A second residential session involving an international study tour is held approximately nine months later. The remainder of the program is taught on campus, Fridays and Saturdays, every other week. Classroom meetings are separated by 12 days or more to accommodate business travel. The Executive Program is offered three times a year. Classes at the Newark campus start in February and August and in October at the NJIT at Mount Laurel campus.

Interest from the business community has been enthusiastic. For more information, contact the Executive Program, (973) 596-6378.

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		U.S. citizens, permanent residents; students enrolled at least half time, based on financial need; must file the Free Application for Federal Student Aid.
Federal Work-Study		U.S. citizens, permanent residents, based on position availability and financial need; must file the Free Application for Student Aid.
Industry Co-op		Full-time students, based on position availability; master's only.
Hourly Jobs		U.S. citizens, permanent residents, international students, full-time students, based on position availability.
Scholarships, Fellowships, Grants		Based on funding source, full-time students, often supporting under-represented groups.
Assistantships		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 January 15th for the fall semester of the following academic year and October 15th for the spring semester of the current academic year. Applications received after these dates may be placed on a waiting list.

Current students seeking financial support must submit an Application for Graduate Financial Support. These forms are available from the Office of Graduate Studies. GRE (general section) or GMAT scores must be available for any student, prospective or current, seeking financial support. Transcripts and other records of courses taken at the undergraduate and graduate level also must be available.

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, discussion, laboratory, or other sections of elementary or intermediate undergraduate-level courses, under supervision of permanent faculty. These duties are considered part-time work and typically include six to nine class contact 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.

Presidential Fellows

A limited number of fellowships, with stipends beginning at $16,200, are offered to outstanding doctoral students. Residence, research and summer support can supplement the stipend. Full tuition and fee support is provided.

Teaching Fellows

Teaching fellows provide services similar to those of an adjunct instructor and their stipends are based on the adjunct salary scale. A maximum of two courses, or six contact hours, per week may be assigned. Tuition remission of 3 credits for each course taught may be awarded in addition to the stipend.

Grader

A grader is appointed for part-time service and grades course work under the direction and supervision of a faculty member. Graders may either be hired on an hourly basis through the Office of Student Employment, or through the Office of Graduate Studies. 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

Private, state, federal or foundation awards that do not require service to NJIT may supplement service-based awards.

Stipend Support Levels

Teaching/Research Assistant (not supported by grants):

Master's	$8,100	9 months at $900/month
Doctoral students	$12,150	9 months at $1,350/month
Doctoral candidates (those who have completed all requirements other than dissertation)	$13,050	9 months at $1,450/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/12 months):

Master's	$10,800--$15,000
Doctoral	$16,000--$23,400

Graduate Assistant: non-academic based positions requiring advanced educational skills, $6,750 for 9 months; and positions not requiring advanced educational skills, $6,075 for 9 months. Students seeking non-academic positions may instead wish to consider hourly employment instead of graduate assistant positions.

Partial awards are possible for all categories of awards. Stipends are paid every other week. Award periods are scheduled for two consecutive 4 1/2-month periods with no gaps between fall and spring award periods. Support levels are reviewed annually.

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.

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 Bureau of Citizenship and Immigration Services (BCIS) and must attain a TOEFL score of at least 550(Paper-based)/213(Computer-based) to be considered for financial support upon admission. Those with TOEFL scores below 550(Paper-based)/213(Computer-based) are required to attend ESL classes and may be eligible for support after satisfactory completion of the required ESL courses. International students are eligible only for merit-based NJIT financial support, as indicated above, and NOT for need-based state or federal funds.

BCIS 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

University Research Experience (URE)

The State of New Jersey established URE to encourage and support underrepresented groups to engage in undergraduate research and pursue graduate study on a full-time basis. Contact the URE office for further information, (973) 596-6470.

Minority Academic Career Program (MAC)

The MAC program supports doctoral students interested in faculty positions in New Jersey. Contact the Office of Graduate Studies for information on this and other state programs.

NSF and NRC Programs

The National Science Foundation and the National Research Council support doctoral stipends and tuition. Application deadlines for these programs are one year in advance of anticipated study, usually in early fall. Contact the Office of Graduate Studies for information on these and other federal programs.

GEM

The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. supports graduate students within an industry and academe-based consortia. Contact the Office of Graduate Studies for information on this and other industry programs.

Federal Direct and Perkins Loans, and Work-Study Programs

U.S. citizens and permanent residents are eligible to apply for federal loans through the William D. Ford Federal Direct and Federal Perkins Loan programs and for federal work-study. Applicants for these programs must file the Free Application for Federal Student Aid (FAFSA) with the Federal Student Aid Programs Processing Center. 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 first-time loan recipients must complete entrance counseling. The FAFSA is available from the Office of Financial Aid and will be mailed upon request. For further information, contact the Office of Financial Aid, (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. TOEFL and ESL requirements are noted in the "International Students and TOEFL" and "Test Requirements" in the Admissions section of this catalog.

Although there is no minimum eligibility score for the GRE or GMAT, NJIT may establish them for certain awards. For instance, GRE mathematical scores between 700 and 800 are typical of NJIT award recipients. 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.

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 Graduate Studies) 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 or 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. A handbook of financial support policies and procedures is maintained by 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, presidential 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, throughout the period of their award except on legal and NJIT holidays. 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 maximum 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 12 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 dean of 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.
- All doctoral students and students on support are required each semester to attend the seminar course offered by their program unless a specific waiver for sound academic reasons has been granted by the dean of graduate studies. Waivers for doctoral students to allow off-campus employment through precompletion practical training authorization or to accept a cooperative education work assignment will generally not be approved.

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 dean of 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

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.

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, as is renewal of award offers. Each award has 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.
- 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.
- 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.
- No student may receive support for more than 12 semesters and 6 summers from any combination of sources or for any number of degrees.
- 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.

Resignations

Students who wish to resign from an award should inform their advisor and the dean of 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 Finance Office and the Office of Graduate Studies for tax information and information about exemption from Social Security taxes. International students should contact the Finance Office and the Office of International Students and Faculty 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.

Students who fail to pay their bills by the due date specified by the Bursar will have their registrations cancelled. Reinstatement is usually very difficult and often unlikely.

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. Students in programs that require more than

30 credits may be permitted to receive tuition remission for more than 12 credits in a semester.

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.

Full-time students who take 12 to 19 credits per semester pay an inclusive tuition block rate. Any credits that students take beyond 19 credits are not included in tuition remission awards. Students will be billed for these credits.

Graduate Certificates

Administered By: Division of Continuing Professional Education

Administration

Associate Vice President, Continuing and Distance Education Gale Tenen Spak Phone: (973) 596-8540

Graduate Certificates Offered:

- **Bioinformatics---(New)** -- relates in its entirety to **NJIT MS in Computational Biology**

- **Business Management Fundamentals---(NEW)** -- relates in its entirety to **NJIT MBA** or **NJIT MS in Management**

- **Construction Management--(NEW)** -- relates in its entirety to **NJIT MS in Civil Engineering** or **NJIT MS in Engineering Management**

- **Information Assurance--(NEW)** --relates in its entirety to **NJIT MS in Computer Engineering** or **NJIT MS in Electrical Engineering** or **NJIT MS in Computer Science.**

- **Information Systems Auditing--(NEW)** --relates in its entirety to **NJIT MS in Information Systems.**

- **Information Systems Design** --relates in its entirety to **NJIT MS in Information Systems.**

- **Information Systems Implementation** --relates in its entirety to **NJIT MS in Information Systems.**

- **Internet Applications Development--(REVISED)** --relates in its entirety to **NJIT MS in Information Systems** or **NJIT MS in ComputerScience.**

- **Management of Technology** --relates in its entirety to **NJIT MBA** or **NJIT MS in Management.**

- **Operations Productivity--(NEW)** --relates in its entirety to **NJIT MS in Industrial Engineering** or **NJIT MS in Engineering Management.**

- **Pharmaceutical Management--(NEW)** -- relates in its entirety to **NJIT MBA** or **NJIT MS in Management** or **NJIT MS in Engineering Management.**

- **Pharmaceutical Technology** -- relates in its entirety to **NJIT MS in Pharmaceutical Engineering.**

- **Practice of Technical Communications--(REVISED)** --relates in its entirety to **NJIT MS in Professional and Technical Communication.**

- **Project Management** --relates in its entirety to **NJIT MS in Engineering Management.**

- **Sustainable Architecture--(NEW)** --relates in its entirety to **NJIT Master of Architecture** or **NJIT MS in Architectural Studies.**

- **Telecommunications Networking** --relates in its entirety to **NJIT MS in Telecommunications** or **NJIT MS in Electrical Engineering** or **NJIT MS in Computer Science.**

- **Virtual Tools for Prefessional Communities--(NEW)** --relates in its entirety to **NJIT MS in Information Systems.**

Note: Because they are employment-driven, the particular graduate certificates offered in any given year may change. See the Continuing Professional Education Catalog for current listings.

The Graduate Certificate program is designed to facilitate the return to formal advanced education by busy adult professionals. Each Graduate Certificate is in a professional field externally validated as “fast track” with employment opportunities through the year 2005. Critical to the arrangement for each Graduate Certificate is the philosophy that NJIT course work can proceed quickly in one calendar year and in tandem with other endeavors of an equally demanding nature such as full-time employment and family/childcare responsibilities.

Certificates may be completed in one calendar year by attending designated or lock-step courses in fall, spring and summer sessions. A typical schedule for students who begin in the fall is: one course in the fall, two in the spring, and one in the summer. Students who start in a spring semester register for one course each in the spring and summer; and two in the following fall. (Should students’ outside pursuits or constraints prevent adherence to this pacing, it may be possible either to accelerate the pacing or to register for missed courses at a later time).

Students can complete some Graduate Certificates in whole and others in part through classes conducted via electronic communications that demand equal effort but which do not require formal classroom attendance. More details concerning the electronic classroom are furnished in the Continuing Professional Education Catalog.

Students study through electronic means or attend one or two, 3-hour class(es) per week in a lock-step sequence on weeknights and Saturdays at NJIT's Newark campus or at off-campus extension locations.

Academic Standards:

Whether taking courses at the Newark campus, at extension sites or by eLearning, participants in the Certificate Program are expected to comply with all the standards and regulations governing NJIT graduate study as set forth in this catalog. Students should be cognizant of any bridge courses or prerequisites for courses within the certificate programs.

Admission Requirements:

As documented by transcript(s), students must possess, at minimum, an undergraduate degree from an accredited college or university or its equivalent with a GPA that meets NJIT academic standards for regular admission as a matriculated master's program student.

Students must submit an application form for the certificate program in the non-degree (non-matriculated) NJIT admission classification. Application forms are available from the Division of Continuing Professional Education (CPE) or online at http://cpe.njit.edu/apply.htm. An official transcript must be submitted to CPE and to Graduate Admissions that shows completion of an undergraduate degree.

On evaluation of prior academic record and other factors, program directors or designees may advise prior completion of bridge course(s) required to facilitate the student's academic performance.

In general, students attending NJIT on a non-matriculated basis are limited to enrolling in no more than three graduate courses. As a special feature of the Graduate Certificate Program, students in good standing who have completed 9 credits toward a certificate will be granted a waiver by the Office of Graduate Studies to continue as a non-matriculated student for the purpose of completing the remaining graduate certificate requirements.

It is anticipated that some certificate recipients may desire to continue their studies toward a corresponding master's degree. Regular university procedures and policies will apply to those interested in making such a progression. These will typically include completion of an application for admission to a degree program, submission of all required transcripts, test scores and letters of reference, and payment of application fees.

Graduate Certificate Program: 12-credit graduate certificates available. See Graduate Certificates in this catalog. For further information, contact the Associate VP for Continuing and Distance Education, (800)624-9850 or (973)-596-3063; e-mail cpe@njit.edu.

Certificate Requirements:

A student must complete 12 graduate credits in the four preselected courses that define the certificate. Graduate certificate students are expected to maintain a cumulative grade point average of 3.0 or higher. In addition, the cumulative GPA for all courses counted for the certificate must be 3.0 or higher. Any bridge course requirements must also have been satisfactorily completed. If, after the advisor's evaluation of courses taken in prior programs at NJIT or at other institutions, the student demonstrates that as many as two of the four courses required for the certificates have already been completed, substitute courses may be approved by the advisor for the certificate. The graduate certificate programs, required courses and corresponding related master's degrees are listed below.

Bioinformatics--- (NEW)

- Credential can be studied in whole, at NJIT in Newark.
- Best suited for Biology undergraduate degree holders or those willing to take from one to three ancillary courses.

- Credential relates in its entirety to NJIT M.S. in Computational Biology.

	BIOL 601	Foundations of Computational Biology I
	BIOL 602	Foundations of Computational Biology II
Select one from:		
*	CIS 631	Data Management System Design
	CIS 744	Data Mining and Management in Bioinformatics
Select one from:		
	MATH 661	Applied Statistics
	IE 644	Application of Stochastic Modeling in Systems Control
	IE 604	Advanced Engineering Statistics

Business Management Fundamentals--- (NEW)

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Credential relates in its entirety to either NJIT MBA or NJIT MS in Management

*	ACCT 615	Management Accounting
*	FIN 600	Financial Economic Development
*	MRKT 620	Competing in Global Markets
*	MIS 645	Operations Management, Planning and Control

Construction Management--- (NEW)

- Credential can be studied, in whole at NJIT in Newark; or partially via eLearning.
- Credential relates in its entirety to NJIT M.S. in Civil Engineering or NJIT M.S. in Engineering Management.

	CE 610	Construction Management
	CE 616	Construction Cost Estimating
*	EM 637	Project Control
Select one from:		
	IE 653	Facilities Management
	EM 632	Legal Aspects in Construction Management

Information Assurance--- (NEW)

- Credential can be studied, in whole, at NJIT in Newark; or partially via eLearning.
- Credential relates in its entirety to NJIT M.S. in Computer Engineering or NJIT M.S. in Electrical Engineering or NJIT M.S. in Computer Science.
- Best suited for Electrical Engineering, Computer Engineering or Computer Science undergraduate degree holders or those willing to take a number of ancillary courses.
- This NJIT Graduate Certificate has been certified by the USA National Security Agency to be compliant with the National Training standard for Information Systems Security (INFOSEC) professionals, NSTISSI No. 4011.

Select one from:		
***	ECE 698	Special Topics: Principles of Information Security
	CIS 608	Crytopgraphy and Security
Select one from:		
	ECE 683	Computer Network Design and Analysis
*	CIS 652	Computer Networks – Architecture, Protocols and Standard
Select one from:		
	ECE 637	Introduction to Internet Engineering
*	CIS 656	Internetworking and Higher Layer Protocols
{	CIS 696	Network Management and Security ***or***
	ECE 638	Network Management and Security

Information Systems Auditing--- (NEW)

- Credential can be studied, in whole, at NJIT in Newark; or partially via eLearning.
- Credential relates in its entirety to NJIT M.S. in Information Systems.

CIS 680	Information Systems Auditing
CIS 681	Computer Security Auditing
* CIS 679	Management of Computer and Information Systems
Select one from:	
* CIS 675	Information Systems Evaluation
* CIS 677	Information Systems Principles
* CIS 676	Requirements Engineering

Information Systems Design

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Course #1 must be taken first.
- Credential relates in its entirety to NJIT M.S. in Information Systems.

CIS 677	Information Systems Principles
CIS 675	Information Systems Evaluation
Select two from:	
CIS 663	Advanced Systems Analysis and Design
CIS 676	Requirements Engineering
* CIS 732	Design of Interactive Systems
* CIS 684	Business Process Innovation

Information Systems Implementation

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Credential relates in its entirety to NJIT M.S. in Information Systems.

* CIS 677	Information Systems Principles
* CIS 601	Object-Oriented Programming in C++
Select two from:	
CIS 663	Advanced Systems Analysis and Design
* CIS 602	WWW: Applications Development and JAVA
* CIS 631	Data Management System Design
CIS 634	Information Retrieval

Internet Applications Development--- (REVISED)

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Credential relates in its entirety to NJIT M.S. in Information Systems or NJIT M.S. in Computer Science.

* CIS 602	WWW: Applications Development and JAVA
* CIS 652	Computer Networks – Architecture, Protocols and Standards
* CIS 658	Multimedia Systems
Select one from	
* CIS 604	Client/Server Computing
* ECE 639	Principles of Broadband ISDN and ATM ***or***
* CIS 697	Principles of Broadband ISDN and ATM
* CIS 656	Internetworking and Higher Layer Protocols

Management of Technology

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Credential relates in its entirety to NJIT M.B.A. or NJIT M.S. in Management.

* MGMT 620	Management of Technology
* HRM 630	Managing Technological and Organization Change
Select two from:	
MGMT 650	Knowledge Management
* MIS 645	Managing IT for Competitive Advantage
* MIS 648	DeCISion Support Systems
* MIS 620	eCommerce Technologies
* MIS 625	Management Strategies for eCommerce
MIS 676	Managing the Digital Firm

Operations Productivity--- (NEW)

- Credential can be studied, in whole, at NJIT in Newark; or partially via eLearning.
- Credential relates in its entirety to NJIT M.S. in Industrial Engineering or NJIT M.S. in Engineering Management.

IE 601	Measurement Methods for Performance Analysis
* IE 673	Total Quality Management
IE 618	Engineering Cost and Production Economics
IE 621	Systems Analysis and Simulations

Pharmaceutical Management--- (NEW)

- Credential can be studied, in whole, at NJIT in Newark; or partially via eLearning.
- Credential relates in its entirety to NJIT M.B.A. or NJIT M.S. in Management or NJIT M.S. in Engineering Management.

PhEn 601	Principles of Pharmaceutical Engineering
PhEn 604	Validation and Regulatory Issues in the Pharmaceutical Industry
Select two from:	
MRKT 620	Competing in Global Markets
FIN 600	Financial Management
* EM 636	Project Management
* EM 637	Project Control
* IE 673	Total Quality Management

Pharmaceutical Technology

- Credential can be studied, in whole, at NJIT in Newark.
- Best suited for Chemical Engineering undergraduate degree holders or those willing to take from one to three ancillary courses.
- Credential relates in its entirety to NJIT M.S. in Pharmaceutical Engineering.

PhEn 601	Principles of Pharmaceutical Engineering
PhEn 603	Pharmaceutical Processing and Manufacturing
PhEn 604	Validation and Regulatory Issues in the Pharmaceutical Industry
Select one from:	
PhEn 602	Pharmaceutical Facility Design
PhEn 612	Pharmaceutical Reaction Engineering
PhEn 614	Pharmaceutical Separation Processes

Practice of Technical Communications--- (REVISED)

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Course #1 must be taken first.
- Credential relates to M.S. in Professional and Technical Communication.

* Eng 601	Advanced Professional and Technical Communication
* Eng 605	Document Design and Desktop Publishing
Two courses from:	
* Eng 620	Proposal Writing
Eng 624	Professional and Technical Editing
* Eng 650	Web-Based Training Design
* Eng 698	Knowledge Management, User Manuals and Online Help

Project Management

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Credential relates to M.S. in Engineering Management.

EM 637	Project Control
EM 691	Cost Estimating for Capital Projects
One course from:	
CE 610	Construction Management
EM 636	Project Management
One course from:	
EM 631	Legal Aspects in Environmental Engineering
EM 632	Legal Aspects in Construction Management
EM 634	Legal, Ethical and Intellectual Property Issues for Engineering Managers

Sustainable Architecture--- (NEW)

- Credential can be studied, in whole, at NJIT in Newark.
- Credential relates in its entirety to NJIT Master of Architecture or NJIT M.S. in Architectural Studies.

ARCH 663	Introduction to Sustainable Architecture
ARCH 664	Indoor Environmental Quality in Sustainable Designed Buildings
ARCH 665	Sustainable Design of Energy Efficient Buildings
ARCH666	Sustainable Design with Efficient Materials and Resource

Telecommunication Networking

- Credential can be studied, in whole, either via eLearning or at NJIT in Newark.
- Course #1 must be taken first.
- Depending on courses, relates to M.S. in Computer Science, M.S. in Telecommunications or M.S. in Electrical Engineering.

* ECE 673	Random Signal Analysis
One course from:	
* ECE 683	Computer Network Design and Analysis
CIS 652	Computer Networks — Architectures, Protocols and Standards
One course from:	
ECE 637	Introduction to Internet Engineering
* CIS 656	Internetworking and Higher Layer Protocols
One course from:	
* ECE 639	Principles of Broadband ISDN and ATM ***or***
* CIS 697	Principles of Broadband ISDN and ATM
ECE 783	Computer Communications Networks

Virtual Tools for Professional Communities-- (NEW)

- Credential relates in its entirety to NJIT M.S. in Information Systems

* CIS 677	Information Systems Principles
* CIS 675	Evaluation of Information Systems
CIS 785	Special Topics: Community Information/Informatics Systems ***or***
CIS 786	Special Topics: Community Information/Informatics Systems

Select one from:

MGMT 650	Knowledge Management
MGMT 676	Managing the Digital Firm
MGMT 690	Electronic Communities in Organizations

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* Available via eLearning.

** See Continuing Professional Education catalog for course descriptions.

*** The final numeration of this course will be assigned after review by NJIT academic bodies.

Research Centers and Specialized Labs

http://www.njit.edu/research/centerandlabs.php

NJIT Faculty Research

NJIT faculty conduct extensive research in the university's research centers and laboratories, and in partnership with other universities, industry and government laboratories. Highlights of major research areas are presented here. Additional information about NJIT research centers mentioned is available and a list of center directors is located at www.njit.edu/research.

ARCHITECTURE

In addition to independent research, architecture faculty are involved in a wide array of interdisciplinary research, mainly through the Center for Architecture and Building Materials Research and the Multi-lifecycle Engineering Research Center.

Areas of Research

Building Technologies and Sciences — Moisture in buildings, building materials, energy transfer through building envelopes, conservation and passive solar heating, building systems integration and building economics.

Computer-Aided Architecture — Use of computers in architectural practice, modeling and simulation, computer application in architectural design, and data structures and graphic representation.

History and Theory of Architecture — Architectural theory and criticism, history of architecture since 1750, urban history and cultural geography, literary themes in architecture, and contemporary art and architectural criticism.

Housing Studies and Urban Design — Housing for new household types, public policies in design arts, technology and architectural design, social meaning of building form, housing environments, community revitalization and economic development.

Urban Infrastructure Planning — Interdisciplinary project planning and design, infrastructure technology and design principles, public space infrastructure, history and theory of urban infrastructure, and financing and implementation of infrastructure projects.

BIOMEDICAL ENGINEERING

NJIT's interdisciplinary biomedical engineering faculty are involved in research and development in collaboration with the following institutions:

Columbia College of Physicians and Surgeons
Hershey Medical Center
Kessler Institute for Rehabilitation
Saint Barnabas Medical Center
UMDNJ-New Jersey Medical School
UMDNJ-New Jersey Dental School
Veterans Administration Medical Center in East Orange

Areas of Research

Mechanical Engineering — In the area of biomechanics, research is ongoing in knee joints, heart valves, spinal disks, spinal fixation devices and a quantification device for lower back pain. Biomaterials research focuses on artificial ligaments and resorbable fracture fixation materials.

Electrical Engineering — Researchers in biomedical signal processing are developing electrocardiogram analysis as a tool for diagnosing and treating stroke disorders and neuromuscular disorders. Other signal processing research involves electroencephalogram analysis in treating epilepsy and electromyogram analysis in fatigue studies.

Chemical Engineering/Chemistry — Studies involve use of membranes for controlled-release of pharmaceuticals, protein separation using affinity chromatography, molecular modeling of drug-receptor interactions, mixing and mass transfer phenomena in bioreactors and reactor analysis and solvent minimization.

CHEMICAL ENGINEERING, CHEMISTRY AND ENVIRONMENTAL SCIENCE

The chemical engineering, chemistry and environmental science research programs are closely associated with these centers;
Center for Membrane Technologies
Multi-lifecycle Engineering Research Center
Otto York Center for Environmental Engineering and Science
Polymer Engineering Center

Areas of Research

Hazardous Waste Treatment and Waste Minimization — Dynamic modeling of biological reactors, anaerobic/aerobic biotreatment processes, in-situ bioremediation, biofiltration of VOCs, kinetic and thermodynamic analysis of combustion and pyrolysis processes, catalytic combustion, acid gas treatment, sampling and analysis of organic and inorganic pollutants, supercritical extraction, treatment of gaseous pollutants by corona discharge, novel routes for solvent-less chemical synthesis, ultrasonic enhancement of in-situ remediation and process design for waste minimization.

Biochemical Processing — Reactor analysis, mixing phenomena, chromatographic separations, molecular modeling of enzyme mimics and drug-receptor interactions.

Materials Processing — Polymer characterization and process engineering, plastics recycling and particle flow systems.

Membrane Separations — Excellent facilities exist for conducting research on membrane separation processes, particularly hollow-fiber membranes. Applications include gas-gas, gas-liquid, and solute-liquid separations, as well as combined reaction/separation processes. Support for these activities comes from industrial and federal research grants, the environmental research centers at NJIT and NJIT's Sponsored Chair in Membrane Separations and Biotechnology.

Research in civil and environmental engineering is conducted within the department and in these NJIT centers:

Center for Manufacturing Systems
Hazardous Substance Management Research Center
Institute for Transportation
Multi-lifecycle Engineering Research Center
Northeast Hazardous Substance Research Center

Areas of Research

Geoenvironmental Engineering Laboratory — This state-of-the-art facility was established with support from a $1 million National Science Foundation (NSF) grant, which was matched with more than $2 million from NJIT. The laboratory provides research support for geoenvironmental projects such as soil decontamination using biological, chemical and/or physical means; modeling of contaminant transformation and transport; and the testing of waste treatment, solidification, and stabilization and containment systems. The equipment includes an environmental scanning electron microscope (ESEM), X-ray fluorescence and X-ray diffraction spectrometers (XRF/XRD), GC/MS and SFE, capillary electrophoresis (CE), UV-VIS, FT/IR, respirometers, particle size analyzer (PSA) and hydraulic conductivity apparatus.

High Performance Concrete Laboratory — Equipped with funds from NSF, this laboratory is capable of testing very high strength concretes under uniaxial as well as triaxial states of stress. The primary testing system is capable of applying up to 1 million pounds of axial load on a specimen in a computer-controlled closed-loop environment. The materials processing component includes two computer-controlled micro-sizers, and fractionators for particle size analysis and categorization of industrial by-product additives to concrete, such as fly-ash, microsilica and blast furnace slags.

Smart Sensors and Nondestructive Testing Laboratory — This laboratory provides means for studying self-sensing systems built into structures to monitor excessive strains, deflections, load distributions, temperature variations and corrosion.

Recycled Plastics Laboratory — This research facility concentrates on developing innovative uses for recycled plastics. In addition to material tests, the lab develops constitutive models and analysis techniques required by the nonlinear characteristics of the material and its variation through the cross section. Computer simulations are used to analyze the barriers during a crash by modifying current programs to include recycled plastic models. Experimental studies include wind and acoustic tests of noise barriers and in-situ implementation of the proposed designs.

COMPUTER SCIENCE AND INFORMATION SYSTEMS

Computer and information science research is conducted in the following laboratories: advanced computer architecture and parallel processing, artificial intelligence, computer communications and networking, data and knowledge engineering, knowledge representation and artificial intelligence, dependable real-time systems, collaborative systems, computer vision, computing education, cognition and learning, hypermedia information systems, neurological computation and robotics, simulation and modeling and software engineering.

Areas of Research

The departments provide research laboratories with infrastructure and coordination for conducting multidisciplinary research and development. Some key areas that the department focuses on are the technology, health care and financial industries, which require research in software engineering, telecommunications, computing systems, artificial intelligence, database, algorithms, and biomedical and information systems. In addition, the department sustains an interdisciplinary research support environment for biomedical and neuroscience applications, computer engineering, computer-mediated communication, enterprise engineering, health care information systems, manufacturing systems, medical imaging and information systems, microelectronics, as well as other disciplines.

ELECTRICAL AND COMPUTER ENGINEERING

In addition to independent research, Department of Electrical and Computer Engineering faculty participate in research at the:
Center for Communications and Signal Processing Research
Electronic Imaging Center
Microelectronics Research Center
Multi-lifecycle Engineering Research Center
New Jersey Center for Wireless Telecommunications

Areas of Research

Ion Beam and Thin Film Laboratory — Studies focus on processing and properties of materials and structures in the form of thin films. The laboratory has a number of thin film deposition systems, including a state-of-the-art ultrahigh vacuum chamber that permits deposition on atomically clean surfaces. Thin film structures, basic elements of modern microelectronic and optoelectronic devices, are increasingly important in almost all areas of technology. Current research includes metal epitaxy on silicon, modification of surfaces with atomic and cluster ions, and development of novel dielectrics with properties controlled by light beams.

Microwave and Lightwave Engineering Laboratory — Research is ongoing in the areas of microwave device modeling and measurement, computer-aided design (CAD) of microwave components and systems, characterization of RF/microwave/optical systems, monolithic microwave integrated circuit design and testing, numerical electomagnetic codes, analysis design and wire antenna multiscattering in vegetation, experimental and theoretical study of linear and semiconductor surfaces, integrated optics, fabrication and characterization.

Multimedia — Research projects are in the areas of multimedia signal processing and compression, multimedia communications, digital content security and data hiding, Internet delivery of multimedia and many others. The multimedia production and Internet delivery studio, with its state-of-the-art webcasting and DVD authoring platforms, facilitates the use of emerging Internet multimedia technologies for education and learning purposes. More than 30 faculty members and about 40 doctoral students are involved in multimedia research.

Communications and Signal Processing — Recent emphasis on wireless and personal communication systems includes multiuser detection and interference cancellation algorithms, smart antennas and space-time processing. Other areas include adaptive systems and arrays, blind signal separation and equalization, synthetic aperture, radar processing and calibration, source encoding and synchronization, detection and estimation and ATM networking. Signal processing research covers wide areas of nonlinear and adaptive signal processing and algorithms, one- and multidimensional signal processing, image-video coding, subband and wavelet transforms, QMF-wavelet filters, and advanced DCT algorithms.

Computer Engineering — Computer engineering faculty members are conducting research in these areas: test generation; fault simulation; design for testability; built-in self-test; data compression; CAD; computer architecture; design verification; computer reliability; fault tolerance; interconnection in high speed digital circuits; microprocessing; Internet-based computer-aided instruction; interconnection networks; multiprocessor systems; nonlinear optimization techniques; genetic algorithms; neural networks; infrared imaging; computer networks; routing in ATM networks; LANs; CEBus; BACnet; parallel computing systems; parallel algorithms; computer vision; Petri nets; discrete event systems; embedded control; computer integrated manufacturing and networking intelligent automation; information display; robotics; ATM switches; and VLSI.

Electronic Imaging — Special filters are widely used in the characterization of chemical or biological systems. Much information on these systems can be deduced from spectral analysis of transmission and reflection of the samples, especially in the infrared (IR) spectral region. Researchers examine tunable filter systems, such as wavefront division interferometers (WDI), together with a two-dimensional IR imager. Such systems are based on multiplexing procedure, which minimizes optical loss. The resolution and the extent of the filtering process is determined by novel electronic processing methods. The goal is to develop a hand-held instrument to monitor harmful molecules in a remote or a nearby environment.

Nonlinear Nanostructures Laboratory — Nanotechnology is a fast-growing interdisciplinary area. While many thin film and granular technologies are within the nano scale, nanotechnology is related to the "added value," i.e., the functionality, of nanostructures. The basic "building block," the nanocluster, is an ultrafine-grained solid with a high percentage of atoms at the grain boundaries. The nonlinear optical properties of nanoclusters are of intense interest for use in optical switching and IR sensing. The confinement of the electronic wave function to small dimensions results in an enormous refractive index change. Experiments are under way on Si nanoclusters grown by either laser ablation or ion implantation.

Wireless Telecommunications — Research activities are distributed among four focus areas: wave propagation models for delivery of advanced broadband services and R.F. engineering of novel devices and systems for wireless digital communications technologies; wideband multiple access systems, and multiuser technologies including adaptive equalization and space-time adaptive processing; wireless networking including architectures, wireless ATM, geolocation, teletraffic modeling, resources allocation; and services, applications and wireless technology transfer.

HISTORY

The Federated History Department of NJIT and Rutgers-Newark conducts research in a wide variety of historical fields, regions and periods. Faculty in the department have obtained many grants from government and private foundations such as the National Endowment for the Humanities; the National Science Foundation; the John Simon Guggenheim Memorial Foundation; Fulbright Fellowships; and the Spencer Foundation. The department produces two periodicals:
Eighteenth-Century Scotland
Horn of Africa

Areas of Research

History of Technology, Environment and Medicine — American environmental history; urban environmental history; the social and cultural history of medicine and technology (including gender issues); military medicine; history of mental health; history of print culture; film, television and history; and technology and warfare.

American History — Social, cultural and diplomatic history; the history of women and the family; African-American history; legal history; public history.

World History — Comparative history; economic history; intellectual, cultural, and political history; modern Africa; modern China; Latin America and the Caribbean; Russia and eastern Europe; medieval Europe and Eurasia; modern France, Spain and Britain.

HUMANITIES AND SOCIAL SCIENCES

The department integrates the humanities and social sciences for the purpose of understanding the cultural, social and scientific contexts informing contemporary culture. Special emphasis is given to research in the study of science, technology and society; the study of communication; the study of environmental and health policy; professional ethics; the study of environmental and health economics; and the study of multicultural and international literature. The department is committed to using the humanities and the social sciences as a coherent model for examining human society. Research is conducted in these centers:
Center for Architecture and Building Science Research
Center for Policy Studies
Institute for Transportation
Multi-lifecycle Engineering Research Center

Areas of Research

Environmental Studies — Research is ongoing in policy studies, health, coastal geomorphology, economics, ethics, history, communications and education. The department hosts the nationally acclaimed environmental publication, Terra Nova.

Professional and Technical Writing — Multimedia design, distance learning, writing assessment and environmental communications are areas that faculty currently pursue. The department hosts a new journal, Newark Review.

Contemporary Literature — This research area includes modern poetry, multicultural and international studies, and the relationship between literature and the natural world.

INDUSTRIAL AND MANUFACTURING ENGINEERING

The Department of Industrial and Manufacturing Engineering has a significant and diverse research program that includes areas such as industrial and operations research, design for manufacturing, quality, assembly and concurrent engineering, robotics, global networking, logistics and simulation issues of small and medium-sized companies, multimedia, environmental and health/safety and medical engineering. Research also is affiliated with these major NJIT research centers:
Center for Manufacturing Systems
Multi-lifecycle Engineering Research Center

Areas of Research

Industrial Engineering, Systems and Operations — Research includes the development of control and scheduling algorithms for the optimization of container terminal operations, global networking and logistics operations for small, medium and large corporations, the impact of telecommuting strategies on traffic flow, engineering system modeling and design tools, distributed virtual laboratory networks between research groups, the R&D of quality systems, quality control and management systems.

Manufacturing Systems and Mechatronics Engineering — Focus is on robotics, robot cell design, flexible computer-integrated manufacturing, system integration of automation systems, flexible assembly system modeling, integration, implementation, non-contact sensing and inspection, CAD/CAM integration, servo pneumatic positioning and sensor technology.

Concurrent/Simultaneous and Total Lifecycle Engineering — This new research field includes the development of new methods and toolsets for small batch luxury automobile manufacturers (such as Rolls-Royce Motor Cars), and general methods, tools and technologies for design for manufacturing, design for quality manufacturing, and assembly and maintenance systems.

Medical, Environmental, Health and Safety Engineering — Activity in this area is increasing. Main areas include the assessment of the realistic impact of environmental factors on productivity, devices and methods for the prevention of repetitive motion injuries, microrobotic manipulators for human artery cleaning, and new medical devices coupled with simulators and expert systems that can be used for interacting with the human body and other medical applications.

Multimedia, Simulation and Virtual Reality Modeling — Research activities are spread between discrete event and continuous system modeling and simulation and areas such as graphical modeling of workcells, object-oriented simulation coupled with AI, engineering multimedia developments for the study of servopneumatic positioning, multimedia for total quality management and the ISO9001 standard, flexible automation, concurrent engineering and the virtual reality simulation (and rapid prototyping) of complex electromechanical products and their manufacturing/assembly processes.

MANAGEMENT

In addition to independent research, School of Management faculty are pursuing research conducted in affiliation with these centers:
Center for Manufacturing Systems
International Intermodal Transportation Center
Multi-lifecycle Engineering Research Center

Areas of Research

Entrepreneurship and Small Business — Assessment of emerging technologies, economics, employment growth, theories and practice in relation to entrepreneurship and private enterprise.

Building Production and Management — Building efficiencies, organization of international construction, environmental technology management, and industrial ecology systems.

Behavioral Science and Organizational Theory — Organizational design and development, organizational behavior, occupational and organizational socialization, legal and ethical issues, public administration, social perception, leadership, attachment and commitment processes in organizations, and transportation behavior.

Economics and Finance — Mathematical programming and multicriteria decision making in financial management, portfolio analysis, emerging international capital markets, applied corporate finance, financial economics, public finance, international competitiveness of U.S. economy, and international economic/financial relationships.

Human Resources Management — Managing new technology, labor management relations, public policy and technological change, and tasks and unit level technologies.

Information Systems Management — Policy analysis, computer auditing, control and security, interface design, systems evaluation, technological forecasting and assessment, management information systems, management and social impacts of computer and information systems, group decision support systems and database analysis.

Information Systems Auditing — Operational auditing, internal auditing.

Marketing Management — Marketing research, new product management, consumer behavior, international marketing, marketing technological innovation, mathematical programming and multicriteria decision making, strategic management, sales management, enhancing global competitiveness and technology transfer.

Operations Management — Project management, industrial quality control, production planning, management of manufacturing systems, and mathematical programming and multicriteria decision making.

Corporate Law and Ethics — Employment law, legal and ethical issues in business, international legal environment of business, job security and unlawful discharge/unjust dismissal.

MATHEMATICAL SCIENCES

The research interests of the faculty focus on the development and use of mathematical and computational tools for solving scientific, technological and industrial problems. The Center for Applied Mathematics and Statistics promotes and represents the research interests of all NJIT mathematical sciences faculty.

Areas of Research

Acoustics and Signal Processing — Faculty involved in acoustics study both the forward and inverse problem of sound propagation in the ocean. Work on the forward problem aims for accurate and computationally efficient solutions of the wave equation for complex oceanic environments. Research on the inverse problem addresses the development of algorithms for source localization and geoacoustic inversion, combining array and statistical signal processing concepts and waveguide physics.

Electromagnetics — The electromagnetics group is concerned with the scattering of electromagnetic waves by complex structures and materials. Methods used include modeling, asymptotics and numerical analysis. Applications to material processing are an important aspect of this work. Current and recent projects include the analysis of microwave sintering of ceramics, including thermal runaway and hot-spot dynamics, electron beam welding of ceramics, nonlinear pulses in optical fibers and the development of numerical methods for Maxwell's equations in free-space and in complex, dispersive media.

Fluid Dynamics and Materials Science — Several faculty are involved in the development of analytical and computational methods and their application to problems arising in fluid dynamics and materials science. A particular area of emphasis is the study of the dynamics of interfaces between two fluids or a fluid and a solid. Research in this area includes liquid jet breakup, bubble dynamics, crystal growth, and flame front propagation as well as related problems in combustion and detonation. Other research areas include stability theory, particulate flows, viscoplastic flows, thin films and physiological fluid mechanics (e.g., blood flow in arteries).

Mathematical Biology — This group is involved in two major research projects. First, the development of strategies to promote improved medical and therapeutic techniques, including use of coupled-oscillator theory for optimal walking strategies, use of elasticity theory for wound suturing and use of virtual reality in studies of epilepsy. Second, the development of testable mathematical models of neuronal networks including modeling the bistability of vertebrate motoneurons, modeling motor patterns in crustacea and modeling of hippocampal place cell dynamics in connection to memory recollection.

Statistics — Faculty research areas and interests include applied probability modeling, statistical inference, statistical reliability theory and applications, survival analysis and applications in biostatistics, time series analysis and forecasting, signal processing, design and analysis of industrial experiments.

MECHANICAL ENGINEERING

The scope of research in the Department of Mechanical Engineering is broad. Projects are carried out within the department's laboratories as well as in collaboration with the following centers:
Center for Manufacturing Systems
Hazardous Substance Management Research Center
Multi-lifecycle Engineering Research Center
Particle Processing Research Center
Polymer Engineering Center

Areas of Research

Bearings and Bearing Lubrication — Research areas include design of hydrodynamic, hydrostatic, rolling element bearings and novel designs of unique bearings, such as composite bearings. Also, the role of bearings in rotor dynamics is investigated. Students are engaged in the design and development of testing machines, which include computer data acquisition, for friction and wear, and for testing bearing materials and lubricant additives. Research is conducted in modeling and compensation of friction in control systems for precise motion control, stick-slip friction, friction-induced vibrations and antilock brakes. Work is conducted in modeling and measurement of dynamic friction in bearings, clutches, vehicle breaks and tires. Other research interests are rheology of lubricants, including viscoelastic and synthetic lubricants.

Computational Fluid Dynamics —- The laboratory for computational fluid dynamics is equipped with state-of-the-art computer equipment consisting of an SGI compute server (Origin 2000), four SGI 02 workstations and PCs. The purpose of the laboratory is the understanding, prediction and control of many fluid flows in the laminar, transitional and turbulent regimes. High performance computing, advanced data analysis, hydrodynamic stability theory and control theory are used for this purpose. Research includes boundary layer and channel flows, wake flows, film flows, ocean water waves and propagating flames. Another thrust area is the numerical simulation of multiphase flows such as particulate and bubbly flows.

Electro-Hydrodynamics Research — The research aims at developing a fundamental theory of the synergism of electric- and shear-induced phenomena in suspensions and to examine the accuracy of predictions regarding the effects of high-gradient strong fields on the particle motions and aggregation. Understanding of these phenomena is used toward the control and manipulation of suspension flows. Applications include the development of a novel filtering technology for online cleaning of in-service fluids in shipboard equipment.

Granular Flow — The goal of this research is to develop predictive models of flowing granular materials critical to the design of efficient and reliable solids handling systems prevalent in the industrial sector (chemicals, food, agriculture, pharmaceuticals, minerals, energy, materials, munitions, and electronics), as particulates are universally found in most products either as raw materials or as the final product. Investigations aimed at understanding observable bulk behavior are carried out as part of the Particle Technology Center and made through realistic dynamic computer simulations, analytical modeling and physical experiments. Paramount is the connection between microstructure evolution and transport properties. Phenomena of interest include hopper flows, vibrated beds, shearing, percolation in packed beds, and segregation.

Multiphase Flow Research — Research objectives are to develop a fundamental knowledge of hydrodynamic and interfacial interactions of phases in multiphase flows as well as develop advanced technologies related to particulate multiphase flows. Projects include drag forces and collisions of interacting particles in viscous flows, fibrous filtration of particulate-laden flows, membrane separation, wet scrubbing, liquid jet evaporation in gas-solid suspension flows, and filtration applications using rotating fluidized beds.

Non-Newtonian Fluid Dynamics — A knowledge of non-Newtonian fluid dynamics is essential in many industries, including those involving plastics, paints, suspensions, oils, lubricants, rubber and detergents. Projects include theoretical and computational analyses of the popular constitutive equations for a range of flow problems, e.g., injection molding, porous media flows, viscoelastic particulate flows, free-surface flows as well as the modeling of non-Newtonian fluids. Both finite element and finite difference methods are used to solve the governing equations in two and three dimensions.

Particle Technology Research — Research includes fundamental and applied projects including modeling and development of novel techniques for dry particle coating and manufacturing of engineered particles; ultrafine particle mixing using dry methods, discrete element modeling (DEM) and numerical simulations of particle flows and processes; granulation with minimal use of liquids; particle transport; and handling/flow and delivery from hoppers. Some past projects were development of non-intrusive particle tracing technique for granular flow experiments; development of motion analysis algorithms for high-speed optical imaging of three-dimensional particle collisions; and pattern recognition and cluster analysis techniques to detect micro-structure in granular flows.

Pattern Recognition/Cluster Analysis/Image Processing Research — This research focuses on the use of “soft computing” methods for various applications: fuzzy clustering algorithms, robust clustering, clustering of relational data, application of robust statistical techniques in cluster analysis, shape detection in noisy data, generalization of fuzzy clustering algorithms for multicharacteristic shape detection, such as hyper-spherical/ellipsoidal shells as cluster prototypes, or adaptive clustering and cluster validity issues. Clustering methods and evidence collection techniques are used for lines, curves and arc detection in digital images. These algorithms are also used in reverse engineering through development of CAD models from image sensor data. Machine vision applications are also studied.

Plastics Engineering — The New Jersey Bell Plastics Laboratory is well equipped with a wide range of state-of-the-art plastics processing and forming equipment, supported by analytical testing capabilities. The laboratory is used for a wide range of research and development activities. Activities include re-engineering of commingled waste plastics, studies on self-reinforced composites, and combined parametric and experimental studies to develop models to explain the interrelationships between product properties and process parameters for injection molding processes. As part of the research activities, students use CAD and computer-aided engineering (CAE) tools in the design, analysis and manufacture of plastics products.

Rapid Intelligent Manufacturing and Prototyping — The research aims to generate fundamental knowledge and develop advanced technologies to enable the design and manufacture of products to be done more quickly and cost-effectively. Research projects include next-generation CAD/CAM system with virtual reality, rapid tooling and manufacturing, rapid freezing prototyping, and environmental performance analysis of solid freeform fabrication processes.

System Integration and Robotic — The research applies theoretical analyses, simulations and experiments to the design and control of mechanical and electromechanical systems (mechatronics). Kinematic and dynamic modeling, system calibration and optimization techniques are used to enhance system performance. Projects include development of design, planning, and control methodologies for effective use of parallel kinematics machines and development of ultrafine motion technologies to enable fast, flexible automated assembly of optoelectronics systems.

Waterjet Technology Research — The Waterjet Research facility develops technologies for the use of high- and super high-speed fluid jets for manufacturing complex components from hard-to-machine materials, cleaning and grinding of sensitive surfaces, and bio-medical applications. Projects include numerical modeling of fluid jets, developing expert systems for jet-based processing, precision cleaning of complex surfaces, using ice for machining applications, and using impact and explosion to form jets.

PHYSICS

Interdisciplinary applied physics research is conducted in collaboration with faculties of NJIT, Rutgers-Newark, Rutgers-New Brunswick, and UMDNJ in areas such as electrical engineering, chemistry and chemical engineering, materials science, industrial and manufacturing engineering, biological sciences and geological sciences. Cooperative research efforts are under way with the National Solar Observatory, Bell Labs-Lucent Technologies, U.S. Army Research Lab, and other industrial and federal research laboratories. Research also is conducted at these major NJIT centers and NJIT-maintained facilities:
Microelectronics Research Center
Center for Solar Research
Big Bear Solar Observatory
Owens Valley Radio Observatory

Areas of Research

Device Physics — Research at NJIT is under way in silicon microfabrication, micromachining and fusion bonding for conventional and novel microelectromechanical (MEMS) device applications, metal-insulator-semiconductor device structures and rapid thermal processes in silicon integrated circuits. Studies at Rutgers-Newark involve sensors for biophysics applications. Facilities for this work include state-of-the-art metrology electrical characterization equipment, cryostats for very low temperature measurements and access to NJIT's Class 10 cleanroom with full process capabilities for 6-inch silicon wafers.

Materials Research — Molecular beam epitaxy (MBE) of III-V semiconductors is used to fabricate various photonic devices, digital integrated circuits and optoelectronic integrated circuits. Research on the synthesis and characterization of chemical vapor deposited (CVD) and physical vapor deposited (PVD) silicon-based dielectric films is ongoing. Optical characterization of materials includes visible and far-infrared spectroscopy, photoconductivity, photoluminescence, spectral emissometry and thermal modulation spectroscopy. Materials studies include photoinduced superconductivity in High-Tc materials (i.e., YBCO) and optical properties of SiC, GaN and porous silicon.

Ultrafast Optical and Optoelectronic Phenomena — Terahertz spectroscopy is used to study ultrafast carrier dynamics in semiconductors. Other areas include ultrafast photodetectors, ultrashort nonlinear pulse propagation in optical fibers and planar waveguides, ultrafast photophysics of semiconductor and quantum well devices, and ultrafast optical switching in novel nonlinear materials. The Ultrafast Optics and Optoelectronics Laboratory is capable of producing ultrashort laser pulses of 100 femtosecond duration over a tuning range of 230-nm (ultraviolet) to 2300-nm (infrared).

Optical Science and Engineering Education — The National Science Foundation (NSF) is supporting the development of an optical science and engineering curriculum with optics research collaboration among NJIT's physics, electrical and computer engineering, and chemical engineering, chemistry and environmental science departments.

Solar Physics — The Center for Solar Research operates two world-class observation facilities: Big Bear Solar Observatory (BBSO) and a dedicated array of solar radio telescopes at Owens Valley Radio Observatory (OVRO), both in California and both formerly managed by Caltech. Research focuses on the development of state-of-the-art instruments for solar observations; the study of solar magnetic fields and extended atmosphere; and the study of solar activities and their terrestrial effects. Solar physics interacts closely with other research areas at NJIT, including device physics, image processing and atmospheric chemistry. With the acquisition of BBSO and OVRO, the NJIT physics department has one of the best-known university-based research efforts in solar physics in the world.

Imaging Technology — A developing initiative builds upon NJIT's nationally recognized work in infrared imaging technology, applying it to the promising area of infrared solar physics. State-of-the-art infrared imaging devices are being developed and tested as part of an IR telescope system to be installed at Big Bear Solar Observatory.

Free Electron Laser Physics — The free electron laser (FEL) on the Rutgers-Newark campus generates short tunable far infrared (FIR) pulses allowing a new class of experiments to be carried out at wavelengths of 150--400 microns. The unique time dependence of the Rutgers' FEL will be used to develop an important class of transient FIR experiments with 50 picosecond resolution. Photon echo techniques using the Rutgers' FEL will be applied to obtain significantly improved resolution for the FIR spectra of DNA. Similar techniques will be used to study quantum wells in semiconductors.

Surface Physics — This area focuses on research on laser-induced physical processes on surfaces. One area of current interest is laser-stimulated hydrogen ion desorption from a hydrogenated Si (100) surface. Another area is the interaction of spin polarized atoms with surfaces.

Discharge Physics — Research on glow discharges for plasma processing of semiconductors and other materials is being carried out under an NSF-sponsored program. Related studies on VUV (vacuum ultraviolet) light sources and unique laser pumping schemes are also under way.

Applied Laser Physics — With industry funding, research is being carried out at Rutgers-Newark on laser processing of materials with low thermal conductivity. The physics involves heat transport, laser properties and material properties. New instrumentation to resolve variations in temperature in time and space is being developed. This work is in collaboration with the Department of Ceramics and Engineering in the Rutgers College of Engineering in New Brunswick.

Biophysics — An NSF-funded research training group program in collaboration with the Rutgers-Newark's chemistry department, the federated biological sciences department and Rutgers-Newark's Center for Molecular and Behavioral Neuroscience provides training and research opportunities in frontier interdisciplinary biophysics areas including spectroscopy, signal processing and biomedical instrumentation. One area of great current interest involves the use of stable isotope tracers for medical diagnostics. Another is the development of microsensors to probe nonlinear auditory response in mammals.

TRANSPORTATION

The interdisciplinary program in transportation through the Institute for Transportation involves about 30 NJIT faculty and 25 NJIT graduate students in its research program activities. Congressional legislation requires that TELUS (Transportation Economic and Land Use System) be customized and deployed for use throughout the United States. TELUS is a computerized system for tracking the progress of transportation projects and assessing their economic and land use impacts and interrelationships. Institute research activities are associated with the following centers at NJIT:
National Center for Transportation and Industrial Productivity (NCTIP)
New Jersey Center for Transportation Information and Decision Engineering (TIDE)

Areas of Research

Mitigation of Increased Highway Congestion — resulting in reduced productivity, increased gridlock, pollution and fuel consumption.

Advanced Traffic Control and Engineering — are requiring new systems for traffic management and new engineering and management techniques to expand the capacity of the transportation infrastructure.

Intelligent Transportation Systems — resulting in more efficient use and increased safety for the existing transportation infrastructure.

Increased Competition — for railroad, truck and air carriers because of deregulation. Carriers must further reduce costs while providing high-quality service and consider that a smaller number of large companies may dominate the market.

Globalization — of markets requiring the ability to efficiently move goods over long distances often using multiple carriers. Several large transportation consortia are likely to establish themselves in world markets in the next decade.

Reduction in Public Assistance to Transportation — and the high social and political costs of building new transportation systems placing a tremendous emphasis on improved management of existing facilities, thereby requiring the introduction of innovative financing practices and larger participation from the private sector.

Increase in Social Awareness — demonstrated by society's concern with the energy consumption of scarce fossil fuels and the negative by-products of transportation such as noise, air and water pollution.

Streamlining the Logistics Process — to reduce transportation and inventory costs through the expedition of raw materials from origins to production plants, semi-finished products between plants and finished products to consumers.

Intermodalism — to combine the best of two or more modes of transportation for the coordinated movement of people or freight. The economy of line haul with the flexibility of another mode for local collection and distribution is an example.

Aircraft Routing — to reduce aircraft noise and to improve air traffic operation.

Tuition and Fees

New Jersey Institute of Technology reserves the right to increase tuition and fees as required.

Students incur a legal obligation to pay tuition and fees when they register for classes. Unless the registrar receives written notice by the fifth day of the semester that a student will not be attending classes, the student will be billed for payment.

Liability for Charges

A student who registers for a course is liable for all tuition and fees. Receipt of a properly completed withdrawal notice by the Registrar's Office will affect the amount of refund, if any, to be issued.

Tuition and Fees 2003-2004 (in U.S. dollars)

Effective July 24, 2003 the charges for tuition and fees for graduate programs are as follows:

TUITION

	New Jersey Resident	Non-Resident
Full-time	$4,810/semester	$6,770/semester
Part-time	$520/credit	$715/credit

NOTES: Part-time = 1--11 credits per semester. Full-time = 12 or more credits per semester. However, for any additional credits taken over 19, there is a per credit charge at the part-time rate in addition to the full-time charge.

FEES

Full-time (fees per semester)

Registration	$66
Academic Facilities	315
Student Services	51
Graduate Student Association	35
Athletics	25
Health Services	12
Technology Infrastructure Fee	70

Total	$574

Part-time (per semester)

Registration	$66
Health Services	$12
Academic Facilities	$33
Student Services	6
Graduate Student Association	3
Athletics	3
Technology Infrastructure Fee	9
Total	$54(Per credit)

In addition to the above, Part-time students are also charged the following per fees per credit:

International Student Fee $60 per semester
International students are charged as the Non-Resident tuition rate.

Health Insurance $173 per academic year
International Students are charged $200 per academic year for taking 3 or more credits.

HEALTH INSURANCE

New Jersey statutes require all full-time students and all international students (whether full- or part-time) to show evidence of existing health insurance, or they will be required to purchase coverage from the university for the rate of $173/$200 per academic year. **United States citizens and permanent residents, carrying less than 12 credits might not be automatically billed, and should immediately take step to purchase insurance if they are not otherwise advised.** Students with comparable coverage may waive the fee for this insurance by completing a waiver card and submitting it to the Office of Health Services during the 30-day enrollment period at the beginning of the semester. Students must be registered for at least 3 credits to be able to purchase insurance from the university. International students with less than 3 credits must contact the Office of Health Services for further information. Students with J-1 visas, see "Health Insurance" under "Student Services" in this catalog for further information.

Full and Part-time students and students interested in supplemental coverage for spouses and families should contact the Office of Health Services for more information.

APPLICATION AND SPECIAL FEES

Application Fees

A nonrefundable fee of $60 must accompany applications for admission. Students who wish to change their degree program must file a new application and pay an additional $60 fee.

Late Payment Fee

Students are charged $50 if they do not pay tuition and fees within the period stipulated in payment instructions.

Late Registration Fee

Registration is required each semester. A late registration fee of $50 is required after the deadline specified in registration instructions.

Maintaining Registration Fee

Students admitted to degree programs and who find it necessary to temporarily discontinue their studies, may maintain their enrollment by paying $50 for each semester they do not register for courses. The mechanism for maintaining registration is the notation MR on the registration form.International students on F-1 and J-1 status may not maintain registration unless they have obtained **prior written** permission **from the Office of International Students and Faculty.**

Doctoral students in the dissertation stage and master's students in the thesis or project stage of their programs are not permitted to maintain registration by this mechanism and must be enrolled in dissertation, thesis or project credits until completion of the dissertation, thesis or project. Additional tuition and fees may be imposed for failure to be enrolled in dissertation, thesis or project credits as required. Other limitations on MR exist for those in academic difficulty.

If international students must interrupt their studies temporarily, they are required to first consult with the Office of Graduate Studies as well as the Office of International Students and Faculty to obtain permission for a leave of absence.

Readmission Application Fee

A non-refundable fee of $60 must accompany applications for readmission.

Transcript Request Fee

There is a $3 fee for each copy of a transcript requested. Requests for transcripts are not honored if there is an unpaid balance on the student's account. Normal services require 10 business days to process a request. Twenty-four hour rush service will be provided upon payment of a $20 rush fee.

Schedule Change Fee

A fee of $15 is charged for each schedule change requested after the deadline specified by the registrar.

Thesis and Dissertation Fees

A minimum fee of $45 is charged for binding two copies of master's theses; and $90 for two copies of doctoral dissertations. The original is not bound and returned to the library for scanning and placement on the Web. Binding fees for additional copies are $15 each for master's theses and $30 for doctoral dissertations (up to five copies total). Arrangements and payment for full publishing and copyright services are handled through the Office of Graduate Studies and by agreement with UMI ProQuest.

Commencement Fee

A $70 fee is charged each time students apply for graduation. If the degree requirements are not completed and a student is not certified for graduation, the student must reapply for graduation and pay the $70 graduation fee again.

Parking Fee

NJIT students who have registered for classes may purchase a parking permit online at www.njit.edu/old/parking. Parking fees (per semester) are $125 for full-time students (12 credits or more) and $65 for part-time students (less than 12 credits). Adjustments to parking fees to reflect changes in full-time or part-time status will automatically be made on the fifth day of the semester only. Written requests for refunds will be granted by the Department of Public Safety only until the fifth day of each semester.

Additional Fees

From time to time, additional fees may be necessary, or current fees may need to be increased. Currently these include:

Distance Learning $65 per semester

Reinstatement Fee

There is a fee for reinstatement of cancelled registration. Reinstatements are possible or permitted only for a limited time for those who had not initially paid their bills in a timely manner.

Continuing Professional Education (CPE) Tuition and Fees

In some cases, there is a differentiation in fees for CPE programs. See *www.cpe.njit.edu/dl* for a current listing of fee labels and fee amounts or call CPE at 1 (800) 624-9850.

Refunds for Withdrawal

Total Withdrawals During Fall or Spring Semesters

When students withdraw from all courses voluntarily (a complete withdrawal) they may receive a refund of some part of the tuition provided they have properly completed a withdrawal on the High lander website.

INSTITUTIONAL REFUND SCHEDULE

Students receive refunds of tuition for complete withdrawal according to the following schedule:

Through the end of	% Refunded
Week 1	100
Week 2	90
Weeks 3 and 4	50
Weeks 5, 6 and 7	25
After Week 7	0

Partial Withdrawals During Fall or Spring Semesters

The percentage of tuition refunded for credit reductions short of complete withdrawal (a partial withdrawal) in a semester is:

Week 1	100% (plus all fees)
Week 2	90%
Weeks 3--15	0%

FEDERAL STUDENT FINANCIAL AID RECIPIENTS

When a student who has received federal financial aid (Federal Pell Grant, FSEOG, Federal Perkins Loan, Federal Work Study, Federal Subsidized and Unsubsidized Direct Loans, and Federal Direct PLUS Loans) withdraws completely, a refund and repayment calculation must be done to determine if a portion of the aid funds must be returned to their respective programs. The calculations use the following percentage refund schedules:

FEDERAL AID RECIPIENTS WHO HAVE ATTENDED NJIT FOR TWO OR MORE SEMESTERS

Students who have attended NJIT for two or more semesters and who receive federal financial aid are refunded the following percentages of tuition, room and board, certain fees and certain other charges. The refund may require federal aid funds to be returned to the federal student assistance programs.

Through the end of	% Refunded
Week 1	100
Day 2--Week 2	90
Weeks 3 and 4	50
Weeks 5, 6 and 7	25
After Week 7	0

FEDERAL AID RECIPIENTS IN THEIR FIRST SEMESTER OF ENROLLMENT AT NJIT

Students in their first semester and receive federal aid are refunded the following percentages of tuition, room and board, certain fees, and certain other charges. The refund may require a portion of financial aid funds to be returned to the federal student assistance programs.

Through the end of	% Refunded
Week 1	90
Weeks 2 and 3	80
Week 4	70
Weeks 5 and 6	60
Week 7	50
Weeks 8 and 9	25
After Week 9	0

When financial aid funds must be returned to the federal student aid programs as determined through the refund and repayment calculation, the funds are distributed in the following order:

1. Unsubsidized Federal Direct Stafford Loans
2. Subsidized Federal Direct Stafford Loans
3. Federal Direct PLUS Loans
4. Federal Perkins Loans
5. Federal Pell Grants
6. FSEOGs
7. Other SFA programs
8. Other federal, state, private or institutional sources of aid
9. The student

Examples of common refund situations for federal student aid recipients are available in the offices of the Bursar and Financial Aid.

After the last day of the second week of classes each semester, students who reduce credits but remain enrolled will not receive any refund of tuition or other charges. For federal and state financial aid purposes, enrollment status is determined on the 15th day of classes, no adjustment from full-time to part-time status is made after the end of the second week of classes.

Refund policy and procedures for summer sessions are published in summer session registration materials.

Emergency Withdrawal

When the Office of the Dean of Graduate Studies approves emergency withdrawals, those students shall receive a refund prorated according to the number of weeks the student attended in the term. Students may request emergency withdrawal for the following reasons: medical circumstances that prevent completing the term; call to military service that prevents completing the term; and mental conditions that prevent completing the term.

Unofficial Withdrawal

Financial aid recipients whose term record shows zero (0) earned credits because of F and/or W grades will be reviewed for class attendance. A withdrawal date will be assigned to any student whose attendance or participation in class cannot be documented, and any federal aid may be reduced or canceled.

Students are strongly encouraged to use the official withdrawal procedure through the Registrar's Office should it become necessary to cease attendance in all courses. Students should also contact the Office of Graduate Studies to complete a discontinuance form.

Payment

Payment for tuition and fees may be made using any of the following methods:

Checks and Money Orders

Checks or money orders must be made payable to NJIT. Write the student ID number on the face of the check or money order. The university reserves the right to add missing ID numbers to checks for payment.

Cash

Cash payments can be made only in person at the Bursar's Office, which is located in the student mall area on the lower level of the Parking Deck.

Credit Cards

At this time, the university only accepts Visa, MasterCard and Discover. For your convenience we allow the use of credit card payment over the web. Go directly to http://my.njit.edu and sign on to Highlander Pipeline, then select view and pay your bill. You may also use the back portion of your invoice to authorize use of the above credit cards or you can opt to pay in person.

Deferred Payment

Students may use the NJIT deferred payment plan. In order to take advantage of this plan, the student must pay one-half of the bill plus a $25 deferral fee. All prior debts must be paid on order to take advantage of the deferral plan.

Student Residency for Tuition Purposes

Residency status for the purpose of tuition assessment will be made by the university based upon N.J.S.A. 18:62-1 et seq. and New Jersey Administrative Code Title 9. These statutes set forth the standards for individuals to legally reside in the state for 12 months prior to enrollment to be eligible for in-state tuition rates. The procedures outlined below will govern the determination of residency status for the purpose of calculating tuition. All students who are not legal residents of New Jersey within the meaning of the statutes will be assessed out-of-state tuition rates.

Initial Determination of Residency

When an application is submitted for admission to any graduate or undergraduate program the admissions office will determine the applicant's resident status for tuition assessment. This determination will be based upon information supplied by the applicant on the application for admission. Applicants who are not citizens of the United States must complete the non-resident portion of the application and supply documentation of their non-immigrant status.

The university reserves the right to correct any errors in resident status based upon incorrect or insufficient information supplied by the student which directly or by inference leads to an inaccurate tuition assessment. When an error has been identified and corrected, tuition will be recalculated for the terms affected, and the student will be held liable for any additional tuition.

Legal Determination of Residence

The following statement from the New Jersey Statutes Annotated defines residence for higher-education purposes: "Persons who have been domiciled within this State for a period of 12 months prior to initial enrollment in a public institution of higher education are presumed to be domiciled in this State for tuition purposes. Persons who have been domiciled within this State for less than 12 months prior to initial enrollment are presumed to be non-domiciliaries for tuition purposes."

The university reserves the right to request the student to have the Internal Revenue Service or the New Jersey Division of Taxation forward tax records to the appropriate university office for review or to request same directly from the student.

An individual who claims to have established a new domicile in New Jersey must show (1) a physical abandonment of the previous domicile, together with an intent not to return to it, and (2) actual presence in New Jersey with the intention of remaining permanently in the state for reasons other than attending school.

An individual from another state or country who has enrolled in any type of educational institution in New Jersey prior to applying to NJIT will be presumed to be in New Jersey primarily for educational purposes and will be presumed not to have established domicile in New Jersey. Although the student may present proof to overcome these presumptions, it must be noted that continued residence in New Jersey during vacation periods or occasional periods of interruption to the course of study does not of itself overcome the presumptions.

THE EFFECTS OF MARRIAGE ON RESIDENCY

A U.S. citizen or permanent resident who marries a bonafide New Jersey legal resident assumes the domicile of that spouse for tuition purposes in the term following marriage. The same test for residency will be applied to spouses when marriage is claimed as the basis for domicile.

No change in status will occur when a legal resident student marries a non-legal resident.

FOREIGN NATIONALS

International students studying under a non-immigrant status (such as F, J, and all others) may be eligible to pay resident tuition upon receipt of their permanent resident card. In addition to receipt of permanent resident status in the United States, students must comply with the definition of "Domicile" as described in that section of the catalog. Any other non-immigrant alien (H-1, E-1, etc., status) will be classified as a non-resident for the assessment of tuition.

Residency will be determined as of the first term following the admission date on the permanent resident card. Applications for residency will not be processed unless a photocopy of both sides of the permanent resident card is included with the application. A tuition refund will be issued if the admission date on the permanent resident card precedes the start date of the current term.

Residence established solely for the purpose of attending a particular college or university cannot be considered as fulfilling the definition of domicile.

Refugees Students attending NJIT as documented refugees may be eligible to pay resident tuition rates provided they are domiciled in New Jersey and maintain good academic standing. Their status will be reviewed each semester by the director of financial aid.

Political Asylum Students who have been granted political asylum are not permanent residents of the United States and are not eligible to pay resident tuition rates. Employment Authorization Visas issued by INS do not qualify students for NJ resident tuition status.

Request for a Change of Residency Status

Requests for a change in residency status must be submitted to the registrar no later than four weeks before the end of the term for which a change in status is sought. A Residency Analysis Form with all supporting affidavits, deemed appropriate by the registrar pursuant to N.J.A.C. 9A:5-1.1 et seq., must be filed at the time of application. Students who qualify for resident tuition assessment based on the information supplied with their request will have their status changed only for the current and subsequent terms. No adjustments in tuition assessments will be made for prior terms. Residency Appeals Appeals on the determination of residency status will be made to the registrar and will be accepted no later than one month after the date of notification of any such determination. Unresolved appeals will be forwarded to the assistant vice president for academic affairs: enrollment planning. The assistant vice president will respond to the appeal within 30 working days of receipt of the appeal. The decision of the assistant vice president for academic affairs: enrollment planning will be final.

Residency Appeals

Appeals for a change in residency status will be made to the registrar and will be accepted no later than one month after the date of notification of any such determination. Unresolved appeals will be forwarded to the assistant vice president for academic affairs: enrollment planning. The assistant vice president will respond to the appeal within 30 working days of receipt of the appeal.

The decision of the assistant vice president for academic affairs: enrollment planning will be final.

Student Responsibilities

Students are responsible for providing relevant and accurate information upon which a residency determination can be made. The burden of proving residency status lies solely upon the student. Moreover, it is considered the obligation of the student to seek advice when in doubt regarding eligibility for in-state tuition assessment. If the student delays or neglects to question eligibility status beyond the period specified above, the student forfeits the right to a residency assessment to which he or she might have been deemed eligible had an appeal been filed at the appropriate time. Students who are classified as resident students but who become non-residents at any time by virtue of a change of legal residence are required to notify the registrar immediately. An independent student loses residency status for in-state tuition payment immediately upon abandonment of the New Jersey domicile. Assessment of non-resident tuition charges will take effect the term following the date of abandonment.

Penalties

If a student has obtained or seeks to obtain resident classification by deliberate concealment of facts or misrepresentation of facts or fails to come forward with notification upon becoming a non-resident, he or she is subject to disciplinary action before the university's professional conduct committee.

Factors Considered in Determining Residence for Tuition Assessment

CLASSIFICATION

Students residing in New Jersey for a period of 12 months before first enrolling at a public institution of higher education in the State of New Jersey are presumed to be state residents for tuition purposes.

Students who have been domiciled within this state for less than 12 months prior to the date of enrollment are presumed to be non-residents for the purpose of calculating tuition. Students who assert residency but whose resident status is challenged by the university, must prove their domicile according to the following regulations.

DOMICILE

"Domicile" means the place where a person has his or her true, fixed, permanent home and principal living establishment, and to which, whenever he or she is absent, he or she has the intention of returning.

Although actual presence is not necessary to preserve domicile once it has been acquired, a person, if absent from the state, must have the intention of returning to New Jersey in order to remain a legal resident.

In determining whether legal resident status has been shown, mere physical presence and the assertion of a declaration of intent to remain in the state may not be sufficient. To assist in determining whether a person is a New Jersey legal resident, the primary evidence of residency, although not dispositive, is a notarized affidavit setting forth domicile and a copy of New Jersey income tax return substantiating employment in New Jersey as the applicant's primary reason for residing in the state. In the case of dependent students, a copy of the parent's or legal guardian's New Jersey tax return will be required in addition to the affidavit. The following additional items may be considered: voter registration of the individual in New Jersey; a New Jersey driver's license and/or a registration or such other information as the university deems acceptable. In unusual circumstances, if primary evidence is not available, the institution may make a determination of New Jersey domicile based exclusively on supplementary evidence; however, supplementary evidence may not be deemed sufficient to justify a determination of legal resident status.

If a student resides with his or her parents or legal guardians for more than six consecutive weeks last or this year, or is dependent upon them for food, clothing, or shelter during the present or prior year, or is claimed, or will be claimed, as a dependent for income tax purposes for the last or current year, the student is deemed to be financially dependent. In such case, the domicile of the individual's parent or legal guardian for the year prior to the term of admission will determine the domicile of the dependent student.

Conversely, if a student has not lived, and will not live, with parents or legal guardians for more than six consecutive weeks during the present or prior year; and has not received and will not receive financial assistance from parents or legal guardians of more than $750 in support of any kind including food, clothing and shelter last year and this year; and has not been claimed as an exemption on parents' or legal guardians' tax return last and this year; and has resources, which should be at least equal to the level of public assistance in the preceding calendar year, the individual is deemed to be financially independent and student's own domicile, for the year prior to the term for which New Jersey domiciliary status is sought, will determine his or her legal resident status.

PRESENCE IN NEW JERSEY DUE TO MILITARY SERVICE

As a general rule, in the absence of any intention to effect a change of domicile, the domicile of a person is not affected or changed by reason of his or her entry into the military service.

United States military personnel and their dependents who are living in New Jersey are regarded as residents of the state for tuition purposes.

B.S./M.S. and Dual Degree Programs

This accelerated dual degree program permits undergraduates to earn credits toward a master’s degree. Students 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 after they complete at least five courses in their major, and have maintained a GPA of 3.0 or better. Students must submit the application for admission to the B.S./M.S. program to the Office of Graduate Studies no later than one year prior to graduation. Applicants must fulfill all university requirements for admission to graduate programs. Some programs will require submittal of GRE or GMAT scores. For all others, these are highly recommended.

Information and applications can be obtained from the Office of Graduate Studies, (973) 596-3462.

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./M.S. in Management program, which allows 12 dual-use credits.

M.S./M.S. and Dual Master's Programs

The M.S./M.S. 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. The Office of Graduate Studies will direct the registrar on transfer of the two dual-use courses to the second program. The M.S./M.S. program option is not intended for students who have left the doctoral programs 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 involving the Master of Architecture, the Master in Infrastructure Planning and the M.S. in Management allow dual use of courses from the first degree to the second. The number of dual use credits for these combinations may exceed 6 credits in accordance with specific program arrangements.

Community and Public Service

Graduate students may also receive financial support through participation in the NJIT Service Corps. Through experiential learning activities, students link classroom theory and concepts with practical application, contribute their expertise and develop leadership, decision-making and interpersonal skills through involvement with non-profit and governmental agencies and community-based organizations.

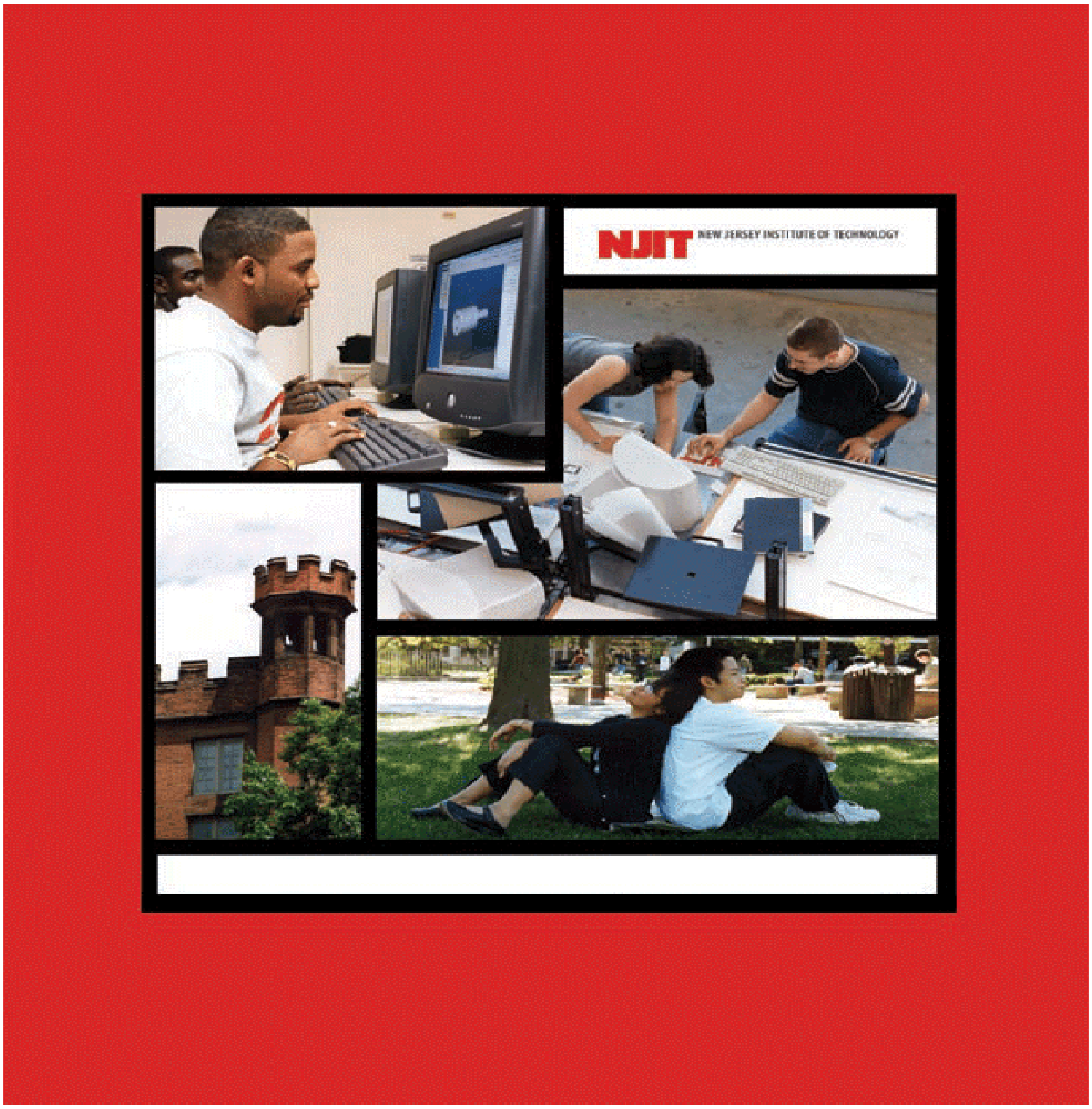
- **Community Service Work Study:** Off-campus employment that is course- and major-related in non-profit and governmental agencies and community-based organizations for eligible Federal Work Study graduate students.
- **Housing Scholars:** Merit-based, competitive full-time summer employment in community-based organizations that design and develop plans for affordable housing projects around the state. Students pursuing graduate degrees in civil engineering, management, computer science, and computer engineering who are U.S. citizens or permanent residents, have completed 6 credits of graduate study, are in good academic standing, have satisfied all other university requirements for financial support, and are approved by their department's co-op advisor are eligible to apply. Architecture students may apply after completing 14 credits of first-year required graduate courses and if they have an overall cumulative 3.2 GPA or above. However, participation cannot begin until 28 credits are completed.
- **Service Learning:** Course-based, students can register for classes that include a community Service Learning option or register for faculty-monitored independent study that includes a community Service Learning component.

For more information, contact the Division of Career Development Services, Community and Public Service, (973) 596-3100.

NJIT
NEW JERSEY INSTITUTE OF TECHNOLOGY

2003-2004 Graduate Catalog

Programs



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Chemistry

Administered By: Department Chemistry and Environmental Science

Administration

Acting Chairperson	Joseph W. Bozzelli
Graduate Advisor	Lev Krasnoperov
Ada C. Fritz Professor of Environmental Engineering and Science	Joseph W. Bozzelli

Faculty

Distinguished Professors	Bozzelli, Venanzi
Professors	Grow, Gund, Kebbekus, Krasnoperov, Mitra
Associate Professors	Dauerman, Getzin
Assistant Professor	Malhotra
Research Professor	Iqbal
Special Lecturer	Skawinski

Degrees Offered: Master of Science in Applied Chemistry

Because the chemistry graduate program is offered in an interdisciplinary department, there are strong ties to chemical engineering and environmental science. There are additional opportunities for interdisciplinary collaborations with the Federated Department of Biological Sciences. The strong research program in the department is supported by major grants from federal and state agencies, and industrial corporations. Our department enjoys close ties to the pharmaceutical and petrochemical industries, and plastics manufacturers through the Polymer Processing Institute. Chemistry plays a major role in several NJIT research centers, including the Hazardous Substance Management Research Center, the Northeast Hazardous Substance Research Center, the Polymer Engineering Center, the Particle Technology Center, and the Center for Membrane Technology. These centers involve collaborations with other universities including MIT, Princeton, Rutgers, Stevens, Tufts, and UMDNJ.

MASTER OF SCIENCE IN APPLIED CHEMISTRY

This program is intended for those interested in advancing their understanding of chemistry. It may be taken on a part-time or full-time basis, and can include a master's thesis as an option.

Admission Requirements:

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. GRE scores must be submitted by those seeking financial support and those whose last prior degree was from outside the United States. International students must achieve a minimum TOEFL score of 550.

Off-Campus Programs: At the National Starch and Chemical Corporation, NJIT offers suffiecient 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 prgrams 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; email: cpe@njit.edu.

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 ChE 791 Graduate Seminar.

CORE:
3 credits from:

Chem 602	Advanced Organic Chemistry II: Reactions
Chem 605	Advanced Organic Chemistry I:Structure

3 credits from:

Chem 661	Instrumental Analysis
Chem 664	Advanced Analytical Chemistry

6 credits:

Chem 610	Advanced Inorganic Chemistry
Chem 658	Advanced Physical Chemistry

THESIS:
Required of those receiving departmental or research-based support; others may choose 6 credits of 600- or 700-level courses in chemical engineering or chemistry instead of thesis.

Chem 701	master's Thesis (6 credits)

ELECTIVE:
12 credits for those completing a master's thesis

18 credits for those not completing a master's thesis

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.

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.

Credits:

Students entering with bachelor's degrees are required to complete a minimum of 78 credits. This includes 42 credits of course work. The required core courses for the M.S. in Chemistry are mandatory; and no less than 24 credits in chemistry or related courses must be taken. At least 12 credits must be in courses at the 700 level (of which at least 6 should be in chemistry), and none may be at the 500 level. The qualifying examinations must be passed (see below). A minimum of 36 credits of research must be completed, and a dissertation must be submitted and defended.

The required core courses are: Advanced Physical Chemistry, Advanced Organic Chemistry (either Structure or Reactions), Advanced Analytical Chemistry or Instrumental Analysis, and Advanced Inorganic Chemistry or Biochemistry.

For students who have completed a masters degree, the program requires a minimum of 24 credits of course work, at least 12 of which are at the 700 level. Of the 700 level courses, 6 credits must be in chemistry. Students must also take 36 credits of research work, followed by the submission and defense of a dissertation. While it is not required that the the core courses be taken, students will have to pass qualifying examinations in these areas (see below). Therefore, it is recommended that they take these courses, unless they already have a strong background in these areas.

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 in their studies. Students entering without the MS degree must also attain a GPA of 3.0 in the core courses.

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.

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".

Mathematics

Administered By: Department of Mathematical Sciences

Administration

Chairperson	Daljit S. Ahluwalia
Associate Chairperson	Robert M. Miura
Director(Undergraduate Program)	Amitabha Bose
Director(Statistics Program)	Manish C. Bhattacharjee
Director(Graduate Program)	Demetrius T. Papageorgiou
Departmental Coordinator	Padma Gulati

Faculty

Foundation Chair	Kriegsmann
Distinguished Professors	Aubry*, Goldberg, Kriegsmann
Professors	Ahluwalia, Andrushkiw, Bhattacharjee, Blackmore, Lacker**, Levy, Luke, Milojevic, Miura**, Papageorgiou, Perez, Stickler, Tavantzis
Associate Professors	Bechtold, Booty, Bose, Bukiet, Chase, Dhar, Dios, Golowasch‡, Kappraff, Katzen, Kondic, Lieb, Michalopoulou†, Nadim‡, Petropoulos, Plastock, Siegel, Sran
Assistant Professors	Berliner, Connell, Elmer, Goldman**, Goodman, Horntrop, Lott, Matveev, Muratov, Raymond, Tao
Special Lecturers	Ratnaswamy
Lecturer	Abdeljaber, Berkowitz, Hunter, Mohebbi, Talwar, Zaleski
Post Doctoral Fellows	Baran, Volkov
Research Professors	Booth, Erneux, Mauri, Spencer, Vanden-Broeck

† Joint appointee with the Department of Electrical and Computer Engineering

‡ Joint appointment with the Federated Department of Biology

* Joint appointment with Department of Mechanical Engineering

** Joint appointment with Department of Biomedical Engineering

Degrees Offered:

Master of Science in Applied Mathematics
Master of Science in Applied Statistics
Doctor of Philosophy in 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, collects and interprets data in order 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 3.0 on a 4.0 scale or equivalent is normally required. Submission of GRE scores is encouraged but not required. However, GRE scores are required for those students applying for financial support. Applications are considered on a case-by-case basis.

Bridge Program: 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 courses that may include undergraduate courses before proceeding to the graduate curriculum. Such courses do not count towards a graduate degree.

Degree Requirements:

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.

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.

CORE:

15 credits:

Math 613	Advanced Applied Mathematics I: Modeling
Math 631	Linear Algebra
*** Math 645	Analysis I
Math 656	Complex Variables I
Math 689	Advanced Applied Mathematics II: ODEs

PROJECT, THESIS (optional):

ME 700	Master’s Project (3 credits)
ME 701	Master’s Thesis (6 credits)

*** Students specializing in applied mathematics or computational mathematics may take Math 545 Advanced Calculus I and Math Math 546 Advanced Calculus II , instead of Math 645 and 3 credits of elective.

REQUIRED COURSES IN AREAS OF SPECIALIZATION:

6 credits:

Analysis:

Math 745	Analysis II
Math 756	Complex Variables II

Appied Mathematics:

Math 614	Numerical Methods I
Math 690	Advanced Applied Mathematics III: PDEs

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

ELECTIVE:
9 credits selected with approval of graduate advisor.

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. Courses offered by appropriate departments at NJIT, UMDNJ, 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.

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 3.0 on a 4.0 scale or equivalent is normally required. Submission of GRE scores is encouraged but not required. However, GRE scores are required for those students applying for financial support. 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.

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.

CORE:
21 credits:

Math 611	Numerical Methods for Computation ***or***
Math 630	Linear Algebra and Applications
Math 644	Regression Analysis Methods
Math 646	Time Series Analysis
Math 661	Applied Statistics
Math 662	Probability Distributions
Math 664	Methods for Statistical Consulting
Math 762	Statistical Inference

PROJECT, THESIS (optional):

ME 700	Master's Project (3 credits)
ME 701	Master's Thesis (6 credits)

ELECTIVE:
9 credits selected with approval of 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. Students are encouraged to choose courses in application areas. Courses offered by appropriate departments at NJIT, UMDNJ, 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.

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 (i) solving modern scientific, technological and industrial problems, and (ii) 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, nonparametric 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.

Degree Requirements:

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

Math 599	Teaching in Mathematics
Math 613	Advanced Applied Mathematics I
Math 631	Linear Algebra
Math 645	Analysis I

Semester II

Math 614	Numerical Methods I
Math 656	Complex Variables I
Math 689	Advanced Applied Mathematics II
Math 745	Analysis II

Semester III

Math 671	Asymptotic Methods I
Math 690	Advanced Applied Mathematics III
Math 712	Numerical Methods II
Math 756	Complex Variables II

Semester IV

Math 676	Advanced Ordinary Differential Equations
Math 707	Advanced Applied Mathematics IV: Special Topics
Math 713	Advanced Scientific Computing
Elective	Course from Natural Sciences or Engineering Relevant to Student's Interests

In addition to these courses, there are advanced courses in:

asymptotic methods
calculus of variations
computational neuroscience
mathematical biology
probability
statistics.

Also, there are special topics courses in:

electromagnetics
fluid dynamics
integral equations
materials science
mathematical biology
microwave processing of materials
wave propagation.

Qualifying Examination: The qualifying examination for the applied mathematics track consists of three components: Analysis, Linear Algebra - Numerical Methods, and Applied Mathematics. Students must achieve a grade of A in each component to pass the qualifying examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Analysis and Linear Algebra - Numerical Methods (August and January), Applied Mathematics (January and May).

The following courses will be useful in helping the students to prepare for the qualifying examinations : Math 645, Math 656, and Math 745 for Analysis; Math 614 and Math 631 for Linear Algebra – Numerical Methods; and Math 613, Math 689, and Math 690 for Applied Mathematics. It should be noted that taking the above courses are 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 these examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. Within six months of passing the qualifying examination a dissertation committee must be formed according to the regulations specified in this catalog.

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.

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

Math 599	Teaching in Mathematics
Math 631	Linear Algebra
Math 645	Analysis I
Math 662	Probability Distributions

Semester II

Math 644	Regression Analysis Methods
Math 668	Probability Theory
Math 745	Analysis II
Math 762	Statistical Inference

Semester III

Math 646	Time Series Analysis
Math 699	Design and Analysis of Experiments
Math 707	Special Topics (Linear Models)
Math 786	Large Sample Theory and Inference

Semester IV

Math 664	Methods for Statistical Consulting
Math 698	Sampling Theory
Math 787	Nonparametric Statistics
Math 761	Statistical Reliability Theory and Applications

Qualifying Examination: The qualifying examination for the applied probability and statistics track consists of three components: Analysis, Linear Algebra, and Statistics. Students must achieve a grade of A in each component to pass the qualifying examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Real Analysis - Probability; Linear Algebra - Distribution Theory and Statistical Inference (August and January); Topics in Statistics (January and May).

The following courses will be useful in helping the students to prepare for the qualifying examinations : Math 645, Math 668, and Math 745 for Real Analysis and Probability; Math 631, Math 662, and Math 762 for Linear Algebra, Distribution Theory and Statistical Inference; Math 644, Math 699, and Math 707 (Linear Models) for Topics in Statistics. The scope of the "Topics in Statistics" examination may include additional advanced courses in statistics that the students may have taken. It should be noted that taking the above courses are 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 these examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. Within six months of passing the qualifying examination a dissertation committee must be formed according to the regulations specified in this catalog.

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.

Students interested in the Pure Mathematics track should contact the Department of Mathematics and Computer Science at Rutgers-Newark.

Applied Physics

Administered By: Physics Departments of NJIT and Rutgers-Newark

Administration

Chairperson (NJIT)	John Federici (Acting)
Chairperson (Rutgers-Newark)	Earl D. Shaw
Associate Chairperson (NJIT)	Frederick Tomblin
Joint Graduate Programs Director and Graduate Advisor	Ken K. Chin Phone: (973) 596-3297 (Room 466 TIE) Email: chin@admin.njit.edu

NJIT Faculty

Distinguished Professors	Goode, Johnson, R. Levy
Professors	Buteau, Carr, Chin, Farmer, Federici, Fink, Gautreau, Ravindra, Savin
Associate Professors	Gary, Russo, H. Wang
Assistant Professors	Jermakian, Tyson
Distinguished Research Professor	Hensel, Zirin
Research Professors/Special Lecturers	Kohn, Moeller, H. Opyrchral, Piatek, Tomblin, Yu

Rutgers-Newark Faculty

Professor Rank II	Murnick
Professors	Shaw
Associate Professor	Wu
Assistant Professor	Burke

Degrees Offered: Master of Science in Applied Physics; Doctor of Philosophy in Applied Physics. Both degrees are offered jointly by NJIT and Rutgers-Newark.

The NJIT and Rutgers-Newark departments of physics offer a unique opportunity to pursue master's and doctoral degrees in applied physics in a joint program combining the resources of two of New Jersey's public research universities.

Interdisciplinary applied physics research is available in collaboration with faculties of NJIT, Rutgers-Newark and Rutgers-New Brunswick, and UMDNJ in 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 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 optical science, microelectronics, device physics, materials science, 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.

Degree Requirements:

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 791/26:755:791 Applied Physics Seminar.

REQUIRED:
12 credits:

Phys 611/26:755:611	Advanced Classical Mechanics
Phys 621/26:755:621	Classical Electrodynamics
Phys 631/26:755:631	Quantum Mechanics
Phys 641/26:755:641	Statistical Mechanics

PROJECT OR THESIS (required):
3 credits:

Phys 700/26:755:700	Master's Project (3 credits) ***or***
Phys 701/26:755:701	Master's Thesis (6 credits)

ELECTIVE:
12 credits if completing a master's thesis; *15 credits* if completing a master's project: Selected in consultation with a graduate advisor.

DOCTOR OF PHILOSOPHY IN APPLIED PHYSICS

This program is for superior students in applied physics who 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.

Degree Requirements:

For students entering with B.S. or B.A. degrees, the Ph.D. requires 75 (600 or 700 level) credits as follows:

39 credits of course work, of which 24 credits are physics courses (including 3 credits of mathematical physics or applied mathematics), and 15 credits are electives. No less than 12 credits must be at the 700 level.

36 credits of Phys 790/26:755:790 Doctoral Dissertation

For students entering with M.S. or M.A. degrees, the Ph.D. requires 54 (above 600 level) credits as follows:

18 credits of course work, of which 9 credits are physics courses (including mathematical physics or applied mathematics), and 9 credits are electives. No less than 12 credits must be at the 700 level.

36 credits of Phys 790/26:755:790 Doctoral Dissertation

Seminar: All doctoral students must enroll in Phys 791/26:755:791 Applied Physics Seminar each semester, including each semester they are enrolled in Phys 790/26:755:790 Doctoral Dissertation.

REQUIRED:
18 credits:

Phys 611/26:755:611	Classical Mechanics
Phys 621/26:755:621	Classical Electrodynamics
Phys 631/26:755:631	Quantum Mechanics
Phys 641/26:755:641	Statistical Mechanics
Phys 721/26:755:721	Classical Electrodynamics II
Phys 731/26:755:731	Quantum Mechanics II

The four 600-level physics courses can be replaced by other courses for entering students who have M.S. degrees and have taken these courses in the master's program.

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.

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 3.0 on a 4.0 scale or equivalent is normally required. Submission of GRE scores is encouraged but not required. However, GRE scores are required for those students applying for financial support. 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.

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.

CORE:

21 credits:

Math 611	Numerical Methods for Computation ***or***
Math 630	Linear Algebra and Applications
Math 644	Regression Analysis Methods
Math 646	Time Series Analysis
Math 661	Applied Statistics
Math 662	Probability Distributions
Math 664	Methods for Statistical Consulting
Math 762	Statistical Inference

PROJECT, THESIS (optional):

ME 700	Master's Project (3 credits)
ME 701	Master's Thesis (6 credits)

ELECTIVE:

9 credits selected with approval of 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. Students are encouraged to choose courses in application areas. Courses offered by appropriate departments at NJIT, UMDNJ, 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.

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 (i) solving modern scientific, technological and industrial problems, and (ii) 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, nonparametric 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.

Degree Requirements:

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

Math 599	Teaching in Mathematics
Math 613	Advanced Applied Mathematics I
Math 631	Linear Algebra
Math 645	Analysis I

Semester II

Math 614	Numerical Methods I
Math 656	Complex Variables I
Math 689	Advanced Applied Mathematics II
Math 745	Analysis II

Semester III

Math 671	Asymptotic Methods I
Math 690	Advanced Applied Mathematics III
Math 712	Numerical Methods II
Math 756	Complex Variables II

Semester IV

Math 676	Advanced Ordinary Differential Equations
Math 707	Advanced Applied Mathematics IV: Special Topics
Math 713	Advanced Scientific Computing
Elective	Course from Natural Sciences or Engineering Relevant to Student's Interests

In addition to these courses, there are advanced courses in:

asymptotic methods
calculus of variations
computational neuroscience
mathematical biology
probability
statistics.

Also, there are special topics courses in:

electromagnetics
fluid dynamics
integral equations
materials science
mathematical biology
microwave processing of materials
wave propagation.

Qualifying Examination: The qualifying examination for the applied mathematics track consists of three components: Analysis, Linear Algebra - Numerical Methods, and Applied Mathematics. Students must achieve a grade of A in each component to pass the qualifying examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Analysis and Linear Algebra - Numerical Methods (August and January), Applied Mathematics (January and May).

The following courses will be useful in helping the students to prepare for the qualifying examinations : Math 645, Math 656, and Math 745 for Analysis; Math 614 and Math 631 for Linear Algebra – Numerical Methods; and Math 613, Math 689, and Math 690 for Applied Mathematics. It should be noted that taking the above courses are 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 these examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. Within six months of passing the qualifying examination a dissertation committee must be formed according to the regulations specified in this catalog.

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.

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

Math 599	Teaching in Mathematics
Math 631	Linear Algebra
Math 645	Analysis I
Math 662	Probability Distributions

Semester II

Math 644	Regression Analysis Methods
Math 668	Probability Theory
Math 745	Analysis II
Math 762	Statistical Inference

Semester III

Math 646	Time Series Analysis
Math 699	Design and Analysis of Experiments
Math 707	Special Topics (Linear Models)
Math 786	Large Sample Theory and Inference

Semester IV

Math 664	Methods for Statistical Consulting
Math 698	Sampling Theory
Math 787	Nonparametric Statistics
Math 761	Statistical Reliability Theory and Applications

Qualifying Examination: The qualifying examination for the applied probability and statistics track consists of three components: Analysis, Linear Algebra, and Statistics. Students must achieve a grade of A in each component to pass the qualifying examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Real Analysis - Probability; Linear Algebra - Distribution Theory and Statistical Inference (August and January); Topics in Statistics (January and May).

The following courses will be useful in helping the students to prepare for the qualifying examinations : Math 645, Math 668, and Math 745 for Real Analysis and Probability; Math 631, Math 662, and Math 762 for Linear Algebra, Distribution Theory and Statistical Inference; Math 644, Math 699, and Math 707 (Linear Models) for Topics in Statistics. The scope of the "Topics in Statistics" examination may include additional advanced courses in statistics that the students may have taken. It should be noted that taking the above courses are 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 these examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. Within six months of passing the qualifying examination a dissertation committee must be formed according to the regulations specified in this catalog.

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.

Students interested in the Pure Mathematics track should contact the Department of Mathematics and Computer Science at Rutgers-Newark.

Architecture

Administered By: New Jersey School of Architecture

Administration

Dean	Urs P. Gauchat
Associate Dean	James E. Dyer
Graduate Program Director	Peter C. Papademetriou
Graduate Program Associate Director	Timothy Wood
M.I.P Planning Program Director	Antonio de Souza Santos
Graduate Program and Admissions Coordinator	Fred Little

Faculty

Distinguished Professor	Mostoller
Professors	Celik, Franck, Gauchat, Goldman, Greenfield, Hawk†, Papademetriou, Santos, Weisman
Associate Professors	Elwell, B. Jackson, Moore, Schuman, Wall, West, Zdepski
Graduate Advisor	Peter C. Papademetriou Phone: (973) 596-3078 (Room 345 WES) Email: march@admin.njit.edu
MSAS Graduate Advisor	David Hawk Phone: (973) 596-3019 (Room 3024 CAB) Email: hawk@admin.njit.edu
Co-op Advisor	Timothy Wood Phone: (973) 596-3078

† Joint appointee with the School of Management

Degrees Offered: Master of Architecture (professional and post-professional options); Master of Science in Architectural Studies; Master in Infrastructure Planning; and dual Master of Architecture (professional, or post-professional) and either Master in Infrastructure Planning, or Master of Science in Management or Master of Science in Civil Engineering

An architect today must be educated to play a leading role in the planning, design and construction of the built environment. New dynamic economic, political, social and technological forces have radically altered how architecture is made and what role architects exercise in the process. 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 two types of degrees: the Bachelor of

Architecture and the Master of Architecture. A program may be granted a five-year, three-year, or two-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, comprise 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 seven 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 97-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.) degree.

Dual Degree M.Arch. and Master of Infrastructure Planning (M.I.P.) Open only to students in the M.Arch. program options, the dual degree program permits students to obtain an M.I.P. in substantially less time than if taken separately; in some cases in only one more semester of full-time study. 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 options, the dual degree program permits students to obtain an M.S. in Management in substantially less time; in some cases in only one more semester of full-time study. 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 options. The dual degree program permits students to obtain an M.S. in Civil Engineering in substantially less time; in some cases in only one more semester of full-time study. Also see the program description under "Civil Engineering" in this catalog.

Admission Requirements for all M.Arch. Options:

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 an appropriate academic background in physics, calculus, or statistics; students who lack such a background will be expected to take equivalent course work before entering the second year of the M.Arch. program. 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). TOEFL scores are required for all international students.

Graduate Certificate Programs: A 12-credit graduate certificate in Sustainable Architecture is available as a step toward this degree. 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.

Degree Requirements for Professional M.Arch.:

This 97-credit program consists of a 61-credit core and an options sequence of 21 credits of required and 15 credits of elective courses. 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 97 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 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.

Degree credits appear in parentheses following the course titles below.

CORE:
61 credits as follows:

Arch 500G	Computer Programming and Graphics Problems (2)
Arch 501G	Architectural Design I (5)
Arch 502G	Architectural Design II (5)
Arch 503G	Architectural Design III (5)
Arch 504G	Architectural Design IV (5)
Arch 511G	Structures I (3)
Arch 512G	Structures II (3)
Arch 513G	Structures III (3)
Arch 521G	Construction I (3)
Arch 522G	Construction II (3)
Arch 523G	Building Performance (3)
Arch 524G	Environmental Control Systems (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)

6 additional credits of architectural history, selected in consultation with graduate advisor

Core courses must be completed before proceeding to the options sequence.

OPTIONS SEQUENCE:
REQUIRED:
21 credits minimum:

Arch 505G	Advanced Design Options I (6)
Arch 506G	Advanced Design Options II (6)
Arch 507G	Advanced Design Options III (6) ***or***
* MARC 701	Master of Architecture Thesis (6)
Arch 579G	Professional Architectural Practice (3)

ELECTIVE:
15 credits selected in consultation with graduate advisor, of which a minimum of 9 credits are architecture electives.

Degree Requirements for Post-Professional M.Arch.

Consists of a minimum of 30 credits. Thesis is optional.

REQUIRED:

Arch 505G	Advanced Design Options I (6)
Arch 507G	Advanced Design Options III (6) ***or***
* MARC 701	Master of Architecture Thesis (6)

ELECTIVE:
18 credits consisting of 12 credits of architecture electives and 6 credits of free electives selected in consultation with graduate advisor.

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* Arch 661 Directed Studies of Architecture (3) is prerequisite for MARC 701 Master of Architecture Thesis. Arch 661 may be

taken as an elective.

Degree Requirements for Dual M.Arch. and M.I.P.:

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 "Infrastructure Planning" in this catalog.

REQUIRED:
15 credits:

Arch 507G	Advanced Design Options III (fulfills MIP 601) (6)
Arch 631H	History and Theory of Infrastructure (taken as M.Arch. architecture history elective and fulfills MIP 631) (3)
Arch 673	Introduction to Infrastructure Planning (taken as M.Arch. elective and fulfills MIP 673) (3) ***or***
Arch 674	Infrastructure Planning in Practice (taken as M.Arch. elective and fulfills MIP 674) (3)
Arch 675	Elements of Infrastructure Planning (taken as M.Arch. elective and fulfills MIP 675) (3)

Additional requirements to complete M.I.P. program:
REQUIRED:
21 credits:

MIP 602	Interdisciplinary Infrastructure Studio II (6)
MIP 612	Introduction to Environmental Policy Studies (3)
MIP 615	Introduction to Transportation Studies (3)
MIP 618	Public and Private Financing of Urban Areas (3)
MIP 652	Geographic Information Systems (3)
MIP 655	Land Use Planning (3)

Degree Requirements for Dual M.Arch. 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.

The requirements to obtain the M.S. in Management degree are:

‡ CORE:
18 credits:

Arch 650	Economy of Building (fulfills M.Arch. elective) (3)
Arch 651	Real Estate Analysis for Architects (fulfills M.Arch. elective) (3)
Arch 652	Architectural Project Management (fulfills M.Arch. elective) (3)
Fin 516	Principles of Financial Management (fulfills M.Arch. elective) (3)
HRM 601	Organizational Behavior (fulfills M.Arch. free elective) (3)
Mgmt 680	Entrepreneurial Strategy (3) ***or***
Mgmt 692	Business Strategy (3)

REQUIRED:
3 credits:

Fin 618	Public and Private Financing of Urban Areas (fulfills M.Arch. free elective) (3)

ELECTIVE:
9 credits from:

Acct 615	Concepts of Strategic Cost Analysis (3)
Fin 624	Financial Management (3)
Mgmt 640	New Venture Management (3)
Mgmt 645	New Venture Finance (3)
MIS 645	Operations Management, Planning and Control (3)
Mrkt 630	Models of Consumer Behavior (3)
Mrkt 638	Sales Management for Technical Professionals (3)

Degree Requirements for Dual M.Arch. 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:

BRIDGE:

CE 200	Surveying (3)
CE 200A	Surveying Lab (1)
CE 501	Introduction to Soil Behavior (3)
Math 105	Elementary Probability and Statistics (3)
Math 119	Applied Calculus and Finite Math (4)

CORE:

CE 610	Construction Management (fulfills M.Arch. free elective) (3)
CE 611	Project Planning and Control (3)
CE 616	Construction Cost Estimating (3)
EM 632	Legal Aspects in Construction (3)

REQUIRED:
12 credits:

Arch 650	Economy of Building (fulfills M.Arch. elective) (3)
Arch 652	Architectural Project Management (fulfills M.Arch. elective) (3)
Arch 675	Elements of Infrastructure Planning (fulfills M.Arch. elective) (3)
MIS 645	Operations Management, Planning and Control (fulfills M.Arch. free elective) (3)

ELECTIVE:
6 credits from:

CE 615	Infrastructure and Facilities Remediation (3)
CE 631	Advanced Reinforced Concrete Design (3)
CE 642	Foundation Engineering (3)
CE 702	Special Topics in Civil Engineering (3)
CE 710	Systems in Building Construction (3)
CE 711	Methods Improvement in Construction (3)
EnE 662	Site Remediation (3)
EnE 671	Environmental Impact Analysis (3)

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 SCIENCE IN ARCHITECTURAL STUDIES (MSAS)

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.A.S. 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.

Degree Requirements:

The program consists of 36 credits of required and elective courses and may be taken either full- or part-time. A thesis is required. Students are required to design their programs in consultation with the graduate advisor.

To remain in good academic standing, students must maintain a cumulative GPA of 3.0 in graduate courses.

REQUIRED:

18 credits:

Arch 661	Directed Studies of Architecture (3)
Arch 686	Research Methods for Environmental Design (3)
Math 687	Quantitative Analysis for Environmental Design Research (3)
MSAS 701	Master of Science in Architectural Studies Thesis (6)

ELECTIVE:

18 credits selected in consultation with the MSAS graduate advisor.

MASTER IN INFRASTRUCTURE PLANNING:

See "Infrastructure Planning" in this catalog for program description.

‡ For those pursuing the dual M.Arch. and M.S. in Management, Arch 579G fulfills Mgmt 691 Legal and Ethical Issues required for the M.S. in Management.

Biology

Administered By: Federated Biological Sciences Department of NJIT and Rutgers-Newark

Administration

Program Director	David Kafkewitz Phone: (973) 353-1306 (Room 135 Smith Hall) Email: biosci@newark.rutgers.edu
Graduate Program Coordinator	Doina Ganea Phone: (973) 353-1162 (Room 135 Smith Hall) Email: ganea@newark.rutgers.edu
Graduate Program Administrator	Amy Trimarco Phone: (973) 353-1235 (Room 135 Smith Hall) Email: trimarco@newark.rutgers.edu

NJIT Faculty

Distinguished Professors	Gund, Tavantzis, Venanzi
Associate Professors	Bose, Booth, Hahn, Lacker, Machotra, Nadim

Rutgers-Newark Faculty

Professors	Cali, Feder, Frenkel, Ganea, Hart, Jonakait, Kafkewitz, Kirby, Weis
Associate Professors	Bonder, Buszaki, Kasper, Morrison, Schnell
Assistant Professors	Hamerlynk, Henebry, Knox

Degrees Offered: Master of Science in Biology; Doctor of Philosophy in Biology. Both degrees are offered jointly by NJIT and Rutgers-Newark.

Departmental equipment, housed at Rutgers-Newark, includes a microscope facility second-to-none in the state of New Jersey. This facility comprises scanning and transmission-electron microscopes, a confocal microscope, and five image-processing stations. In addition, the department boasts an oligo synthesizer, automated DNA sequencer, ultracentrifuges, phosphor-imager, scintillation and gamma counters, FPLC, and AAALAC-approved animal facility, and a greenhouse. Individual research laboratories house tissue culture facilities, electrophysiological equipment, fluorescence microscopes, and thermal cyclers. Additional facilities are available at neighboring institutions. Affiliations are maintained with UMDNJ and industrial research laboratories.

MASTER OF SCIENCE IN BIOLOGY

The Master of Science in Biology is designed to provide students with advanced knowledge of both plant and animal biology and microbiology.

Admission Requirements:

Applicants are expected to have an accredited undergraduate degree in biology from an accredited institution. Candidates with other appropriate backgrounds will be considered. The following cognate undergraduate courses are required: general chemistry, organic chemistry, physics, and calculus.

Bridge Program: To ensure academic success in their graduate studies, students may be required to take additional undergraduate or graduate courses before beginning graduate curricula. Such courses are not counted toward degree requirements.

Degree Requirements:

A minimum of 30 credits is required. These must include at least one 3-credit course in each of four of the following five areas: cell biology and biochemistry, molecular biology, physiology, ecology, and plant biology. After taking one course from each of four of the five areas, students may choose to concentrate their remaining credits in any of these five areas. A research component may be satisfied by either writing a thesis or submitting a research paper. Students electing to write a thesis must complete a minimum of 24 credits of course work and 6 credits of research and must pass an oral defense of the submitted thesis. Students who choose the research paper option are required to take 30 credits of course work, pass a written comprehensive exam and complete a research paper.

REQUIRED:

30 credits selected in consultation with graduate advisor

THESIS OR RESEARCH PAPER (required):

6 credits: master's thesis research, topic selected in consultation with graduate advisor *or*

non-credit bearing research paper written on completion of 30 credits of course work.

DOCTOR OF PHILOSOPHY IN BIOLOGY

The Ph.D. in Biology is designed to provide students with advanced knowledge of research in the areas of cell/molecular/biochemistry or ecology/evolution.

Degree Requirements:

The doctoral curriculum in biology is divided into two tracks. Students may select either the cell/molecular/biochemical track or the ecology/evolution track. Each track has a set of required courses that provide a formal foundation in research fields covered in each track. Students must earn at least a grade of B in order to receive credit for these courses. The remainder of the course work is chosen in consultation between the student and the advisor and the Standards Committee with permission of the graduate program director. During the first year all doctoral students undertake rotations through at least two departmental research laboratories.

REQUIRED:

36 credits of course work, including three core courses

36 credits minimum of doctoral dissertation research

CORE (required):

Cell/Molecular/Biochemical:

9 credits:

26:120:515	Molecular Biology of Eukaryotes
26:120:526	Cell Biology
26:120:571	Biochemistry

Ecology/Evolution:

3 credits from:

16:120:565	Community Dynamics
26:120:586	Landscape Ecology
26:120:587	Systems Ecology: Ecosystems in the Landscape

3 credits from:

16:215:533	The Behavior of Animal Populations
16:215:590	Population Ecology
26:120:593	Physiological Ecology

3 credits from:

26:120:503	Plant Morphology
26:120:532	Evolution
26:120:594	Systematics

Qualifying Examination — At the completion of the core course requirements and of 6 credits of successful laboratory rotations, the student takes the qualifying examination. The examination consists of a written and oral examination in the cell/molecular/biochemical track; and a written review paper, an oral presentation, and an oral examination in the ecology/evolution track.

Formation of Dissertation Committee — After successful completion of the qualifying examination, the student chooses an advisor, begins research for the dissertation, and forms a dissertation committee. The dissertation committee for all students is composed of the student's thesis advisor, and at least three other members of the graduate faculty. One member must be from outside the program. The dissertation committee administers at least one dissertation prospectus meeting and the final defense of the dissertation. In addition, the dissertation committee may meet with the student once every six months to assess the student's progress.

Biomedical Engineering

Administered By: Department of Biomedical Engineering

Administration

Chairperson	William Hunter
Associate Chairperson and Undergraduate Program Director	David Kristol
Graduate Advisor	Stanley Reisman Phone: (973) 596-3527 Email: reisman@njit.edu

Faculty

Foundation Professor	William C. Van Buskirk (biomechanics)
Distinguished Professor	Van Buskirk
Professors	W. Hunter, D. Kristol, H.M. Lacker, S. Reisman
Research Professors	R. Greene, M. Jaffe
Associate Professor	Foulds
Assistant Professors	T. Alvarez, T. Arinzeh
Special Lecturers	B. Mantilla

Degrees Offered: Master of Science in Biomedical Engineering

The M.S. in Biomedical Engineering program stresses the application of the principles and practices of engineering, science and mathematics in solving clinical problems in medicine and surgery. Biomedical engineering students can concentrate on the chemical, computer, electrical, industrial or mechanical engineering aspects of biomedical engineering. Major research areas include modeling, simulation and analysis in the areas of cardiovascular dynamics; signal processing of electrocardiograms, electroencephalograms, and electromyograms; clinical image processing; and the design and analysis of clinical instrumentation and prosthetic devices such as knees, heart valves, hips, voice boxes, and ostomy devices.

Research is conducted cooperatively between NJIT and the medical and dental schools of UMDNJ, the Kessler Institute for Rehabilitation, St. Barnabas Medical Center, Veteran's Administration Medical Center in East Orange, and several hospitals in the New Jersey-New York metropolitan area. In addition, cooperative research opportunities exist with a number of biomedical and pharmaceutical companies within a short commuting distance from NJIT.

MASTER OF SCIENCE IN BIOMEDICAL ENGINEERING

The M.S. in Biomedical Engineering is designed for students who wish to pursue a professional career in biomedical engineering. The master's program integrates the traditional branches of engineering with medical and biological systems. Upon completion of the program, graduates have the background for employment by a medical instrument or device company, for biomedical research, or for continued education toward a more advanced degree in biomedical engineering or medicine.

Admission Requirements:

Applicants are expected to have an undergraduate degree in science or engineering and courses in thermodynamics, differential equations, scientific computer programming, statics and/or dynamics, and an introductory course in electrical engineering.

Bridge Program: Students who lack an appropriate background are required to make up deficiencies before beginning their graduate curriculum. The program of courses is designed in consultation with graduate advisors and may include undergraduate courses. These courses are not counted toward degree requirements.

Degree Requirements:

Students must take at least 30 course credits consisting of required courses and elective courses chosen within an area of specialization as described below.

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.

REQUIRED:

9 credits:

BME 667	Systems Studies in Biomedical Engineering
* BME 669	Quantitative Physiology for Engineers
Math 661	Applied Statistics

3 credits from:

BME 627	Introduction to Biomedical Engineering
BME 672	Biomaterials
ME 671	Biomechanics of Human Structure and Motion

THESIS:

BME 701	Master's Thesis (6 credits)

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* BME 669 may be waived with permission of the program director if a student has passed a physiology course previously. An elective may be substituted.

AREAS OF SPECIALIZATION:

Choose one area of specialization with the approval of the program director. Additional courses may be taken with approval of the program director. The courses and areas are suggestions only, students can develop their own area with approval of the program director.

Instrumentation:

6 credits:

ECE 686	Instrumentation Systems and Microprocessors
ECE 687	Data ManagDesign of Medical Instrumentation

Imaging:

6 credits:

ECE 643	Digital Imaging Processing I
ECE 789	Selected Topics in Electrical and Computer Engineering

Signal Processing:

6 credits:

ECE 640	Digital Signal Processing
ECE 740	Advanced Digital Signal Processing

Biomechanics:

6 credits:

ME 622	Finite Element Methods in Mechanical Engineering
ME 635	Computer-Aided Design

Biomaterials:

6 credits:

BME 698	Selected Topics in Biomedical Engineering
BME 699	Selected Topics in Biomedical Engineering

Biomathematics:

6 credits:

Math 672	Biomathematics I: Biological Waves and Oscillations
Math 673	Biomathematics II: Pattern Formation in Biological Systems

Biotechnology:

6 credits:

Chem 601	Special Topics in Chemistry
Chem 673	Biochemistry

Man-Machine Interaction:

6 credits:

IE 661	Man Machine Systems
IE 669	Human Design Factors in Engineering

ELECTIVE:

Select from the following courses. Other courses, such as those available at UMDNJ's Graduate School of Biomedical Sciences, can be taken if approved by the program director. See the program director for information about UMDNJ courses.

6 credits if completing a master's thesis; *12 credits* if not completing a master's thesis:

BME 672	Biomaterials
ChE 624	Transport Phenomena I
ChE 626	Mathematical Methods in Chemical Engineering
ChE 645	Fundamentals of Rheology
CIS 653	Microcomputers and Applications
CIS 661	Systems Simulation
CIS 662	Model Analysis and Simulation
CIS 670	Artificial Intelligence
ECE 601	Linear Systems
ECE 643	Digital Image Processing I
ECE 657	Semiconductor Devices
ECE 660	Control Systems I
ECE 673	Random Signal Analysis I
ECE 684	Advanced Microprocessor Systems
ECE 686	Instrumentation Systems and Microprocessors
ECE 687	Design of Medical Instrumentation
Math 651	Applied Mathematics I
Math 652	Applied Mathematics II
Math 672	Biomathematics I: Biological Waves and Oscillations
Math 675	Partial Differential Equations
Math 707	Advanced Applied Mathematics IV: Special Topics Biology
ME 653	Control of Electromechanical Networks
ME 671	Biomechanics of Human Structure and Motion

Biomedical Informatics

Administered By: Department of Computer and Information Science and UMDNJ

Administration

Program Director (UMDNJ)	Syed Haque Phone: (973) 972-6871 Email: haque@umdnj.edu
Associate Program Director and Graduate Advisor (NJIT)	James Geller Phone: (973) 596-3383 (Room 4307 GITC) Email: geller@homer.njit.edu

Faculty

Faculty from UMDNJ and Department of Computer and Information Science, as appropriate

Degrees Offered: The Biomedical Informatics (BINF) programs offered jointly by NJIT and UMDNJ (both M.S. and Ph.D.) are being phased out. Admission applications for the joint program are therefore no longer being accepted. Students who were enrolled in either program as of the Spring 2002 semester will have until December 2006 (for the master's degree) and December 2008 (for the PhD) to complete the degree under the joint program.

Students who have interest in an MS program in Biomedical Informatics may wish to consider the NJIT MS degree in Information Systems with specialization in Biomedical Informatics. That program is continuing. UMDNJ will also continue to offer an MS and a PhD program in Biomedical Informatics through the UMDNJ School of Health Related Professions. Students should contact UMDNJ directly for more information on these.

MASTER OF SCIENCE IN BIOMEDICAL INFORMATICS

The master's program prepares students for the application of computer and information sciences to support and manage health care and hospital management systems, laboratory automation, quality assurance, resource allocation, biomedical research, clinical decision making, and biotechnology systems.

Admission Requirements:

Applicants are expected to have an undergraduate degree in science or engineering and courses in thermodynamics, differential equations, scientific computer programming, statics and/or dynamics, and an introductory course in electrical engineering.

Bridge Program: Students are expected to have basic proficiency in a procedural programming language, database concepts, elementary calculus and differential equations. Those who lack this background are expected to take UMDNJ's BINF 4000 Essentials of Health Computer Science or its equivalent. Students who lack an academic background in the health science disciplines are required to take a course in engineering physiology or an equivalent.

Graduate Certificate Program: A 12-credit graduate certificate in health care information systems is available as a step toward this degree. Students can complete this certificate in part through classes conducted via electronic communications. 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

Degree Requirements:

Students must complete at least 36 degree credits: 18 in required core courses; 6 in an area of emphasis; 6 in electives (in consultation with an advisor); and 6 of thesis. Courses are offered at NJIT and UMDNJ.

CORE:

18 credits:

BINF 600/BINF 5100	Introduction to Biomedical Informatics
BINF 601/BINF 5005	Health Care Information Systems
BINF 602/BINF 5020	Biomedical Modeling and Decision-Making Systems
BINF 603/BINF 5030	Visualization in Biomedical Sciences
BINF 621/BINF 5210	Research Methods in Health Sciences
CIS 610	Data Structures and Algorithms

THESIS (required):
6 credits:

BINF 700/BINF 6000	Directed Research/Project

AREAS OF EMPHASIS:
6 credits:
Choose one of the four groups. Students should consider course prerequisites in determining course selection.

Group 1: Clinical Decision Support Systems:

BINF 612/BINF 5125	Clinical Problem Solving and Decision Making
CIS 631	Data Management System Design

Group 2: Health Care Management Systems:

BINF 613/BINF 5130	Health Care Decision Support Systems
CIS 631	Data Management System Design

Group 3: Health Sciences Education/Multimedia Systems:

BINF 631/BINF 5311	Intelligent Instructional Systems ***and***
BINF 632/BINF 5312	Interactive Learning Systems for the Health Sciences ***or***
CIS 658	Multimedia Systems

Group 4: Bioinformatics/Biotechnology Systems:

BINF 622/BINF 5220	Topics in Bioinformatics
BINF 623/BINF 5230	Advances in Molecular and Cellular Genetics

ELECTIVE:
6 credits:
Choose two courses in consultation with advisor.

BINF 614/BINF 5135	Clinical Systems Interface Design
BME 669	Quantitative Physiology for Engineers
CIS 632	Advanced Database System Design
CIS 634	Information Retrieval
CIS 650	Computer Architecture
CIS 652	Computer Networks Architectures, Protocols and Standards
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 670	Artificial Intelligence
CIS 671	Knowledge-Based Systems
CIS 672	Expert System Methods and Design
* CIS 678	Medical Terminologies
CIS 688	Programming for Interactive Environments
MIS 648	Decision Support Systems

* pending

DOCTOR OF PHILOSOPHY IN BIOMEDICAL INFORMATICS

The Ph.D. degree program builds upon the M.S. in Biomedical Informatics and provides students with expertise in the development and application of biomedical computing solutions and systems. The Ph.D. program is intended for biomedical informatics professionals and scholars who desire to continue to explore the synergism between computer science and the nation's health care delivery system with faculty who are at the forefront of research and development in this field. Students will be able to develop and apply theories and techniques of biomedical informatics to design, testing and evaluation of data structures and algorithms for the conversion of scientific data into biomedical knowledge. They gain a thorough understanding of the processes of conversion and the properties of medical information.

Admission Requirements:

Students admitted to the joint doctoral program in biomedical informatics must meet both NJIT and UMDNJ admission requirements. Students must hold an undergraduate or graduate degree in a health field or biomedical informatics, computer science, engineering or a related field from an accredited institution, with a minimum GPA of 3.5. Students must submit: official baccalaureate and master's degree transcripts, curriculum vitae, three letters of recommendation, and GRE/GMAT/MCAT/DAT or comparable graduate admission examination scores. International students must demonstrate proficiency in the English language by scoring a minimum of 550 on the TOEFL. In addition, applicants must demonstrate superior performance in a procedural programming language, database concepts and mathematics corresponding to the contents of CIS 431, CIS 505, Math 111, Math 121 and Math 211. See the NJIT undergraduate catalog for course descriptions. Students who fail to demonstrate performance in these areas will be required to take prerequisite courses. Applicants must have taken appropriate courses in biomedical informatics and demonstrate aptitude, interest and commitment to scholarly activities and research, documented by the quality of papers and projects completed by the applicant and letters of recommendation submitted by persons familiar with the applicant's academic work.

Degree Requirements:

The Ph.D. in Biomedical Informatics requires completion of at least 61 credits beyond the master of science degree and maintenance of a cumulative graduate GPA of 3.0 or better with no more than two grades of C.

REQUIRED:

24 credits of advanced courses at the 600 level (above 5000 level at UMDNJ) subject to advisor's approval and related to the expected research area of specialization are required. A minimum of 12 credits must be at the 700 level (7000 level at UMDNJ). For course descriptions of 7000-level courses, see the program director.

36 credits of dissertation research culminating in a dissertation, which meets the publication requirements of both UMDNJ and NJIT. A maximum of 6 credits of pre-doctoral research can be applied to the dissertation research requirement.

Qualifying Examination — Students must pass a qualifying examination of preparatory studies in the areas of biomedical informatics theory and systems as well as selected biomedical informatics courses related to the area of the student's interest.

Dissertation Proposal and Defense — After successfully completing the qualifying examination students must submit and give an oral defense of a dissertation proposal.

Research — Students who have passed the qualifying examination are permitted to register for doctoral dissertation research. The student's doctoral advisor and doctoral committee supervise the student's extensive research.

Dissertation and Defense — Students are required to write a dissertation summarizing the results of their research and give an oral defense in front of the student's doctoral committee. Submission of a journal quality paper on the student's dissertation research to a peer-reviewed journal.

Participate in the graduate colloquium/seminars, BINF 7910 Biomedical Informatics Seminar or CIS 791 Graduate Seminar every semester.

Participate in the instruction of at least one course in biomedical informatics or a related area under the supervision of a faculty member.

Business Administration in Management of Technology

NJIT's MBA in the Management of Technology is designed to prepare students for the challenges ahead by providing students with the knowledge and the skills to achieve success. The MBA curriculum focuses on the major sectors in the field of Management in order to provide students with a thorough understanding of how to approach the challenges they will face every day in the business world. Topics covered in the core management courses include accounting, marketing, human resources management, finance, economics, and information technology. NJIT's focus on the Management of Technology provides students with the skills necessary to compete in this new, knowledge-based economy and trains students to recognize new trends and integrate emerging technology into business solutions. Recognizing the impact of the Internet and the field of Electronic Commerce on businesses of the future, the School of Management has established a specialization in E-Commerce as part of the Master of Business Administration in the Management of Technology. Students may also choose to specialize in Infrastructure Management, Financial Management, Management Information Systems, Operations Management or Transportation and Logistics.

Admission Requirements:

Prerequisite to the degree program is a common body of knowledge of management disciplines: managerial accounting, managerial economics, finance, management information systems, operations research and marketing. Students with satisfactory grades in undergraduate course in these areas are not required to take them again. Students are required to complete the GMAT prior to being accepted into the program; however, students with a master's degree or higher from an accredited U.S. institution are not required to take the GMAT. A student may transfer up to nine credits from a graduate program from another school, providing they were not used to obtain another degree.

Off-Campus Programs: At Howmedica Corporation, Chubb Institute, National Starch and Chemical Corporation, Raritan Valley Community College and Telcordia Technologies, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see Extension Programs in this catalog. In addition, there are 12-credit graduate certificates in Business Management Fundamentals, Management of Technology and Pharmaceutical Management. See Graduate Certificates for more information on these programs. 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; email cpe@njit.edu.

Degree Requirements:

Students must complete a minimum of 48 degree credits, accumulated in four different areas—Fundamental Management Knowledge (27 credits), Managing Data-Centric Organizations (6 credits), Managing Technology and Technological Change (6 credits) and an area of concentration that requires 9 credits. Students who lack the appropriate Management background may be required to take up to 12 credits of basic bridge courses in marketing, MIS, finance or economics.

BRIDGE: MANAGEMENT BACKGROUND COURSES:

ECON 565	Managerial Economics
FIN 516	Principles of Financial Management
MIS 545	Management of Information Systems
MRKT 530	Principles of Marketing

MODULE 1: FUNDAMENTAL MANAGEMENT KNOWLEDGE (27 credits):

ACCT 615	Management Accounting
FIN 600	Financial and Economic Environment
FIN 624	Financial Management
HRM 601	Organizational Behavior
MRKT 620	Competing in Global Markets
MIS 680	Management Science
MGMT 645	Managing I.T. for Competitive Advantage
MGMT 660	Managing Supply and Value Chains
MGMT 680	Entrepreneurial Strategy ***or***
MGMT 692	Strategic Management

MODULE 2: MANAGING DATA-CENTRIC ORGANIZATIONS (Choose two courses for 6 credits):

MIS 648	Decision Support Systems for Managers
MGMT 635	Data Mining and Analysis for Managers
MGMT 650	Knowledge Management

MGMT 710	Forecasting Methods for Business Decisions

MODULE 3: MANAGING TECHNOLOGY AND TECHNOLOGICAL CHANGE (Choose two courses for 6 credits):

HRM 630	Managing Technological and Organizational Change
MGMT 620	Management of Technology
MGMT 676	Managing the Digital Firm
MGMT 710	Electronic Communities in Organizations

MODULE 4: CONCENTRATIONS (Choose one area):

Electronic Commerce (choose 3 courses):

MIS 620	E-Commerce Technologies
MIS 625	Management Strategies for E-Commerce
MIS 635	Telecommunications Management
MGMT 676	Managing the Digital Firm
MGMT 690	Electronic Communities in Organizations
MRKT 645	Internet Marketing Strategies

Financial Management (choose 3 courses):

Fin 626	Financial and Investment Institutions
Fin 627	International Finance
Fin 631	Working Capital Management and Credit Analysis
Fin 632	Financial Valuation of Technology-Based Companies
Fin 634	Mergers, Acquisitions, and Restructuring
MGMT 630	Decision Analysis

Management Information Systems (choose 3 courses):

MIS 625	Management Strategies for E-commerce
MIS 635	Telecommunications Management
MIS 690	Executive Information Systems
CIS 631	Data Management and Systems Design
CIS 632	Advanced Database Systems Design
CIS 675	Information Systems Evaluation
EM 636	Project Management
MGMT 630	Decision Analysis

Infrastructure Management (choose 3 courses):

ARCH 650	Economy of Building
ARCH 651	Real Estate Analysis
ARCH 652	Architectural Project Management
EM 636	Project Management
HRM 605	Managing High Performance Work Teams

Operations Management (choose 3 courses):

IE 674	Quality Maintenance and Support Systems
MGMT 630	Decision Analysis
MNE 601	Manufacturing Systems
MNE 602	Flexible and Computer Integrated Manufacturing
MNE 603	Management of Manufacturing Systems

Transportation and Logistics (choose 3 courses):

MGMT 630	Decision Analysis
MGMT 710	Business Forecasting Methods
TRAN 603	Introduction to Urban Transportation Planning
TRAN 740	Management of Transportation Carriers
TRAN 765	Multi-level Freight Transportation Systems Analysis

The Master of Science in Management

The Master of Science in Management is a diverse graduate program that offers students an unusual opportunity to specialize in a variety of Management and Information Systems areas, or in the specialist programs in Electronic Commerce and Organization

Management. Courses are offered at NJIT's Newark campus, as well as at extension campuses. The School also offers an extensive evening and weekend schedule.

Usually consisting of 15 credits, each specialization offers students broad flexibility in completing their academic requirements. In addition, they may meet course requirements by completing 15 credit hours of core courses. The core courses (totaling 15 credits) are chosen from a wide variety of subjects including organizational behavior, financial management and accounting and business strategy. If there is sufficient demand, at least one course in each area of specialization will be available during the summer. In addition, up to 12 credits may be required as background courses to provide students with an understanding of fundamental management issues, including courses on economics, financial management, management information systems, and marketing.

Admission Requirements:

Prerequisite to the degree program is a common body of knowledge of management disciplines: managerial accounting, managerial economics, finance, management information systems, operations research and marketing. Students with satisfactory grades in undergraduate course in these areas are not required to take them again. Students are required to complete the GMAT prior to being accepted into the program; however, students with a master's degree or higher from an accredited U.S. institution are not required to take the GMAT. A student may transfer up to nine credits from a graduate program from another school, providing they were not used to obtain another degree.

Degree Requirements:

Students must complete a minimum of 30 degree credits: 15 credits of core Management courses and 15 credits in the area of specialization. Students who lack the appropriate Management background may be required to take up to 12 credits of basic bridge courses in marketing, MIS, finance or economics.

MANAGEMENT BACKGROUND COURSES (Bridge courses):

Econ 565	Managerial Economics
Fin 516	Principles of Financial Management
MIS 545	Management Information Systems
Mrkt 530	Principles of Marketing

MANAGEMENT CORE:

Acct 615	Management Accounting
Fin 624	Financial Management
HRM 601	Organizational Behavior
Mrkt 620	Competing in Global Markets
MGMT 680	Entrepreneurial Strategy ***or***
MGMT 692	Strategic Management

SPECIALIZATIONS:

Management Information Systems:

Required

MIS 645	Managing Information Technology for Competitive Advantage
MIS 648	Decision Support Systems for Managers

Electives (9 credits)

CIS 631	Data Management and Systems Design
CIS 632	Advanced Database Systems Design
CIS 671	Management of Computer and Information Systems
CIS 675	Information Systems Evaluation
CIS 679	Network Management and Security
EM 636	Project Management
MGMT 650	Knowledge Management

Electronic Commerce:

Required

MIS 620	E-Commerce Technologies
MIS 625	Management Strategies for E-Commerce

Electives (9 credits)

CIS 652	Computer Networks-Architectures, Protocols and Standards
CIS 656	Internetworking and Higher Layer Protocols
CIS 679	Network Management and Security
CIS 688	Programming for Interactive Environments
MGMT 635	Data Mining and Analysis for Managers
MGMT 690	Electronic Communities in Organizations
MRKT 645	Internet Marketing Strategies

Organization Management:

Required

HRM 605	Managing High Performance Work Teams
HRM 606	Human Resource Management

Electives (9 credits)

HRM 610	Seminar on Leadership Skills
HRM 630	Managing Technological and Organizational Change
HRM 640	Seminar in Cultures in Organizations
HRM 685	Cross Cultural Management Issues
MGMT 650	Knowledge Management
MGMT 690	Electronic Communities in Organizations

Chemical Engineering

Administered By: Otto H. York Department of Chemical Engineering

Administration

Chairperson	Basil Baltzis
Associate Chairperson for Undergraduate Studies	Dana Knox
Associate Chairperson for Graduate Studies and Industrial Relations	Reginald Tomkins
Director of Pharmaceutical Engineering Program	Piero Armenante

Faculty

Distinguished Professors	Armenante, Lewandowski, Pfeffer, Sirkar
Foundation Professor	Sirkar (Membrane Separations)
Professors	Baltzis, Greenstein, Hanesian, Kimmel, Perna, Tomkins, Xanthos
Associate Professors	Barat, Knox, Loney
Assistant Professors	Bart, Hahn, Huang, Simon, Wu
Honorary Professor	York
Distinguished Research Professor	Gogos
Research Professors	Hyun, Todd
Joint Appointments	Bozzelli (Chemistry), Grow (Chemistry), Dave (Mechanical Engineering)
Special Lecturer	Kisutcza
Undergraduate Advisor	Dana Knox Phone: (973) 596-3599 Email: knoxd@adm.njit.edu
Graduate Advisor	Reginald Tomkins Phone: (973) 596-5656 Email: tomkinsr@adm.njit.edu

Degrees Offered: Master of Science in Chemical Engineering; Doctor of Philosophy in Chemical 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, ChE 501 and ChE 502, 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. Applicants seeking financial support must submit GRE scores. Non-support seeking applicants must also submit GRE scores unless they hold a B.S. degree in chemical engineering from an ABET-accredited program in the U.S.A. International students must achieve a minimum TOEFL score of 213 (computer based) or 550 (non-computer based).

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. Students following option 1 (below) must also successfully complete a master's thesis.

CORE COURSES:

12 credits:

ChE 611	Thermodynamics
ChE 612	Kinetics of Reactions and Reactor Design
ChE 624	Transport Phenomena I
ChE 626	Mathematical Methods in Chemical Engineering

OPTION 1:

Required of those receiving partial or full departmental or research-based support. Students who do not receive financial support, may follow Option 1 without the Seminar and ChE 599 requirements listed below.

THESIS:

ChE 701	Master's Thesis (6 credits)

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. 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.

SEMINAR:

In addition to the minimum 30 degree credits required, all students who receive departmental or research-based support must enroll each semester in ChE 791 Graduate Seminar.

ChE 599, Methods for Teaching Assistants and Graduate Assistants :

In addition to the minimum 30 degree credits, students receiving departmental support must enroll in ChE 599 at least once a year.

ELECTIVE COURSES (12 credits):

A minimum of 3 credits of 600- or 700-level courses in chemical engineering. Of the remaining 9 credits, at least 3 credits must be in chemical engineering, pharmaceutical engineering, or chemistry. No more than 3 credits may be at the 500-level. 500-level courses offered in the department do not count towards degree requirements.

OPTION 2:

Available to students who do not receive any departmental or research-based support.

ELECTIVE COURSES (18 credits) :

A minimum of 9 credits of 600- and 700-level courses in chemical engineering. Of the remaining 9 credits, at least 3 credits must be in chemical engineering, pharmaceutical engineering, or chemistry. No more than 3 credits may be at the 500-level. 500-level courses offered in the department do not count towards degree requirements.

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.

Degree Requirements: To graduate, students must have an approved dissertation and attain an overall GPA of at least 3.0. In addition, students admitted to the program without a master's degree in chemical engineering must also attain a minimum GPA of 3.0 in the following four required courses: ChE 611, ChE 612, ChE 624 and ChE 626.

Course Work (24 credits): At least 24 credits of course work beyond the master's degree are required, of which at least 12 credits must be at the 700-level. For the required 700-level courses, at least 6 credits must be in chemical engineering or chemistry. No more than 6 credits may be in Independent Study (ChE 705 or Chem 705). No more than 3 credits in Independent Study may be taken with the same supervising faculty member. The supervising faculty member may never be the student's dissertation advisor. Students need always to get departmental approval for the courses they take for their degree requirements.

ChE 790, Doctoral Dissertation (36 credits): A minimum of 36 credits of ChE 790 , Doctoral Dissertation are required. Students cannot register for ChE 790 before they have officially selected a dissertation advisor and passed the doctoral qualifying examination. Should the required 36 credits of ChE 790 be completed before submission of the final dissertation document, students must register for a minimum of 3 credits of ChE 790 each semester until the dissertation has been submitted and accepted.

Seminar and ChE 599: In addition to the minimum 60-degree credits specified above, students must register every semester for ChE 791 , Graduate Seminar. Part-time students may request that this requirement be waived for some semesters. In addition, students who receive support through teaching and/or graduate assistantships must register for ChE 599 , Methods for Teaching Assistants and Graduate Assistants, at least every other semester they receive such assistantships.

Additional Requirements for Students Admitted without a Master's Degree in Chemical Engineering (18 credits):

In addition to the requirements specified above, students admitted to the program without a master's degree in chemical engineering must complete an additional 18 credits of course work as follows:

ChE 611	Thermodynamics
ChE 612	Kinetics of Reactions and Reactor Design
ChE 624	Transport Phenomena I
ChE 626	Mathematical Methods in Chemical Engineering

6 credits from 600- or 700-level courses in Electives chemical engineering, pharmaceutical engineering, or chemistry.

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 students are expected to pass a qualifying examination that tests general competence in chemical engineering at the master's level. Students with a master's degree in chemical engineering must take the exam during the first year of their studies. Students admitted to the program without a master's degree in chemical engineering must take the exam within the first three semesters of their studies. All students must pass the exam within the first two years of their studies. Students are allowed only two attempts to pass the examination.

The doctoral qualifying examination is offered in January and June of every year. It is an 8-hour written examination. Students are expected to solve/answer 6 problems as follows: 1 problem in Applied Mathematics for Chemical Engineers, 1 problem in Reaction Kinetics and Reactor Design, 1 problem in Chemical Engineering Thermodynamics, 1 problem in Transport Phenomena, and 2 problems from 2 different elective areas out of six elective areas offered on the exam. The 6 elective areas may vary, but they are announced to the students at least three months before an examination is held. There are two problems in each of the required and elective areas and students have to select one problem from each area. All problems are weighed equally and are graded on the 0 to 10 scale. A grade of at least 42 out 60 points (i.e., at least 70%) implies an automatic pass. A grade of no more than 30 out of 60 points (i.e., no more than 50%) implies that the student has failed the exam. Students receiving grades higher than 50% but less than 70% (i.e., more than 30 but less than 42 points out of 60) may pass, fail, or conditionally pass the exam based on the decision of the departmental committee on Graduate Studies.

Students are notified about an upcoming exam (date, elective areas) at least three months in advance and asked to respond in writing if they intend to take the exam.

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 Engineering

Administered by: Department of Civil and Environmental Engineering. Colton Hall, Room 200.

Administration

Chairperson	John Schuring
Associate Chairpersons	Hsin-Neng Hsieh, Walter Konon

Faculty

Distinguished Professor	Spillers
Professors	Bagheri, Chan, Deutschman, Dresnack, Golub, Greenfeld, Hsieh, Hsu, Khera, Konon, Meegoda, Raghu, Schuring, Wecharatana
Associate Professors	Olenik, Axe, Chien, Ding, Marhaba
Assistant Professors	Daniel, Liu
Undergraduate Advisor	Walter Konon Phone: (973) 596-2476 (Room 223 COL) Email: konon@njit.edu
Graduate Advisor	Hsin-Neng Hsieh Phone: (973) 596-5859 (Room 219 COL) Email: hsieh@njit.edu

Degrees Offered: Master of Science in Civil Engineering; Doctor of Philosophy in 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.

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.

Bridge Program: 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.

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 in this catalog.

Degree Requirements:

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.

Seminar: In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in CE 791 Graduate Seminar.

AREAS OF SPECIALIZATION:

Construction Engineering and Management:

Bridge Program:

CE 200	Surveying
CE 200A	Surveying Laboratory
CE 210	Construction Materials and Procedures
CE 341	Soil Mechanics
CE 341A	Soil Mechanics Laboratory
CIS 101	Computer Programming and Problem Solving (or equivalent)
Math 225	Survey of Probability and Statistics
Math 112	Calculus II
Mech 237	Strength of Materials

One design course, approved by program advisor

REQUIRED:

12 credits:

CE 610	Construction Management
CE 611	Project Planning and Control
CE 616	Construction Cost Estimating
EM 632	Legal Aspects in Construction

THESIS:

Required of those receiving departmental awards; elective for all others

CE 701	Master’s Thesis (6 credits)

ELECTIVE:

Select 9 credits if completing a master’s thesis; 15 credits if not completing a master’s thesis, from:

Arch 647	Special Topics in Computer Applications
Arch 675	Elements of Infrastructure Planning
CE 545	Rock Mechanics I
CE 553	Design and Construction of Asphalt Pavements
CE 614	Underground Construction
CE 615	Infrastructure and Facilities Remediation
CE 631	Advanced Reinforced Concrete Design
CE 637	Short Span Bridge Design
CE 642	Foundation Engineering
CE 659	Flexible and Rigid Pavements
CE 700	Civil Engineering Project
CE 702	Special Topics in Civil Engineering
CE 710	Systems in Building Construction
CE 711	Methods Improvement in Construction
EM 660	Financing an Industrial Enterprise
EM 693	Managerial Economics
EnE 662	Site Remediation
EnE 671	Environmental Impact Analysis
HRM 693	Employment Relationships and the Law
IE 603	Behavioral Science in Engineering Organizations

3 credits from:

Arch 647	Special Topics in Computer Applications
CE 602	Geographic Information System
EM 602	Management Science
EM 655	Management Aspects of Information Systems
Math 611	Numerical Methods for Computation
MIS 545	Management Information Systems

Other suitable electives may be taken subject to approval of program advisor.

Environmental Engineering:

Bridge Program:

CE 320	Fluid Mechanics
CE 321	Water Resources Engineering
CE 322	Hydraulic Engineering
CE 501	Introduction to Soil Behavior
Chem 126	General Chemistry II
CIS 101	Computer Programming and Problem Solving (or equivalent)
Math 222	Differential Equations
Mech 234	Engineering Mechanics
Mech 236	Dynamics

REQUIRED:

6 credits:

EnE 663	Water Chemistry
EnE 661	Microbiology for Environmental Engineers

THESIS:

Required of those receiving departmental awards; elective for all others

CE 701	Master's Thesis (6 credits) ***or***
EnE 701	Master's Thesis

ELECTIVE:

Select 15 credits if completing a master's thesis; 21 credits if not completing a master's thesis, from:

CE 602	Geographic Information System
CE 604	Environmental Modeling in Remote Sensing
CE 618	Applied Hydrogeology
CE 620	Open Channel Flow
CE 621	Hydrology
CE 623	Groundwater Hydrology
CE 626	Sediment Transport
CE 647	Geotechnical Aspects of Solid Waste
CE 648	Flow Through Soils
CE 700	Civil Engineering Project ***or***
EnE 700	Environmental Engineering Project
CE 702	Special Topics in Civil Engineering ***or***
EnE 702	Special Topics in Environmental Engineering
EnE 610	Hazardous Site Operations
EnE 620	Environmental Chemodynamics
EnE 660	Introduction to Solid and Hazardous Waste Problems
EnE 662	Site Remediation
EnE 664	Physical and Chemical Treatment
EnE 665	Biological Treatment
EnE 666	Analysis of Receiving Waters
EnE 667	Solid Waste Disposal Systems
EnE 668	Air Pollution Control

EnE 669	Water and Wastewater Analysis
EnE 670	Advanced Processes in Water Pollution Control
EnE 671	Environmental Impact Analysis

Up to 6 credits may be selected from departments other than civil and environmental engineering subject to approval of program advisor.

3 credits from:

Math 611	Numerical Methods for Computation
Math 661	Applied Statistics
Math 687	Quantitative Analysis for Environmental Design Research

Other suitable electives may be taken subject to approval of program advisor.

Geoenvironmental Engineering:

Bridge Program:

CE 320	Fluid Mechanics
CE 321	Water Resources Engineering
CE 501	Introduction to Soil Behavior
Chem 126	General Chemistry II
CIS 101	Computer Programming and Problem Solving (or equivalent)
Math 222	Differential Equations

REQUIRED:

12 credits:

CE 618	Applied Hydrogeology
CE 647	Geotechnical Aspects of Solid Waste
EnE 663	Water Chemistry
EnE 662	Site Remediation

THESIS:

Required of those receiving departmental awards; elective for all others

CE 701	Master’s Thesis (6 credits)

ELECTIVE:

Select 9 credits if completing a master’s thesis; 15 credits if not completing a master’s thesis, from:

CE 545	Rock Mechanics I
CE 602	Geographic Information System
CE 621	Hydrology
CE 623	Groundwater Hydrology
CE 641	Engineering Properties of Soils
CE 642	Foundation Engineering
CE 643	Advanced Foundation Engineering
CE 644	Geology in Engineering
CE 646	Geosynthetics and Soil Improvement
CE 700	Civil Engineering Project
CE 702	Special Topics in Civil Engineering
CE 743	Contaminant Transport in Soils
EM 631	Legal Aspects in Environmental Engineering
EM 633	Legal Aspects of Health and Safety
EnE 660	Introduction to Solid and Hazardous Waste Problems
EnE 661	Microbiology for Environmental Engineers
EnE 664	Physical and Chemical Treatment
EnE 665	Biological Treatment
EnE 667	Solid Waste Disposal Systems
EnE 669	Water and Wastewater Analysis
EnE 671	Environmental Impact Analysis

Other suitable electives may be taken subject to approval of program advisor.

3 credits from:

Math 611	Numerical Methods for Computation
Math 651	Applied Mathematics I
Math 661	Applied Statistics
Math 687	Quantitative Analysis for Environmental Design Research

Geotechnical Engineering:

Bridge Program:

CE 320	Fluid Mechanics
CE 332	Structural Analysis
CE 341	Soil Mechanics
CE 341A	Soil Mechanics Laboratory
CE 443	Foundation Design
CIS 101	Computer Programming and Problem Solving (or equivalent)
Math 222	Differential Equations

REQUIRED:

6 credits from:

CE 641	Engineering Properties of Soils
CE 642	Foundation Engineering

THESIS:

Required of those receiving departmental awards; elective for all others

CE 701	Master’s Thesis (6 credits)

ELECTIVE:

Select 12 credits if completing a master’s thesis; 18 credits if not completing a master’s thesis, from:

CE 545	Rock Mechanics I
CE 643	Advanced Foundation Engineering
CE 644	Geology in Engineering
CE 645	Rock Mechanics II
CE 646	Geosynthetics and Soil Improvement
CE 647	Geotechnical Aspects of Solid Waste
CE 648	Flow Through Soils
CE 700	Civil Engineering Project
CE 702	Special Topics in Civil Engineering
CE 741	Theoretical Soil Mechanics
CE 742	Geotechnology of Earthquake Engineering
CE 743	Contaminant Transport in Soils

3 credits from:

CE 553	Design and Construction of Asphalt Pavements
CE 610	Construction Management
CE 611	Project Planning and Control
CE 614	Underground Construction
CE 631	Advanced Reinforced Concrete Design
CE 659	Flexible and Rigid Pavements
Mech 630	Theory of Elasticity

3 credits from:

Math 611	Numerical Methods for Computation
Math 651	Applied Mathematics I
Math 661	Applied Statistics

Structural Engineering:

Bridge Program:

CE 332	Structural Analysis
CE 333	Reinforced Concrete Design
CE 341	Soil Mechanics

CE 341A	Soil Mechanics Laboratory
CE 432	Steel Design
CIS 101	Computer Programming and Problem Solving (or equivalent)
Math 222	Differential Equations

REQUIRED:
3 credits:

CE 639	Applied Finite Element Method

THESIS:
Required of those receiving departmental awards; elective for all others

CE 701	Master's Thesis (6 credits)

ELECTIVE:
Select 18 credits if completing a master's thesis; 24 credits if not completing a master's thesis, from:

CE 531	Design of Masonry and Timber Structures
CE 545	Rock Mechanics I
CE 631	Advanced Reinforced Concrete Design
CE 632	Prestressed Concrete Design
CE 634	Structural Dynamics
CE 635	Fracture Mechanics of Engineering Materials
CE 636	Stability of Structures
CE 637	Short Span Bridge Design
CE 638	Nondestructive Testing Methods in Civil Engineering
CE 641	Engineering Properties of Soils
CE 642	Foundation Engineering
CE 661	Analysis and Design of Shell Structures
CE 700	Civil Engineering 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 738	Advanced Matrix Analysis of Structures
CE 739	Structural Optimization
Mech 540	Advanced Strength of Materials
Mech 630	Theory of Elasticity

Other suitable electives may be taken subject to approval of program advisor.

3 credits from:

Math 611	Numerical Methods for Computation
Math 630	Linear Algebra and Applications
Math 651	Applied Mathematics I
Mgmt 580	Managerial Science

Urban and Transportation Engineering:
REQUIRED:
12 credits from:

CE 650	Urban Systems Engineering
CE 655	Land Use Planning
CE 660	Traffic Studies and Capacity
Math 661	Applied Statistics

THESIS:
Required of those receiving departmental awards; elective for all others

CE 701	Master's Thesis (6 credits)

ELECTIVE:
Select 9 credits if completing a master's thesis; 15 credits if not completing a master's thesis, from:

CE 552	Geometric Design of Transportation Facilities
CE 553	Design and Construction of Asphalt Pavements
CE 603	Introduction to Urban Transportation Planning
CE 625	Public Transportation Operations and Technology
CE 653	Traffic Safety
CE 659	Flexible and Rigid Pavements
CE 700	Civil Engineering Project
CE 705	Mass Transportation Systems
CE 751	Transportation Design
CE 752	Traffic Control
CE 753	Airport Design and Planning
CE 754	Port Design and Planning
CE 765	Multi-modal Freight Transportation Systems Analysis
Tran 604	Public and Private Financing of Urban Areas
Tran 610	Transportation Economics
Tran 643	Transportation Finance

3 credits from:

CE 602	Geographic Information System
EnE 671	Environmental Impact Analysis
EPS 521	Urban Social Structure

Other suitable electives may be taken subject to approval of program advisor.

DOCTOR OF PHILOSOPHY 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. All international students must also achieve a minimum TOEFL score of 550.

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.

36 credits minimum of CE 790 Doctoral Dissertation is generally required. These 36 credits should be completed before submission of the final dissertation document. Students must register for a minimum of 3 credits of CE 790 until the dissertation has been submitted and accepted.

24 credits minimum of course work beyond the master's degree are required, of which at least 12 credits must be at the 700 level; the remaining credits may be at the 600 level.

Seminar: CE 791 Graduate Seminar is 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.

Computational Biology

Administered by: College of Computing Sciences

Administration

Program Director	Michael Recce
Program Coordinator	Karen Gansner Phone: (973) 596-3483 (GITC 3800) Email: Gansner@njit.edu

Faculty

Distinguished Professors	Venanzi
Professors	Gund, Wang
Associate Professors	Recce
Assistant Professors	Cohen, Malhotra

Degrees Offered: Master of Science in Computational Biology

New Jersey Institute of Technology has introduced a Master's Degree in Computational Biology to address the growing need for professionals with an educational background that blends biology with computer science and mathematics. This combination of skills is needed both in the pharmaceutical and biotechnology industries, as well as in biomedical research. Faculty at NJIT specialize in technological, computational, and mathematical aspects of biology, including the application and development of DNA microarray techniques, modeling of molecules, genetic data mining and warehousing, fluid flow in biological systems, biophysical models of neurons and networks of neurons, and rehabilitation technology, among other areas. Cross training in biology, computer science, and mathematics is necessary for all of these subjects.

Master of Science in Computational Biology

This master's program is designed to provide computational biology skills for those with a background in either biology or computer science/physical science.

Admission Requirements:

- Introductory course in Biology
- Computer Programming (at least one semester, equivalent to CIS 113)
- Cell and Molecular Biology (one course)
- Calculus (two semesters or the equivalent)
- Statistics (one course)
- Linear Algebra (recommended)

Students without the necessary prerequisites may be admitted provided they complete the necessary coursework in addition to the graduate requirements of the program. Additional bridge courses, depending on the student's background, may also be a condition of acceptance.

Graduate Certificate Program: A 12-credit graduate certificate in Bioinformatics 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.

Degree Requirements:

A minimum of 30 credits is required for the degree, excluding bridge courses. The graduate curriculum consists of core courses, a thesis or a research project course, and electives.

The core courses are:

Biol 601	Foundations of Computational Biology
Biol 602	Current Trends in Computational Biology

* Biol 603	Molecular Biology for Physical and Computational Scientists ***or***
** CIS 505	Programming, Data Structures, and Algorithms ***and***
CIS 610	Data Structures and Algorithms
CIS 631	Data Management System Design
Biol 700/701	Master's Project/Thesis

The course of study involves a master's thesis or projects for a total of six credits. Prerequisite: Matriculation for the master's degree and departmental approval.

Electives from the following. Other courses may be substituted with the permission of the program advisor.

Biol 794	Computational Biology Colloquium (1 credit)
Chem 601	Introduction to Medicinal Chemistry
Chem 602	Molecular Modeling and Drug Discovery
Chem 658	Advanced Physical Chemistry
Chem 673	Biochemistry
Chem 702	Special Topics: Computational Chemistry
R120:443	Immunology
R120:452	Molecular Biotechniques
R120:548	Biology of Cancer
R120:512	Mammalian Physiology
R120:515	Molecular Biology of Eukaryotes
R120:516	Microbial Ecology
R120:524	Cell and Molecular Developmental Biology
R120:526	Cell Biology
R120:573	Pharmacology
R120:640	Topics in Immunology
Math 611	Numerical Methods
Math 630	Linear Algebra and Applications
Math 635	Analytical and Computational Neuroscience
Math 636	Computational Systems Neuroscience
Math 637	Foundations of Mathematical Biology
Math 644	Regression Analysis
Math 661	Applied Statistics
Math 662	Probability Distribution
CIS 601	Object-Oriented Programming-C++
CIS 602	Java Programming
CIS 632	Advanced Database System Design
CIS 731	Applications of Database Systems
CIS 734	Data Mining
CIS 782	Pattern Recognition
CIS 786	Algorithms in Computational Biology
BME 669	Engineering Physiology

* For students with computer science, mathematical, or physical science backgrounds (pending).

** For students without a computer science background.

Computer Engineering

Administered By: Department of Electrical and Computer Engineering

Administration

Chairperson	Atam P.Dhawan
Associate Chairpersons	Sotirios Ziavras(graduate), Edwin Hou(undergraduate)

Faculty

Distinguished Professors	Savir
Professors	Misra, Rosenstark, Zhou, Ziavras, Shi*
Associate Professors	Carpinelli, Hou, Manikopoulos, Tekinay
Assistant Professors	Papavassiliou, Rojas-Cessa, Zakrevski, Zhu
Graduate Advisor	Sotirios Ziavras Phone: (973) 596-5651 Email: ziavras@njit.edu

* Joint appointee with the Department of Computer and Information Science

Degrees Offered: Master of Science in Computer Engineering; Doctor of Philosophy in 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.

Admission Requirements:

Students are expected to have an undergraduate education in engineering or computer science. Students 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 director of computer engineering for bridge requirements. Bridge courses do not count toward degree requirements.

Bridge Program: Students with undergraduate degrees in computer science take courses from:

CoE 252	Computer Architecture
CoE 353	Advanced Computer Architecture
CoE 395	Microprocessor Lab
EE 231	Circuits and Systems I
ECE 684	Advanced Microprocessor Systems

Students with undergraduate degrees in electrical engineering take courses from:

CIS 105	Computer Programming

CIS 335	Data Structures and Algorithm Design
CoE 353	Advanced Computer Architecture
CoE 395	Microprocessor Lab
ECE 684	Advanced Microprocessor Systems

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.

Degree Requirements:

Students must complete 30 credits. 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.

Seminar: All M.S. students are required to register for two semesters of ECE 791 (Graduate Seminar). All Ph.D. students are required to register for six semesters of ECE 791.

CORE:

Required for all specializations

6 credits:

CIS 610	Data Structures and Algorithms
ECE 690	Computer Systems Architecture

PROJECT OR THESIS (required):

ECE 700	Master's Project (3 credits) ***or***
ECE 701	Master's Thesis (6 credits)

AREAS OF SPECIALIZATION:

ELECTIVEs:

15 credits if completing master's thesis or 18 credits if completing master's project:

A list of suggested complementary elective courses is available for each area of concentration/specialization. Consult the graduate advisor of computer engineering for a current list of these courses. Other courses may be used as electives with the permission of the graduate advisor.

Computer Architecture and Systems:
REQUIRED:

6 credits:

ECE 658	VLSI Design I
ECE 692	Embedded Computing Systems

Microprocessor-Based Systems:
REQUIRED:

6 credits:

ECE 686	Instrumentation Systems and Microprocessors
ECE 688	Microcontrollers in Instrumentation

Intelligent Systems:
REQUIRED:

6 credits:

ECE 605	Discrete Event Dynamic Systems
ECE 609	Artificial Neural Networks

VLSI System Design:

REQUIRED:

6 credits:

ECE 658	VLSI Design I
ECE 758	VLSI Design II

Computer Networking:
REQUIRED:

6 credits:

ECE 683	Computer Network Design and Analysis
CIS 656	Internetworking and Higher Layer Protocols

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.

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 studies committee.

Degree Requirements:

A minimum of 60 degree credits beyond the master's degree or 90 credits beyond the bachelor's degree is required; 24 credits of course work beyond the master's degree, with at least 12 at the 700 level; and 36 credits of doctoral dissertation. Doctoral students must register each semester for 1/2 credit of ECE 791 Graduate Seminar. Students must attain a minimum overall GPA of 3.0. Students admitted into the program at the baccalaureate level must complete a total of 87 credits, consisting of 51 course credits and 36 dissertation credits. At least 12 course credits must be at the 700 level. Courses will be selected in consultation with the graduate advisor. 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. Students who complete 36 credits of ECE 790 before research is finished must register for a minimum of 3 credits of ECE 790 each semester thereafter until the dissertation is accepted.

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 may be applied toward ECE 790. For further information, see Academic Policies and Procedures in this catalog and the department Handbook for Graduate Students.

Computer Science

Administered By: Department of Computer Science, Guttenberg Information Technologies Center, Room 4400.

Administration

Dean, College of Computer Sciences	Dr. Stephen Seidman
Associate Dean, College of Computing Sciences	Dr. Fadi Deek
Assistant to the Dean, College of Computing Sciences	Serena Branson
Chairperson, Computer Science Department	Dr. Narain Gehani
Acting Chairperson, Computer Science Department	Dr. James McHugh
Associate Chairperson, Computer Science Department	Dr. Frank Shih
Graduate Advisor , Computer Science Department	Michael Tress

Faculty

Distinguished Professor	Joseph Leung
Professors	Alexander Thomasian, Ali Mili, Boris Verkhovsky, Frank Shih, James McHugh, James Geller, Jason Wang, Teunis Ott, Yehoshua Perl, Wojciech Rytter
Associate Professors	Andrew Sohn, Artur Czumaj, Daochuan Hung, David Nassimi, Dimitrios Theodoratos, Edward Sarian, Elsa Gunter, James Calvin, John Ryon, Marvin Nakayama, Michael Baltrush
Assistant Professors	Alexandros Gerbessiotis, Barry Cohen, Chengjun Liu, Vincent Oria

Degrees Offered: Master of Science in Computer Science; Doctor of Philosophy in 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 and information 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

Recognizing that a variety of academic backgrounds may be suited to this discipline, this program is for students who want advanced studies in computer science.

Admission Requirements:

Applicants are expected to have backgrounds in computer science and mathematics equivalent to the bridge program courses listed below. Students who lack this background may be admitted and required to take these courses and attain a cumulative GPA of 3.0. At the discretion of the department, students who have completed courses equivalent to the bridge program will be granted a corresponding reduction in the bridge requirements. See the undergraduate catalog for descriptions of 100- to 300-level courses. These courses are not counted toward degree requirements although CIS 505 and CIS 510 as graduate courses, are included in the calculation of the cumulative graduate GPA. Also see the Admissions section in this catalog.

Bridge Program:

CIS 251	Computer Organization
CIS 332	Principles of Operating Systems
CIS 333	Introduction to UNIX Operating System
CIS 505	Programming, Data Structures, and Algorithms
CIS 510	Assembly Language Programming and Principles
Math 111	Calculus I
Math 112	Calculus II
Math 211	Calculus III
Math 226	Discrete Analysis
Math 333	Probability and Statistics

Off-Campus Programs: At the NJIT at Mount Laurel branch campus and 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 **Information Systems Auditing, Information Systems Design, Information Systems Implementation, Internet Applications Development, or Virtual Tools for Professional Communities** 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.

Degree Requirements:

Students are assigned an advisor to assist them in formulating a program of study and in selecting an area of specialization. A minimum of 30 credits must be taken, including a set of core courses, a thesis or project, and required and elective courses.

With the approval of the graduate advisor, students may take 700-level courses in computer science, or courses outside the department as electives.

Seminar: Those students who receive departmental or research-based support must enroll every semester in CIS 791 Graduate Seminar.

CORE:

9 credits:

CIS 610	Data Structures and Algorithms
CIS 635	Computer Programming Languages
CIS 650	Computer Architecture

3 credits from:

CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 636	Compiling System Design
CIS 651	Data Communications
CIS 673	Software Design and Production Methodology

PROJECT OR THESIS:

CIS 700	Master's Project (3 credits) ***or***
CIS 701	Master's Thesis (6 credits)

Advanced Course CIS 700 Project Replacement Option:

M.S. in Computer Science students, instead of taking 3 credits of CIS 700 Master's Project, may choose to take 6 credits (i.e. 2 courses) from the following list of approved graduate-level courses in addition to the 27 credits of other 600-level courses. A list of these courses appears below:

CIS 611	Introduction to Computability and Complexity
CIS 659	Image Processing and Analysis
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 668	Parallel Algorithms
CIS 671	Knowledge-Based Systems
CIS 674	Natural Language Processing
CIS 731	Applications of Database Systems

CIS 732	Design of Interactive Systems
CIS 734	Data Mining
CIS 735	Computer Mediated Communication Systems
CIS 744	Data Mining for Management in Bioinformatics
CIS 750	High Performance Computing
CIS 759	Advanced Image Processing and Analysis
CIS 762	Computerized Information Systems for Planning and Forecasting
CIS 767	Computer-Based Decision Systems
CIS 780	Computer Vision
CIS 782	Pattern Recognition and Applications

AREAS OF SPECIALIZATION:

The student may take other electives or develop an area of specialization with the approval of the graduate advisor.

Artificial Intelligence:

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 670	Artificial Intelligence
CIS 671	Knowledge-Based Systems
CIS 672	Expert System Methods and Design
CIS 674	Natural Language Processing
CIS 780	Computer Vision

Other 600/700-level courses as approved by graduate advisor.

Computer Algorithms and Theory of Computing:

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 540	Fundamentals of Logic and Automata
CIS 605	Discrete Event Dynamic Systems
CIS 611	Introduction to Computability and Complexity
CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 640	Recursive Function Theory
CIS 641	Formal Languages and Automata
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 668	Parallel Algorithms
CIS 669	Computational Geometry

Other 600/700-level courses as approved by graduate advisor.

Computer Communications and Networking:

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 604	Client/Server Computing
CIS 630	Operating System Design
CIS 651	Data Communications
CIS 652	Computer Networks-Architectures, Protocols and Standards
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 735	Computer Mediated Communication Systems
CIS 741	Communication Network Design

Other 600/700-level courses as approved by graduate advisor.

CIS 608	Cryptography and Security

Computer Systems, and Parallel and Distributed Processing:
ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 630	Operating System Design
CIS 633	Distributed Systems
CIS 636	Compiling System Design
CIS 637	Real-Time Systems
CIS 651	Data Communications
CIS 653	Microcomputers and Applications
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 665	Algorithmic Graph Theory
CIS 668	Parallel Algorithms
CIS 750	High Performance Computing
ECE 658	VLSI Design I
ECE 758	VLSI Design II
ECE 689	Digital System Design for Machine Arithmetic
ECE 784	Digital Systems Architecture

Other 600/700-level courses as approved by graduate advisor.

Database and Knowledge-Based Engineering:
ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 632	Advanced Database System Design
CIS 651	Data Communications
CIS 658	Multimedia Systems
CIS 670	Artificial Intelligence
CIS 671	Knowledge-Based Systems
CIS 672	Expert System Methods and Design

Other 600/700-level courses as approved by graduate advisor.

CIS 734	Data Mining
CIS 744	Data Mining for Management in Bioinformatics

Image Processing and Computer Graphics:
ELECTIVE :
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 630	Operating System Design
CIS 632	Advanced Database System Design
CIS 657	Principles of Interactive Computer Graphics
CIS 659	Image Processing and Analysis
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 682	Geometric Modeling
CIS 759	Advanced Image Processing and Analysis
CIS 780	Computer Vision
ECE 601	Linear Systems
ECE 643	Digital Image Processing I
ME 635	Computer-Aided Design

Other 600/700-level courses as approved by graduate advisor.

CIS 782	Pattern Recognition and Applications

Information Systems Applications and Management:
ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 601	Object-Oriented Programming
CIS 602	Java Programming
CIS 603	Advanced Programming Environments and Tools
CIS 604	Client/Server Computing
CIS 631	Data Management System Design
CIS 658	Multimedia Systems
CIS 661	Systems Simulation
CIS 662	Model Analysis and Simulation
CIS 673	Software Design and Production Methodology
CIS 675	Information System Evaluation
CIS 676	Requirements Engineering
CIS 677	Information System Principles
CIS 679	Management of Computer and Information Systems
CIS 684	Business Process Innovation
CIS 688	Programming for Interactive Environments
CIS 731	Applications of Database Systems
CIS 732	Design of Interactive Systems
CIS 735	Computer Mediated Communication Systems
CIS 767	Decision Support Systems

Other 600/700-level courses as approved by graduate advisor.

CIS 623	Qualitative Research on Information systems
CIS 624	Learning Systems

Numerical Computation:
ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 621	Numerical Analysis I
CIS 622	Numerical Analysis II
CIS 657	Principles of Interactive Computer Graphics
CIS 667	Design Techniques for Algorithms
Math 614	Numerical Methods I
Math 630	Linear Algebra and Applications
Math 690	Advanced Applied Mathematics III: PDEs
Math 712	Numerical Methods II

Other 600/700-level courses as approved by graduate advisor.

Software Engineering:
ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 601	Object-Oriented Programming
CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 636	Compiling System Design
CIS 657	Principles of Interactive Computer Graphics
CIS 667	Design Techniques for Algorithms
CIS 670	Artificial Intelligence
CIS 673	Software Design and Production Methodology
CIS 676	Requirements Engineering

CIS 683	Object-Oriented Software Development
CIS 688	Programming for Interactive Environments

Other 600/700-level courses as approved by graduate advisor.

Systems Analysis, Simulation and Modeling:
ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project, from:

CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 661	Systems Simulation
CIS 662	Model Analysis and Simulation
CIS 673	Software Design and Production Methodology
CIS 675	Information System Evaluation
CIS 676	Requirements Engineering
CIS 684	Business Process Innovation
CIS 732	Design of Interactive Systems

Other 600/700-level courses as approved by graduate advisor.

CIS 663	Advanced System Analysis and Design

MASTER OF SCIENCE IN INFORMATION SYSTEMS

MSIS Program Web Site: http://is.njit.edu/msis/
Please check this site for any updates and additional information.

The field of Information Systems (IS) concerns the effective design and use of information technologies by individuals, groups and organizations. IS can be applied to many different areas, including support of business, science, engineering, community, social and education activities, both in the public and private sectors. Across all these areas, IS is broadly concerned with the effective use and integration of computing technologies into human endeavors; that is, with *human-centered* computing.

The study of Information Systems is based upon the concept that there is a growing body of knowledge on the relationships between people and computers that is independent of any specific application. Understanding of the total system involves both the human and the computing environment as an integrated whole. Students will master both the technology and the understanding of human behavior in the computing environment.

The MSIS program provides solid grounding in three principal areas, all of which are applicable to the areas described above:
- Systems analysis and software engineering
- Information and communication technologies
- Management of information systems

The program emphasizes the planning, investigation, design, development, application, management and evaluation of Information Systems. The program trains students to be integral members of application design and development teams.

The program also provides exposure to the state-of-the-art in IS research, so that students will be prepared to work with both emerging concepts and technologies. For students wishing to become directly involved in research, there are ample opportunities to participate in ongoing projects, as well as to write a master's thesis under faculty supervision. A number of master's-level courses are also included in the Ph.D. curriculum. The MSIS program is designed as a subset of the Ph.D. program in IS. The description here includes several notes for students considering continuing on with the Ph.D. program.

The program is offered both face-to-face and in a distance learning mode employing collaborative learning methods including team and project activities.

Admission Requirements:

The field of IS is broadly interdisciplinary. Applicants with degrees in any field are therefore welcome to apply for the MS IS 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.

Applicants with undergraduate degrees in Information Systems, Management Information Systems, Information Technology, Computer Science, Computer Engineering and similar areas usually are sufficiently prepared for entry. Requirements for entry include a working knowledge of the C++ programming language, at least one year of calculus, one course in calculus-based probability and statistics, and finally an additional advanced mathematics course such as discrete analysis.

Applicants must have a GPA of 3.0 or higher in their prior academic work. (Applicants not meeting this requirement, but who have significant work experience since their last degree may be considered on an individual basis.)

Applicants without a prior undergraduate or master's degree from the United States must submit GRE, GMAT or MCAT scores for admission.

Bridge Program:

Computer and Information Systems Technology:

* CIS 505	Programming, Data Structures, and Algorithms (teaches C language programming; required for remaining bridge courses)
CIS 332	Principles of Operating Systems
CIS 350	Computers and Society
CIS 431	Database System Design and Management
CIS 465	Advanced Information Systems

Mathematics:

Math 111	Calculus I
Math 112	Calculus II
Math 226	Discrete Analysis
Math 333	Probability and Statistics

Students must get a B in all CIS bridge courses, and no grade lower than a C in the others.

Students without an excellent command of English may be required to take specific written and spoken English courses.

Final determination of bridge requirements can only be made from the examination of a completed formal application folder. Applicants with prior coursework covering the bridge topics should attach a note to their application clearly showing which courses correspond to these bridge requirements, if possible.

Off-Campus Programs: At the NJIT at Mount Laurel branch campus and 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 **Information Assurance, Internet Applications Development or Telecommunications Networking** 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.

Important Note: Students assigned to bridge courses or English courses must take these courses before taking before taking 600- and 700-level graduate courses. It is possible, however, to sign up for graduate courses (i) in the final semester in which bridge courses are taken and (ii) when prerequisites delay taking of a particular bridge course.

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* Note that CIS 505 is a concentrated, advanced level programming course. It is equivalent to CIS 113 and CIS 114 , and students may choose to take these two courses instead.

Degree Requirements:

The student is required to take 36 credits (12 courses).

The course planning form, posted on the MSIS Web site, lays out much of the information in this program description. Students should use it to plan out their courses for the MS IS degree. They should bring this (or email it) to the Program Director whenever they wish to discuss their progress.

The required courses are:

IS Core Courses (6 courses/18 credits)

All six IS core courses are required:

CIS 677	Information Systems Principles
CIS 663	Systems Analysis and Design
CIS 675	Research Methods for Information Systems
** CIS 679	Management of Information Systems
CIS 634	Information Retrieval
CIS 658	Multimedia Systems

We recommend that students start taking the core courses immediately. Note that one must take CIS 677 before CIS 675 or CIS 679.

Electives (6 courses/18 credits):

The remaining six courses are electives. All CIS courses at the 600- and 700-level are valid electives.

MS IS students may take no more than 2 non-CIS courses total. Not all courses at NJIT are valid electives. Be sure the check the Non-CIS Electives list on the MSIS website to determine which courses are valid electives! (Students with a CS or IS academic background or with several years work experience in IS or CS will be informed as part of the application process that they may take up to four courses outside the CIS area.) Students must have written approval from the IS Advisor to take more than two courses outside CIS.

Non-seminar CIS 785 and CIS 786 (special topics), and IS- or CS- related independent study courses in any department count as CIS electives, but are not mandatory.

We encourage Masters students doing well in the program to take electives at the 700-level.

**** Students planning to continue with the IS Ph.D. program may take up to four non-CIS courses after gaining written approval from their MS IS Advisor. They also should check the Ph.D. program requirements and consider taking specific required courses as MS IS elective. They are advised to take as many 700-level courses as possible.*

Masters Project and Masters Thesis

We strongly encourage students to consider a one-semester Masters Project (CIS 700) or two-semester masters Thesis (CIS 701). The masters project provides the opportunity to apply knowledge and skills to develop an application system or solve a complex problem. The thesis option extends the project by conducting publishable research in the project area. Both courses count as IS electives, and are not mandatory for graduation.

**** Students planning to continue with the IS Ph.D. program may not take a CIS 700 implementation project for Ph.D. credit. Similarly, only 3 credits of CIS 701 will count towards the IS Ph.D. program. If you are doing a different kind of masters project or thesis, then please check with the Ph.D. program coordinator regarding Ph.D. credit.*

While we encourage people to partake in NJIT's Cooperative Program , it does not count as IS elective credit.

For further details, please see http://is.njit.edu/msis/

** Students who have taken CIS 455 as an undergraduate are not required to take CIS 679 and may substitute an elective CIS course.

AREAS OF SPECIALIZATION:

Select one of the following areas and choose two of the courses listed in that area. The student is responsible for checking with the program director to determine if the necessary course prerequisites have been met.

Interdisciplinary Information Systems:

The application of information systems in fields such as the physical or social sciences, engineering, the arts, humanities, and public administration.

6 credits from:

HRM 601	Organizational Behavior ***or***
HRM 655	Theory and Research in Organizational Behavior

{	Mgmt 691	Legal, Ethical and Privacy Issues in Computing ***or***
	Eng 603	Cultural and Technological Change
	IE 661	Human Design Factors in Engineering

Management Information Systems:
Traditional business and commercial applications of information systems.

6 credits from:

{	Acct 610	Internal Auditing Concepts and Procedures ***or***
	Acct 615	Concepts of Strategic Cost Analysis
	Fin 624	Financial Management
{	HRM 601	Organizational Behavior ***or***
	HRM 655	Theory and Research in Organizational Behavior
{	Mrkt 631	Market Planning and Analysis ***or***
	Mrkt 632	Marketing Strategy for Technology-Based Organizations

Electronic Enterprise Design:
The use of information systems methodologies and methods for redesigning organizations employing modern information technology and concepts.

6 credits from:

	CIS 676	Requirements Engineering
	CIS 634	Information Retrieval
{	CIS 684	Business Process Innovation ***or***
	CIS 762	Computerized Information Systems for Planning and Forecasting

Multimedia Communication:
Use of multimedia data with regard to development, presentation, utilization and understanding by individuals and organizations.

6 credits from:

Eng 604	Communication Theory
Eng 605	Document Design and Electronic Publishing
Eng 610	Creating Hypertext Projects: A Task-Oriented Approach
Eng 613	Multimedia Presentations

Biomedical Informatics:
Application of information systems in the biomedical and health areas. Biomedical informatics is also available as a master`s and a doctoral degree. See "Biomedical Informatics" in the Degree Programs section of this catalog.

6 credits from:

BINF 602/BINF 5020	Biomedical Modeling and Decision-Making Systems
BINF 603/BINF 5030	Visualization in Biomedical Sciences
BINF 621/BINF 5210	Research Methods in Health Sciences

Students considering earning a doctorate or who are already enrolled in the Ph.D. in Computer and Information Science program in the information systems specialization should consider the following Rutgers-Newark courses for the area of specialization.

Interdisciplinary Information Systems:

26:620:555	Seminar in Organizational Behavior
26:620:556	Seminar in Organizational Theory
26:620:671	Management of Innovation and Technology
26:620:677	Culture and Organizations

Evaluation Methods and Tools:

26:630:660	Qualitative Research Methods
26:630:668	Causal Modeling
26:960:577	Introduction to Statistical Linear Models

Data Analysis and Modeling Tools:

26:630:576	Quantitative Methods in Marketing
26:630:625	Clustering Analysis
26:711:585	Control Models

ELECTIVES:

18 credits chosen from one or more elective areas. A minimum of two courses is required from any single area selected. The following are some representative specialty areas available in the computer and information science department. The student may propose any specialty set of courses desired including up to two additional courses in other departments. There are many possible specialty areas possible. Choices should be approved by the program director.

Advanced Information Systems Design:

CIS 634	Information Retrieval and Data Mining
CIS 658	Multimedia Systems
CIS 676	Requirements Engineering
CIS 684	Business Process Innovation
CIS 731	Applications of Database Systems
CIS 732	Design of Interactive Systems
CIS 735	Computer Mediated Communication Systems
CIS 762	Computerized Information Systems for Planning and Forecasting
CIS 767	Decision Support Systems

Information Systems Supporting Technology:

CIS 601	Object-Oriented Programming
CIS 602	Java Programming
CIS 610	Data Structures and Algorithms
CIS 631	Database Management System Design
CIS 635	Programming Languages
CIS 652	Computer Networks
CIS 661	Simulation

Communications and Networking:

CIS 651	Data Communications
CIS 652	Networks Architectures, Protocols, and Standards
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols

Artificial Intelligence, Expert Systems, and/or Knowledge-Based Systems:

CIS 670	Artificial Intelligence
CIS 671	Knowledge-Based Systems
CIS 672	Expert System Methods and Design
CIS 674	Natural Language Processing

Ph.D. in Computer Science

Bridge Program:

Applicants are expected to have backgrounds in computer science and mathematics equivalent to the bridge program courses listed below. Students who lack this background may be admitted and required to take these courses and attain a cumulative GPA of 3.0.

CIS 251	Computer Organization
CIS 332	Principles of Operating Systems
CIS 333	Introduction to UNIX Operating System
CIS 505	Programming, Data Structures, and Algorithms
CIS 510	Assembly Language Programming and Principles

Math 111	Calculus I
Math 112	Calculus II
Math 211	Calculus III
Math 226	Discrete Analysis
Math 333	Probability and Statistics

Core Requirements:

All Ph.D. Students are required to take qualifying examinations in the following areas:

CIS 610	Data Structures and Algorithms
CIS 611	Computability and Complexity
CIS 665	Algorithmic Graph Theory

Concentration Areas:

A Ph.D. 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.

Biomedical Informatics:

CIS 631	Data Management System Design
CIS 632	Advanced Database System Design
CIS 634	Information Retrieval
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 670	Artificial Intelligence
CIS 678	Medical Terminologies
CIS 734	Data Mining
BIOL 601	Foundations of Computational Biology
	Other 600/700-level courses as approved by advisor.

Computer Algorithms and Theory of Computing:

CIS 610	Data Structures and Algorithms
CIS 611	Introduction to Computability and Complexity
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 668	Parallel Algorithms
CIS 669	Computational Geometry
IE 704	Sequencing and Scheduling
	Other 600/700-level courses as approved by advisor.

Computer Systems, and Parallel and Distributed Processing:

CIS 630	Operating System Design
CIS 633	Distributed Systems
CIS 636	Compiling System Design
CIS 637	Real-Time Systems
CIS 650	Computer Architecture
CIS 668	Parallel Algorithms
CIS 750	High Performance Computing
ECE 658	VLSI Design I
ECE 758	VLSI Design II
ECE 689	Digital System Design for Machine Arithmetic
ECE 785	Parallel Processing Systems
	Other 600/700-level courses as approved by advisor.

Databases, Data Mining, and Knowledge-Based Engineering:

CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 632	Advanced Database System Design
CIS 634	Information Retrieval
CIS 658	Multimedia Systems
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 670	Artificial Intelligence

CIS 671	Knowledge-Based Systems
CIS 731	Applications of Database Systems
CIS 734	Data Mining
	Other 600/700-level courses as approved by advisor.

Image Processing and Computer Graphics:

CIS 630	Operating System Design
CIS 632	Advanced Database System Design
CIS 657	Principles of Interactive Computer Graphics
CIS 659	Image Processing and Analysis
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 682	Geometric Modeling
CIS 759	Advanced Image Processing and Analysis
CIS 780	Computer Vision
CIS 782	Pattern Recognition and Applications
ECE 601	Linear Systems
ECE 643	Digital Image Processing I
ME 635	Computer-Aided Design
	Other 600/700-level courses as approved by advisor.

Networking and Security:

CIS 604	Client/Server Computing
CIS 630	Operating System Design
CIS 651	Data Communications
CIS 652	Computer Networks-Architectures, Protocols and Standards
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 696	Network Management and Security
CIS 697	Principles of Broadband ISDN and ATM
CIS 741	Communication Network Design
CIS 752	Communication Protocol Synthesis and Analysis
	Other 600/700-level courses as approved by advisor.

Software Engineering:

CIS 601	Object-Oriented Programming
CIS 610	Data Structures and Algorithms
CIS 611	Introduction to Computability and Complexity
CIS 630	Operating System Design
CIS 635	Computer Programming Languages
CIS 636	Compiling System Design
CIS 641	Formal Languages and Automata
CIS 667	Design Techniques for Algorithms
CIS 673	Software Design and Production Methodology
CIS 676	Requirements Engineering
CIS 683	Object-Oriented Software Development
CIS 688	Programming for Interactive Environments
	Other 600/700-level courses as approved by advisor.

Systems Analysis, Simulation and Modeling:

CIS 605	Discrete Event Dynamic Systems
CIS 621	Numerical Analysis I
CIS 622	Numerical Analysis II
CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 637	Real-Time Systems
CIS 651	Data Communications
CIS 654	Telecommunication Networks Performance Analysis
CIS 661	Systems Simulation
CIS 662	Model Analysis and Simulation
CIS 741	Communication Network Design
	Other 600/700-level courses as approved by advisor.

DOCTOR OF PHILOSOPHY IN MANAGEMENT (Computer Information Systems Major only)

Administered By: Department of Computer and Information Science

contact Computer Information Systems Major Program Coordinator and Advisor: Murray Turoff (973) 596-3366 (Room 4106 GITC), e-mail turoff@vc.njit.edu

Ph.D. in Information Systems

Objectives:

The program in Information Systems is designed to produce scholars who possess a commanding knowledge of the nature of Information Systems, applications of and research on Information Systems, and the supporting technology in Computer Science.

The program seeks to develop individuals who can expand both the practice and theory of information systems for complex applications and/or organizational environments. It deals with integrated information, computer and communication systems that support and augment individuals and groups in any field of application: management, business, engineering and manufacturing, health and medicine, education, social sciences, arts and humanities, etc.

There have been dramatic developments in information systems, computing technology, economics, and related social sciences which have substantially affected the underlying methodological and scientific frameworks of business. The area of information systems has shown explosive growth as organizations have become increasingly complex, electronically integrated, and interdependent.

Graduates will be prepared for research, teaching, and/or practice in this field. The program also emphasizes the behavioral and organizational context of computer-based information systems, their requirements, design, implementation, user acceptance, management, and the evaluation of their effectiveness and consequences.

The program is designed to attract students from different disciplinary backgrounds and encourages an interdisciplinary approach to the concepts of information system design, utilization, and evaluation. It provides students with the ability to analyze and organize the information needs and resources of an application environment and to design and develop systems to respond to those needs.

Students are expected, as a result of the program, to be able to advance the state of the art of knowledge in information systems. They are prepared for research and/or development activities in either academia or industry. They are expected to be able to deal with the evolution and creation of systems to handle new application areas.

An outstanding student with a Bachelors or Masters in any field may apply and be accepted, conditional on accomplishing an appropriate set of bridge courses to make up necessary pre-requisites or knowledge deficiencies in such areas as Computers and Mathematics.

Program Admission Requirements:

A student seeking admission to this Doctor of Philosophy program must satisfy the following minimum admission requirements.

Students must have successfully completed a baccalaureate program from an accredited institution.

Submit:

1. Resume of Experience and Background (This should include details of experience, knowledge, and skills with respect to computer technology and information systems.)

2. Transcripts of academic record; GPA should be 3.5 or better on a 4.0 scale.

3. Three letters of recommendation by persons familiar with the student's academic work and/or related work experience

4. GRE, GMAT, or MCAT scores. The normal minimum GRE total score is 1850.

International students must demonstrate proficiency in the English language by scoring a minimum score required by the university (which is currently 550) on the TOEFL exam. However, those seeking support must demonstrate a level of spoken and written English proficiency sufficient for teaching activities (600 or over on the TOEFL). Students may be admitted below the minimum score but will be required to take English and retake the TOEFL to prove proficiency.

Applications should include documented aptitude, interest in and commitment to scholarly activities and research. This may be demonstrated by quality of papers or projects completed by the student or employee, and/or letters of recommendation by individuals qualified to judge your professional performance.

In addition, applicants must have demonstrated superior performance in the following areas/courses or their equivalents. Applicants who have not met all these course requirements prior to admission, may be provisionally accepted and then complete these requirements while in the program. Those seeking support must have satisfied this knowledge requirement.

Table of Undergraduate Prerequisites or demonstrated knowledge :

IS Technical Background				
Mathematics:	Calculus: two semesters Post Calculus Probability &Statistics Course Discrete Math Methods Course			
Computing:	Four undergraduate courses in Computer Science in such areas as programming, data structures, data bases, software engineering, communications, etc.	Appropriate work experience may be applicable to satisfying part or all of this requirement.	A working knowledge of one development oriented computer language such as C++ or JAVA.	Computers and Society may be required if no similar course has been taken.

Admission to Candidacy Requirements:

Admission to the doctoral program does not imply candidacy for a degree. To be admitted to candidacy, the student must::

1. Qualifying exams The student must take the qualifying exam which will cover the IS core area. Full time Ph.D. students usually take the exam within 18 months of matriculation; e.g., if they enter in September of 2000, they should plan to take the exam by January of 2002. The exam is given every January, and if needed, in June.

Students will be provided with a reading list of all course materials that they are responsible for in the four courses involved in the qualifying exam. The objective of the qualifying exam is to determine if the student has mastered the basic knowledge in the field of Information Systems.

2. Maintain a grade average of 3.5 (B+) or better in the core courses. No graduate course may have a grade of less than B and count toward candidacy, this includes potential transfers. A grade of B or better in each core course is required in order to take the qualifying exam.

3. Successfully complete courses in Computing Systems technical foundations. Credits may be utilized for these requirements, with the approval of an advisor, from a prior master's degree, if the courses match these requirements.

4. Choose a Research Specialty within Information Systems that will be the focus of the Ph.D. dissertation. A total of at least 12 courses will be needed for this Specialty area; up to two may be Independent Study or the IS Ph.D. seminar, CCS788. At least 5 of these must be at the 700 level. Up to four may be in an application area track, for which credit may be applied from a previous master's degree, with the approval of the advisor.

5. Develop a state of the art paper in your specialty area under the guidance of a faculty member. The State of the Art Paper will usually form the basis for one or more publications and for the student's subsequent dissertation proposal. The state-of-the-art paper, once approved by the advisor, will be submitted to an exam committee approved by the program director but including the student's advisor. The examination committee will determine the nature of any additional comprehensive exam after careful review of the state-of-the-art paper.

After fulfilling these requirements, the student will be a candidate for the doctoral degree with all work but the dissertation completed (ABD).

6. Dissertation Proposal and Dissertation

This comprises the original research leading to a dissertation and demonstrating the student's ability to conceive and carry out independent research.

Six (6) credits of Pre-doctoral research allow the student to identify a research problem and to prepare a proposal for solving the problem in the dissertation. The proposal must be in writing and be defended orally in the presence of a formal review committee before it is accepted. The student is expected to successfully pass the proposal defense within a period of two (2) years after passing the qualifying examination. The committee, chaired by the student's research advisor, will contain at least four (4) faculty members, with at least one (1) committee member from outside CIS. The outside member may be from other institutions or industry provided he or she is currently engaged in relevant research. It is expected this committee will later become the thesis committee.

Dissertation and Defense:

At least twenty-four (24) credits of dissertation research is required. After the research is completed, the dissertation will be defended at an open meeting of the NJIT faculty, in the presence of the dissertation committee.

However, if the student does not successfully complete the dissertation within a period of four years after passing the qualifying examination, the student's ABD status will be removed and the state of the art paper must be redone and the examination must be taken and passed again to restore that status.

Summary of Academic credit requirements:

Area	Courses	Credits
	8	
Advanced courses: Application area and Research Specialty		36
Predoctoral Research		6
Total	20	

Those entering with a Masters degree are required to complete a minimum of 24 additional course credits. However, they must also satisfy the candidacy requirements. Up to 36 credits may be transferred from a Master's degree if the courses are appropriate for satisfying the Ph.D. requirements. The transferability of credits for specialty area courses must have the approval of both the program director and the student's research specialty advisor.

Other Requirements:

7. Participation in the Ph.D. IS graduate seminar for at least 4 semesters or credits (CIS 787/788).

8. Teaching or assistance in teaching at least one course in Information Systems or a related area, under the supervision of a faculty member.

9. Submission of at least one research paper for publication in a peer reviewed conference or journal.

10. Submission of the final draft of the dissertation in the format required by the university, with signed approvals of the dissertation committee.

Should twenty-four (24) credits of dissertation research be completed before submission of the final copy of the dissertation and its acceptance by the department, it will be necessary for the student to register for a minimum of six (6) additional dissertation credits per year until the dissertation has been submitted and accepted. The oral examination will be given only after the submission of the final draft of the dissertation.

We encourage part time students to take part in this program but most thesis advisors will require a full time effort after successful completion of the qualifying exam, during the period when the dissertation proposal is being developed and the dissertation research begun.

Many of the courses are available in distance mode, but a period of on campus study will be necessary to complete advanced courses and dissertation proposal requirements.

Core Requirements:

An extensive foundation of twelve courses (36 credits) which are intended to establish a core of expertise in computing, information systems, and management is required: four courses in Computing Sciences tools and methodologies; four courses in Information Systems; and four courses in an application area or environment. Most of these courses are already core courses or options in the MS in Information Systems. The Ph.D. student is expected to maintain a B+ average in the 12 core courses.

Computing Sciences Tools and Methodologies:

To ensure a strong technical foundation, Ph.D. students should choose four courses (to be selected from at least four of the five areas below); MS students should choose a minimum of two courses (selected from at least two of the five areas). Additional courses from this list can be included as electives.

Programming languages and Methodologies: CIS 601, CIS 602, CIS 603, CIS 604, CIS 635, CIS 683

Database Design: CIS 631, CIS 632, CIS 731

Communications and Networks: CIS 633, CIS 651, CIS 652, CIS 654, CIS 656, CIS 696, CIS 697, CIS 741

Artificial Intelligence: CIS 670, CIS 671, CIS 672, CIS 674

Simulation: CIS 605, CIS 661, CIS 662

Information Systems Core:
CIS 663 Advanced Systems Analysis (OR, for those who entered before fall 2002, CIS 673 Software Design and Production Methodology)

CIS 677 Information System Principles

CIS 675 Information System Evaluation

CIS 679 Management of Computer and Information Systems

Advanced Courses (12 courses, 36 credits):
At least five of these courses must be at the 700 level.

A. (Optional)Application Environment or "Track":
A student program of study may support an application area with a two to four-course concentration of courses focusing on a specific type of information systems environment. The courses are usually taken outside an area of IS or CS, and must be approved by the Ph.D. advisor This may be a specific application area for Information Systems or an interdisciplinary area that supports the development of improved Information systems. Those entering the program with a masters may have satisfied this requirement as part of their master's degree. Areas that might be included are any management area, health and medical applications, sciences, advanced analysis, engineering, etc. Alternatively, the student may concentrate all advanced courses within the College of Computing Sciences.

Examples of four-course concentrations or "application track" areas include:

Management Track (two to four of the following):
FIN 624 Financial Management

HRM 601 Organizational Behavior or HRM 655 Theory and Research in Organizational Behavior or 26:620:555 Theory and Research in Organizational Behavior (Rutgers)

MRKT 631 Market Planning and Analysis or MRKT 632 Marketing Strategy for Technology Based Organizations or 26:630:576 Quantitative Methods in Marketing (Rutgers)

ACCT 610 Internal Auditing Concepts and Procedures or ACCT 615 Concepts of Strategic Cost Analysis

Management IS Track (two to four of the following):
MIS 645 Operations Management, Planning, and Control

MIS 655 Information Systems Audit, Control and Security

MIS 665 Electronic Commerce

Mgmt 630 Design Analysis, or Mgmt 685 Operations Research and Decision Making, or EM 714 Multicriteria Decision Analysis, or MIS 648 Decision Support Systems, or MIS 690 Executive Information Systems

MIS 654 Design of Accounting Information Systems

Industrial Engineering Track (two to four of the following):
EM 636 Project Management

IE 621 Systems Analysis and Simulation

IE 661 Man-Machine Systems, or IE 669 Human Design Factors in Engineering

IE 760 Quantitative Methods in Human Factors, or IE 761 Advanced Studies in Human Factors, or IE 762 Psychophysical Methodsin Human Factors

Multimedia Communications (two to four of the following):
ENG 604 Communication Research and Theory

ENG 605 Electronic Publishing and Design

ENG 613 Multimedia Presentations

ENG 710 Creating Hypertext Projects: A Task Oriented Approach

Biomedical Informatics (Courses offered at UMDNJ):

BINF 5010 Bioinformatics Database Systems

BINF 602/BINF5020 Biomedical Modeling and Decision Making Systems

BINF 603/BINF5030 Visualization in Biomedical Sciences

BINF 621/BINF5210 Research Methods in Health Sciences

IS Research Methods Track:

HRM 655 Theory and Research in Organizational Behavior or 26:620:555 Theory and Research in Organizational Behavior (Rutgers)

MGMT 760 Research Methods and Multivariate Analysis or 26:960:577 Introduction to Statistical Linear Models (Rutgers) or 26:630:576 Quantitative Methods in Marketing (Rutgers)

- An Advanced Qualitative Research Methods course from NJIT or Rutgers
- One additional advanced research methods course For a list of "pre-approved" graduate courses outside of the College of Computing Sciences that may be applied towards graduate degrees in IS, please follow the "quick link" from http://is.njit.edu/msis/. The student and advisor may also design a custom "application track."

B. Research Area Studies:

Upon successful completion of the qualifying examinations the student must select a research specialty area under the approval of an advisor. These 24 to 30 credits (8-12 courses, depending on the number of application track courses) must constitute a coherent body of knowledge in support of the student's expected area of specialization and research. This may include courses eligible for transfer credit from a prior program beyond the Bachelor's. This planned program of study will be filed with the program director, but may be changed later with the consent of the advisor. It should be updated at least once every academic year. Course choices must be focused and include both the beginning and advanced course or courses in a given topic.

State of the Art Paper and Comprehensive Exam:

The state of the art paper is a product the student works on with an advisor towards the end of the period when he or she is taking the 36 credits of advanced study. It focuses on summarizing the students' command and understanding of the current research issues and activity in the specialty area and important related findings from all of the coherent set of courses in the advanced study. The student may include in the advanced study an independent study or seminar course (CIS 776) with the advisor to allow for the compilation of the State of the Art paper under the advisor's guidance.

The State of the Art Paper will usually form the basis for the student's subsequent dissertation proposal. It will summarize literature in the specialty area, carefully exposing related research areas from relevant topics making up the specialty area. The objective of this requirement is to insure the student has obtained a solid understanding of the research issues in the chosen area of study. Full time students should plan to complete the state of the art paper within one semester of passing the qualifying examination on the IS core areas; e.g., if the student takes the qualifying exam in January 2002, he or she should complete the state of the art paper by September of 2002.

The state-of-the-art paper, once approved by the advisor, will be submitted to an exam committee approved by the program director but including the student's advisor, who will also make recommendations as to other members. The examination committee will determine the nature of any additional comprehensive exam after careful review of the state-of-the-art paper.

Dissertation Proposal and Dissertation:

This comprises the original research leading to a dissertation and demonstrating the student's ability to conceive and carry out independent research.

Dissertation Proposal and Defense:

The purpose of the six (6) credits of Pre-doctoral research is to allow the student to identify a research problem and to prepare a proposal for solving the problem in the dissertation. The proposal must be in writing and be defended orally in the presence of a formal review committee before it is accepted. Our objective is to have the full time student successfully defend the dissertation proposal approximately one year after passing the qualifying exam; e.g., if the student takes the exam in January 2002, he or she should try to defend a dissertation proposal by the spring semester of 2003. Students entering with only a bachelor's degree or who are attending part time may take somewhat longer. In any case, the student is expected to successfully pass the proposal defense within a period of two (2) years after passing the comprehensive examination.

The thesis proposal review committee will be made formal when the student has passed the comprehensive examination. The committee, chaired by the student's research advisor, will contain at least four (4) faculty members, with at least one (1) committee member from outside the CIS department. The outside member may be from other institutions or industry provided he or she is currently engaged in relevant research. The members of the committee will be appointed by the student's research advisor with the agreement of the student and the Program Director. It is expected this committee will later become the thesis committee.

Dissertation and Defense:

With the approval of the dissertation proposal, the student may conduct research under the guidance of the research advisor. At least twenty-four (24) credits of dissertation research is also required. However, if the student does not complete the dissertation within the twenty-four (24) credits, the student must continue to register for at least three (3) credits of dissertation research each semester until the dissertation is accepted by the dissertation committee as completed. After the research is completed, the dissertation will be defended at an open meeting of the NJIT faculty, in the presence of the dissertation committee.

The formal dissertation committee will be formed after the student has successfully defended the dissertation proposal. The purpose of the dissertation committee is to guide the student to carry out high quality research and to evaluate the student's progress during the research. The primary dissertation research advisor must be a member of the tenure-track faculty of CIS. The Committee, chaired by the student's research advisor, will contain at least four(4) faculty members and at least one(1) committee member from outside of NJIT. The members of the committee will be nominated by the student's research advisor for the Ph.D. Program director's approval. The Ph.D. Program director will formally appoint the examination committee.

Dismissal from the Program:

Any student failing any part of the qualifying examination or comprehensive examination including the state-of- the-art paper, or any course work may petition the Ph.D. Program Director for a second try presenting, in conjunction with the Program Director, a plan for rectifying any deficiencies. The student may be required to retake the entire examination or only selected parts. The plan to rectify deficiencies may require the completion of additional course work.

Students failing the qualifying examination or comprehensive examination, including advanced course work, a second time will be dismissed from the program. Students may be denied permission to take a second qualifying examination or comprehensive and be dismissed from the program. Students failing the qualifying examination, comprehensive examination, or advanced course work may, with the approval of the department, elect to complete all requirements for the master's degree in Information Systems or the masters degree in Computer Science provided they do not already have such a degree.

Part-time students:

The program welcomes part time students. A great many of the required courses are being offered in a distance learning mode as well as the normal face to face offerings.

It should be recognized that after completing the courses and exams and entering the phase of dissertation work most Ph.D. students need to invest a minimum full time effort for six months to a year to insure success.

Industry Collaborative Doctor of Philosophy:

Individuals currently engaged in relevant research areas in industry or other organizations should check the Industry Collaborative Doctor of Philosophy program (See Graduate Catalog) offered by NJIT which allows the waver of residency requirements and more specific tailoring of requirements.

Admissions &Support:

Outstanding full time Ph.D. students are encouraged to apply for support. There may be either Teaching Assistantships or Research Assistantships available. Current minimum requirements for consideration for support are GRE scores of 2100 or above, a GPA of 3.7 or above, and work experience or outstanding accomplishments. However, a student accepting such an appointment will be asked to sign a commitment to pay back the tuition part of their Assistantship if they choose to leave the program for a full time job before becoming ABD. This does not apply when the student is asked to leave the program for poor performance or in the case of medical reasons. The forms for applying for the above programs may be obtained from the Office of University Admissions (NJIT, University Heights, Newark NJ 07102, Tel: 973 596 3300), Forms for admission also appear on the NJIT website (http://www.njit.edu). A non refundable fee is required with the actual application for admission. Those seeking work experience credit for admission prerequisites for technical knowledge in computers should include in the application package a detailed resume with specific details of various related job experiences.

Program Director for IS Ph.D. Degree:

Those interested in the Ph.D. in Information Systems who have specific questions may contact the program director Starr

Roxanne Hiltz (Email: hiltz@adm.njit.edu, homepage: http://eies.njit.edu/~hiltz/). However, it is impossible to express (before the complete application is reviewed) any specific opinions about admission, support, and or transfer credits. If you do wish to visit, please arrange via email first and/or check on office hours with the department secretaries (973-596-3366). There are no office hours during the summer.

Other Information:

The **NJIT web site** is http://www.njit.edu and one may find there web pages for the College of Computing Science Information Systems Department and the **School of Management.** One can at those sites, and related ones, learn about the faculty, many of the courses and some of the current research taking place. Applications for graduate admission may be found at the web site for the **NJIT Office of Admission.**

Related Programs:

NJIT currently offers M. S. degree in Computer Science and the M. S. degree in Information Systems through the Department of Computer and Information Science. In addition an M. S. degree in Management offered by the School of Management includes concentrations in both Information Systems Management and Information Systems Auditing. The IS degrees at the master levels train individuals to be part of application development teams and to posses a high degree of computer skills for the development of applications. The management degrees are meant to train managers knowledgeable in the utilization of computers in a commercial organization but do not require the same degree of technical capability.

There is also a B. S. in Computer Science and a B. A. in Information Systems offered by the CIS Department at NJIT. While these are adequate preparatory programs for entering the Masters or Ph.D. program in Information Systems, they are not the only path that may be taken.

The M. S. in Information Systems is a subset of the requirements for the Ph.D. program and the student who is unsure about a full commitment to a Ph.D. program should consider that option. Also one may obtain the M. S. in IS along the way to the Ph.D. in IS.

There is also a Ph.D. in Biomedical Informatics offered jointly by NJIT and UMDNJ, New Jersey’s University of the Health Sciences. Students may enroll with either NJIT or UMDNJ. The NJIT enrolled students are required to meet the requirements for the IS Ph.D. with only slight differences. They may also obtain the NJIT MS in Information Systems as part of this program.

The CIS department also offers the Computer Information System concentration in the Ph.D. in Management offered by the Rutgers Graduate School of Management at the Rutgers Newark campus. Ph.D. Students have the right to choose their research areas and advisors. This is explained in the referenced IS policy document on student rights.

Electrical Engineering

Administered By: Department of Electrical and Computer Engineering

Administration

Chairperson	Atam Dhawan
Associate Chairpersons	Edwin Hou(Undergraduate), Sotirios Ziavras(Graduate)
Graduate Advisor	Nirwan Ansari(MS Telecom Eng, MS Internet Eng) Phone: (973) 596-3670, Email: nirwan.ansari@njit.edu Richard Haddad(MS Electrical Eng - Part Time) Phone: (973) 596-3516 (Room 223 ECE), Email: hadda@admin.njit.edu Durga Misra(MS Electrical Eng - Full Time) Phone: (973) 596-5739 (Room 223 ECE), Email: dmisra@njit.edu Sotirios Ziavras(MS Computer Eng and PhD EE & CoE) Phone: (973) 596-5651 (Room 223 ECE) Email: ziavras@njit.edu
Assistant Chairperson	Mohammed Feknous (Mount Laurel Campus)
Distinguished Professors	Bar-Ness, Friedland, Savir

Faculty

Professors	Akansu, Ansari, Carr, Cornely, Grebel, Haddad, Haimovich, Klapper, Misra, Reisman, Rosenstark, Shi, Sohn, Strano, Whitman, Zhou, Ziavras
Associate Professors	Carpinelli, Chang, Frank, Ge, Hou, Hubbi, Manikopoulos, Niver, Sosnowski, Tsybeskov
Assistant Professors	Abdi, Loncaric, Papavassiliou, Rojas-Cessa, Tekinay, Zakrevski
Professional/Instructional Staff	Feknous
Doctoral Programs Coordinator	Sotirios Ziavras Phone: (973) 596-5651 (Room 223 ECE) Email: ziavras@njit.edu

Degrees Offered: Master of Science in Electrical Engineering; Doctor of Philosophy in 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 program offers 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. For further information, see the Admissions section in this catalog.

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 such as the ones listed below 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.

ECE 321	Random Signals and Noise
ECE 232	Signals and Systems II
ECE 333	Signals and Systems III
ECE 361	Electromagnetic Fields I
ECE 362	Electromagnetic Fields II
ECE 372	Electronic Circuits II
ECE 373	Electronic Circuits III

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

Degree Requirements:

Upon entering the program, students select an area of specialization supervised by an area coordinator. 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. Students should consult with the area coordinator or designee of their area of specialization 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 thesis or 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.

Seminar: All students receiving departmental or research-based support are required to register every semester for ECE 791 Graduate Seminar.

PROJECT, THESIS:

Thesis is required for all those receiving departmental or research-based support. For all others, a project or thesis is optional.

ECE 700	Master's Project (3 credits)
ECE 701	Master's Thesis (6 credits)

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 area coordinator or designee. Two non-ECE graduate courses may be chosen. Students should contact the appropriate associate chairperson for graduate studies for guidance.

Area Coordinators:

Communication, Signal Processing and Microwave: A. Haimovich
Computer Networking: S. Papavassiliou
Computer Architecture and Systems: J. Carpinelli
Solid State, VLSI and Electrooptics Systems: D. Misra
Intelligent Systems: T. Chang

Electrical Engineering CORE:

Applies to all areas of specialization in Electrical Engineering

6 credits:

ECE 601	Linear Systems
ECE 673	Random Signal Analysis I ***or***
ECE 620	Electromagnetic Field Theory

Communication, Signal Processing and Microwave::

Choose communications or digital signal processing or microwave.

REQUIRED:

Communications:
6 credits:

ECE 642	Communication Systems I
ECE 742	Communication Systems II

Digital Signal Processing :
6 credits:

ECE 640	Digital Signal Processing
ECE 740	Advanced Digital Signal Processing

Microwave Engineering :
6 credits:

ECE 630	Microwave Engineering
ECE 632	Antenna Theory

ELECTIVE:
Applies to both communications, digital signal processing and microwave. Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; or 18 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Computer Networking:
These two courses are required for computer networking specialization.

REQUIRED:
6 credits:

ECE 683	Computer Network Design and Analysis
ECE 783	Computer Communication Networks

ELECTIVE:
Applies to computer networking systems. Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; or 18 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Computer Architecture and Systems:
These two courses are required for computer architecture and systems.

REQUIRED:
6 credits:

ECE 689	Digital System Design for Machine Arith
ECE 690	Computer Systems Architecture

ELECTIVE:
Applies to computer architecture and systems. Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; or 18 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Solid State, VLSI and Electrooptics Systems:
REQUIRED:
Solid State Devices:
6 credits:

ECE 650	Electronic Circuits
ECE 657	Semiconductor Devices

VLSI Design :
6 credits:

ECE 658	VLSI Design - I
ECE 758	VLSI Design - II

Electrooptics :
6 credits:

ECE 622	Wave Propagation
ECE 626	Optoelectronics

ELECTIVE:
Select 6 credits if completing a master's thesis; 9 credits if completing a master's project; or 12 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Intelligent Systems:
REQUIRED:
9 credits:

ECE 605	Discrete Event Dynamic Systems
ECE 609	Artificial Neural Networks
ECE 610	Power System Steady-State Analysis
ECE 660	Control Systems I

ELECTIVE:
Select 9 credits if completing a master's thesis; 12 credits if completing a master's project; or 15 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

DOCTOR OF PHILOSOPHY IN ELECTRICAL ENGINEERNG

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.

Students who lack an appropriate background will be required to take additional courses that cannot be applied as degree credits.

Degree Requirements:

Course selection is determined in consultation with the area faculty.

24 credits minimum of course work beyond the master's degree.

12 credits of 700-level courses (normally associated with the area of specialization as listed in the master's degree description). For details, see the department "Handbook for Graduate Students."

36 credits of ECE790 Doctoral Dissertation.

Registration for 1/2 credit of ECE 791 Graduate Seminar is required of all doctoral students every semester. Waivers of the seminar requirement may occur with the approval of the dean of graduate studies.

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. Students who complete 36 credits of ECE 790 before their research is finished, must register for a minimum of 3 credits of ECE 790 every semester thereafter until the dissertation has been accepted. 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 may be applied toward the ECE 790 requirement.

Engineering Management

Administered By: Department of Industrial and Manufacturing Engineering

Administration

Chairperson	Athanassios K. Bladikas
Associate Chairperson	George Abdou
Program Director and Graduate Advisor	Carl Wolf Phone: (973) 596-3657 (Room 2511 GITC) Email: wolf@admin.njit.edu

Faculty

Professors	Abdel-Malek, Caudill, Das, Ranky, Sebastian, Tricamo, Wolf
Associate Professor	Abdou, Bengu, Bladikas, McDermott
Assistant Professors	Jeng, Sengupta, Yang

Degrees Offered: Master of Science in 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.

Bridge Program: Students who lack appropriate academic preparation may be required to take one or more of the following courses before being admitted to the program. These courses are taken in addition to degree requirements:

EM 501	Industrial Management
EM 502	Engineering Cost Analysis
EM 503	Methods and Applications of Industrial Statistics and Probability

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 the NJIT at Mount Laurel branch campus and 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.

Degree Requirements:

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 or a 6-credit thesis is optional. 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 offered by the Department of Industrial and Manufacturing Engineering.

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.

CORE:

18 credits:

Acct 615	Concepts of Strategic Cost Analysis
EM 602	Management Science
EM 636	Project Management
HRM 601	Organizational Behavior
IE 673	Total Quality Management
MIS 648	Decision Support Systems

PROJECT OR THESIS (optional):

IE 700	Master's Project (3 credits:) ***or***
IE 701	Master's Thesis (6 credits:)

AREAS OF SPECIALIZATION:

For all areas of specialization, select 6 credits if completing a master's thesis; 9 credits if completing a master's project; 12 credits if not completing either a master's project or thesis.

Project Management:

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

Cost Engineering:

EM 632	Legal Aspects in Construction
EM 637	Project Control ***or***
IE 618	Engineering Cost and Production Economics
EM 691	Cost Estimating for Capital Projects
Fin 624	Financial Management

Technical Marketing:

EM 640	Distribution Logistics
EM 641	Engineering Procurement and Materials Management
Mrkt 631	Market Planning and Analysis
Mrkt 636	Design and Development of High Technology Products

Technological Entrepreneurship:

EM 634	Legal, Ethical and Intellectual Property Issues for Engineering Managers
Mgmt 620	Management of Technology
MnE 655	Concurrent Engineering
Mrkt 636	Design and Development of High Technology Products

Quality:

EM 674	Benchmarking and Quality Function Deployment
IE 605	Engineering Reliability

IE 672	Industrial Quality Control
MnE 654	Design for Manufacturability

Facility Management:

Arch 650	Economy of Building
EM 632	Legal Aspects in Construction
Fin 624	Financial Management
IE 653	Facility Maintenance

Manufacturing Systems Management:

MnE 601	Manufacturing Systems
MnE 602	Flexible and Computer Integrated Manufacturing
MnE 603	Management of Manufacturing Systems
MnE 655	Concurrent Engineering

Management Information Systems:

EM 655	Management Aspects of Information
IE 651	Industrial Simulation
IE 661	Man-Machine Systems
MIS 690	Executive Information Systems

Engineering Management:

EM 635	Management of Engineering Research and Development
EM 714	Multicriteria Decision Making
HRM 606	Human Resource Management
IE 618	Engineering Cost and Production Economics
MIS 645	Operations Management, Planning and Control
MnE 655	Concurrent Engineering

Engineering Science

Administered By: Office of the Dean, Newark College of Engineering

Administration

Program Director and Graduate Advisor	David Kristol Phone: (973) 596-3584 (Room 330 COL) Email: kristol@njit.edu

Faculty

Professors from Newark College of Engineering and College of Science and Liberal Arts, as appropriate

Degrees Offered: Master of Science 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.

Bridge Program: 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 courses will be individually-designed in consultation with the student's graduate advisor. Such courses are not counted toward degree requirements.

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.

REQUIRED:

15 credits, selected in consultation with graduate advisor: *6 credits* of 600-level mathematics *3 credits* of 600-level physics, chemistry, or biology *6 credits* of 600-level engineering courses

PROJECT OR THESIS (optional):

3 or 6 credits: selected in consultation with graduate advisor

ELECTIVE:

15 credits selected in consultation with graduate advisor

The elective credits must form a meaningful and coherent program integrated with the specialization in science or engineering.

Electrical Engineering

Administered By: Department of Electrical and Computer Engineering

Administration

Chairperson	Atam Dhawan
Associate Chairpersons	Edwin Hou(Undergraduate), Sotirios Ziavras(Graduate)
Graduate Advisor	Nirwan Ansari(MS Telecom Eng, MS Internet Eng) Phone: (973) 596-3670, Email: nirwan.ansari@njit.edu Richard Haddad(MS Electrical Eng - Part Time) Phone: (973) 596-3516 (Room 223 ECE), Email: hadda@admin.njit.edu Durga Misra(MS Electrical Eng - Full Time) Phone: (973) 596-5739 (Room 223 ECE), Email: dmisra@njit.edu Sotirios Ziavras(MS Computer Eng and PhD EE & CoE) Phone: (973) 596-5651 (Room 223 ECE) Email: ziavras@njit.edu
Assistant Chairperson	Mohammed Feknous (Mount Laurel Campus)
Distinguished Professors	Bar-Ness, Friedland, Savir

Faculty

Professors	Akansu, Ansari, Carr, Cornely, Grebel, Haddad, Haimovich, Klapper, Misra, Reisman, Rosenstark, Shi, Sohn, Strano, Whitman, Zhou, Ziavras
Associate Professors	Carpinelli, Chang, Frank, Ge, Hou, Hubbi, Manikopoulos, Niver, Sosnowski, Tsybeskov
Assistant Professors	Abdi, Loncaric, Papavassiliou, Rojas-Cessa, Tekinay, Zakrevski
Professional/Instructional Staff	Feknous
Doctoral Programs Coordinator	Sotirios Ziavras Phone: (973) 596-5651 (Room 223 ECE) Email: ziavras@njit.edu

Degrees Offered: Master of Science in Electrical Engineering; Doctor of Philosophy in 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 program offers 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. For further information, see the Admissions section in this catalog.

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 such as the ones listed below 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.

ECE 321	Random Signals and Noise
ECE 232	Signals and Systems II
ECE 333	Signals and Systems III
ECE 361	Electromagnetic Fields I
ECE 362	Electromagnetic Fields II
ECE 372	Electronic Circuits II
ECE 373	Electronic Circuits III

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

Degree Requirements:

Upon entering the program, students select an area of specialization supervised by an area coordinator. 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. Students should consult with the area coordinator or designee of their area of specialization 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 thesis or 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.

Seminar: All students receiving departmental or research-based support are required to register every semester for ECE 791 Graduate Seminar.

PROJECT, THESIS:

Thesis is required for all those receiving departmental or research-based support. For all others, a project or thesis is optional.

ECE 700	Master's Project (3 credits)
ECE 701	Master's Thesis (6 credits)

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 area coordinator or designee. Two non-ECE graduate courses may be chosen. Students should contact the appropriate associate chairperson for graduate studies for guidance.

Area Coordinators:

Communication, Signal Processing and Microwave: A. Haimovich
Computer Networking: S. Papavassiliou
Computer Architecture and Systems: J. Carpinelli
Solid State, VLSI and Electrooptics Systems: D. Misra
Intelligent Systems: T. Chang

Electrical Engineering CORE:

Applies to all areas of specialization in Electrical Engineering

6 credits:

ECE 601	Linear Systems
ECE 673	Random Signal Analysis I ***or***
ECE 620	Electromagnetic Field Theory

Communication, Signal Processing and Microwave::

Choose communications or digital signal processing or microwave.

REQUIRED:
Communications:
6 credits:

ECE 642	Communication Systems I
ECE 742	Communication Systems II

Digital Signal Processing :
6 credits:

ECE 640	Digital Signal Processing
ECE 740	Advanced Digital Signal Processing

Microwave Engineering :
6 credits:

ECE 630	Microwave Engineering
ECE 632	Antenna Theory

ELECTIVE:
Applies to both communications, digital signal processing and microwave. Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; or 18 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Computer Networking:
These two courses are required for computer networking specialization.

REQUIRED:
6 credits:

ECE 683	Computer Network Design and Analysis
ECE 783	Computer Communication Networks

ELECTIVE:
Applies to computer networking systems. Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; or 18 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Computer Architecture and Systems:
These two courses are required for computer architecture and systems.

REQUIRED:
6 credits:

ECE 689	Digital System Design for Machine Arith
ECE 690	Computer Systems Architecture

ELECTIVE:
Applies to computer architecture and systems. Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; or 18 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Solid State, VLSI and Electrooptics Systems:
REQUIRED:
Solid State Devices:
6 credits:

ECE 650	Electronic Circuits
ECE 657	Semiconductor Devices

VLSI Design :
6 credits:

ECE 658	VLSI Design - I
ECE 758	VLSI Design - II

Electrooptics :
6 credits:

ECE 622	Wave Propagation
ECE 626	Optoelectronics

ELECTIVE:
Select 6 credits if completing a master's thesis; 9 credits if completing a master's project; or 12 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

Intelligent Systems:
REQUIRED:
9 credits:

ECE 605	Discrete Event Dynamic Systems
ECE 609	Artificial Neural Networks
ECE 610	Power System Steady-State Analysis
ECE 660	Control Systems I

ELECTIVE:
Select 9 credits if completing a master's thesis; 12 credits if completing a master's project; or 15 credits if not completing either a master's project or thesis. See the department Handbook for Graduate Students for suggestions. Course selection must be approved by the associate chairperson for graduate studies, the area coordinator or the thesis advisor.

DOCTOR OF PHILOSOPHY IN ELECTRICAL ENGINEERNG
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.

Students who lack an appropriate background will be required to take additional courses that cannot be applied as degree credits.

Degree Requirements:

Course selection is determined in consultation with the area faculty.

24 credits minimum of course work beyond the master's degree.

12 credits of 700-level courses (normally associated with the area of specialization as listed in the master's degree description). For details, see the department "Handbook for Graduate Students."

36 credits of ECE790 Doctoral Dissertation.

Registration for 1/2 credit of ECE 791 Graduate Seminar is required of all doctoral students every semester. Waivers of the seminar requirement may occur with the approval of the dean of graduate studies.

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. Students who complete 36 credits of ECE 790 before their research is finished, must register for a minimum of 3 credits of ECE 790 every semester thereafter until the dissertation has been accepted. 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 may be applied toward the ECE 790 requirement.

Engineering Management

Administered By: Department of Industrial and Manufacturing Engineering

Administration

Chairperson	Athanassios K. Bladikas
Associate Chairperson	George Abdou
Program Director and Graduate Advisor	Carl Wolf Phone: (973) 596-3657 (Room 2511 GITC) Email: wolf@admin.njit.edu

Faculty

Professors	Abdel-Malek, Caudill, Das, Ranky, Sebastian, Tricamo, Wolf
Associate Professor	Abdou, Bengu, Bladikas, McDermott
Assistant Professors	Jeng, Sengupta, Yang

Degrees Offered: Master of Science in 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.

Bridge Program: Students who lack appropriate academic preparation may be required to take one or more of the following courses before being admitted to the program. These courses are taken in addition to degree requirements:

EM 501	Industrial Management
EM 502	Engineering Cost Analysis
EM 503	Methods and Applications of Industrial Statistics and Probability

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 the NJIT at Mount Laurel branch campus and 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.

Degree Requirements:

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 or a 6-credit thesis is optional. 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 offered by the Department of Industrial and Manufacturing Engineering.

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.

CORE:

18 credits:

Acct 615	Concepts of Strategic Cost Analysis
EM 602	Management Science
EM 636	Project Management
HRM 601	Organizational Behavior
IE 673	Total Quality Management
MIS 648	Decision Support Systems

PROJECT OR THESIS (optional):

IE 700	Master's Project (3 credits:) ***or***
IE 701	Master's Thesis (6 credits:)

AREAS OF SPECIALIZATION:

For all areas of specialization, select 6 credits if completing a master's thesis; 9 credits if completing a master's project; 12 credits if not completing either a master's project or thesis.

Project Management:

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

Cost Engineering:

EM 632	Legal Aspects in Construction
EM 637	Project Control ***or***
IE 618	Engineering Cost and Production Economics
EM 691	Cost Estimating for Capital Projects
Fin 624	Financial Management

Technical Marketing:

EM 640	Distribution Logistics
EM 641	Engineering Procurement and Materials Management
Mrkt 631	Market Planning and Analysis
Mrkt 636	Design and Development of High Technology Products

Technological Entrepreneurship:

EM 634	Legal, Ethical and Intellectual Property Issues for Engineering Managers
Mgmt 620	Management of Technology
MnE 655	Concurrent Engineering
Mrkt 636	Design and Development of High Technology Products

Quality:

EM 674	Benchmarking and Quality Function Deployment
IE 605	Engineering Reliability

IE 672	Industrial Quality Control
MnE 654	Design for Manufacturability

Facility Management:

Arch 650	Economy of Building
EM 632	Legal Aspects in Construction
Fin 624	Financial Management
IE 653	Facility Maintenance

Manufacturing Systems Management:

MnE 601	Manufacturing Systems
MnE 602	Flexible and Computer Integrated Manufacturing
MnE 603	Management of Manufacturing Systems
MnE 655	Concurrent Engineering

Management Information Systems:

EM 655	Management Aspects of Information
IE 651	Industrial Simulation
IE 661	Man-Machine Systems
MIS 690	Executive Information Systems

Engineering Management:

EM 635	Management of Engineering Research and Development
EM 714	Multicriteria Decision Making
HRM 606	Human Resource Management
IE 618	Engineering Cost and Production Economics
MIS 645	Operations Management, Planning and Control
MnE 655	Concurrent Engineering

Engineering Science

Administered By: Office of the Dean, Newark College of Engineering

Administration

Program Director and Graduate Advisor	David Kristol Phone: (973) 596-3584 (Room 330 COL) Email: kristol@njit.edu

Faculty

Professors from Newark College of Engineering and College of Science and Liberal Arts, as appropriate

Degrees Offered: Master of Science 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.

Bridge Program: 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 courses will be individually-designed in consultation with the student's graduate advisor. Such courses are not counted toward degree requirements.

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.

REQUIRED:

15 credits, selected in consultation with graduate advisor: *6 credits* of 600-level mathematics *3 credits* of 600-level physics, chemistry, or biology *6 credits* of 600-level engineering courses

PROJECT OR THESIS (optional):

3 or 6 credits: selected in consultation with graduate advisor

ELECTIVE:

15 credits selected in consultation with graduate advisor

The elective credits must form a meaningful and coherent program integrated with the specialization in science or engineering.

Environmental Engineering

Administered By: Department of Civil and Environmental Engineering

Administration

Chairperson	John Schuring

Faculty

Professors	Chan, Dresnack, Golub, Hsieh
Associate Professors	Axe, Ding, Marhaba, Olenik
Graduate Advisor	Hsin-Neng Hsieh Phone: (973) 596-5859 (Room 219 COL) Email: hsieh@njit.edu

Degrees Offered: Master of Science in Environmental Engineering; Doctor of Philosophy in 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.

Bridge Program: Students who lack appropriate background are asked to make up deficiencies by taking a program of courses, including any prerequisites, that is designed in consultation with graduate advisors. See the undergraduate catalog for description of bridge courses. These courses are taken in addition to the degree requirements:

CE 320	Fluid Mechanics
CE 321	Water Resources Engineering
CE 322	Hydraulic Engineering
CE 501	Introduction to Soil Behavior
Chem 126	General Chemistry II
CIS 101	Computer Programming and Problem Solving (or equivalent)
Math 222	Differential Equations
Mech 234	Engineering Mechanics
Mech 236	Dynamics

Degree Requirements:

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.

Seminar: In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in EnE 791 Graduate Seminar.

REQUIRED:
12 credits as follows:

EnE 663	Water Chemistry
EnE 660	Introduction to Solid and Hazardous Waste Problems
EnE 661	Microbiology for Environmental Engineers

Graduate mathematics or computer science course approved by graduate advisor.

THESIS:
Required of those receiving departmental awards; elective for all others.

EnE 701	Master's Thesis (6 credits)

ELECTIVE:
Select 12 credits if completing a master's thesis; 18 credits if not completing a master's thesis, from:

CE 601	Advanced Remote Sensing
CE 602	Geographic Information System
CE 604	Environmental Modeling in Remote Sensing
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 610	Hazardous Site Operations
EnE 620	Environmental Chemodynamics
EnE 662	Site Remediation
EnE 664	Physical and Chemical Treatment
EnE 665	Biological Treatment
EnE 666	Analysis of Receiving Waters
EnE 667	Solid Waste Disposal Systems
EnE 668	Air Pollution Control
EnE 669	Water and Wastewater Analysis
EnE 670	Advanced Processes in Water Pollution
EnE 671	Environmental Impact Analysis
EnE 700	Environmental Engineering Master's Project
EnE 702	Special Topics in Environmental Engineering

Other suitable electives may be taken subject to approval of graduate advisor.

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. All international students must also achieve a minimum TOEFL score of 550.

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.

36 credits minimum of EnE 790 Doctoral Dissertation is generally required. These 36 credits should be completed before submission of the final dissertation document. Students must register for a minimum of 3 credits of EnE 790 until the dissertation has been submitted and accepted.

24 credits minimum of course work beyond the master's degree is required, of which at least 12 credits must be at the 700 level; the remaining credits may be at the 600 level.

Seminar: EnE 791 Graduate Seminar is required for all doctoral students every semester.

Preliminary Qualifying Examination: Full-time students must take the preliminary 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 preliminary 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 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.

Environmental Policy Studies

Administered By: Division of Policy Sciences

Administration

Division Director, Program Director	Nancy Jackson
Program Coordinator	Michele Collins Phone: (973) 596-3371 Email: eps@njit.edu

Faculty

Professors	Beaton
Associate Professors	Jackson
Assistant Professors	Cohen, Qiu
Affiliated Faculty	Bagheri, Katz, Kebbekus, Watts
Affiliated Faculty	Chou

Degrees Offered: Master of Science in Environmental Policy Studies, Ph.D. Environmental Science, policy concentration

The Master of Science in Environmental Policy Studies 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 foundation courses in geography, economics, ethics and policy. Application courses on economic modeling, geospatial analysis and applied ethics enable students to acquire skills in the tools and methods used in environmental problem solving and policy analysis. The core faculty is multidisciplinary with strengths in geography, economics, planning and ethics. Affiliated faculty have strengths in GIS, remote sensing, chemistry, engineering, and history. Graduates of the program have secured employment in both the public and private sectors including: U.S. Environmental Protection Agency, regional planning commissions, local community development programs, private engineering and planning firms, and software development corporations. Graduates have entered doctoral level programs in environmental science, history and law.

The Ph.D. in Environmental Science - policy concentration is offered jointly with the Department of Chemistry and Environmental Science at NJIT. 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 of Chemistry and Environmental Science and the Graduate Program in Environmental Policy Studies offers a research-oriented doctoral degree in Environmental Science with a concentration in Environmental Policy. The program emphasis is on the integration of the environmental and social science to develop more effective responses to resource problems. For more information about this program and the degree requirements please visit the Department of Chemistry and Environmental Science website.

MASTER OF SCIENCE IN ENVIRONMENTAL POLICY STUDIES

The program is designed to provide students the opportunity to acquire skills in the tools and methods used in environmental problem solving and policy analysis. The program may be completed on a part-time or full-time 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. geography, geology, meteorology), social sciences (e.g. economics, ethics, policy sciences), engineering (e.g. environmental, 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 575 or above.

Degree Requirements:

Students are required to complete a total of 30 graduate course credits: 18 credits of required Foundation courses and 12 credits of elective courses selected from Application courses. Students may elect to write a 6 credit thesis. All courses are three credits unless indicated.

CORE:

18 credits:

EPS 601	Research Design for the Social and Policy Sciences
EPS 612	Policy and the Environment
EPS 614	Economics of the Environment
EPS 622	Sustainable Development
EPS 638	Physical Geography
EPS 660	Ethics and Environmental Policy

THESIS OPTION:

EPS 701	Master's Thesis (6 credits)

APPLICATION COURSES:

Students must complete 12 credits of application courses. Those students that wish to pursue a master's thesis must complete 6 credits of application courses in addition to the thesis:

Students may select from courses in a number of different disciplines. The following is a partial listing of course offerings:

Environmental Policy Studies:

EPS 632	Econometrics for Environmental Policy
EPS 640	Applied Cost-Benefit Analysis for Environmental Policy
EPS 652	Applied Geomorphology
EPS 698	Special Topics in Environmental Policy
EPS 725	Independent Study I
EPS 726	Independent Study II

Environmental Science:

EvSc 612	Environmental Analysis
EvSc 613	Environmental Problem Solving
EvSc 614	Quantitative Risk Assessment
EvSc 621	Ecological Risk Assessment
EvSc 622	Bioremediation

Civil and Environmental Engineering:

CE 506	Remote Sensing of the Environment
CE 602	Geographic Information Systems
EnE 671	Environmental Impact Analysis
EnE 662	Site Remediation

Environmental Science

Administered By: Department of Chemistry and Environmental Science

Administration

Chairperson	Joseph W. Bozzelli
Graduate Advisors	Barbara Kebbekus, Som Mitra
Ada C. Fritz Professor of Environmental Engineering and Science	Joseph W. Bozzelli

Faculty

Distinguished Professors	Bozzelli, Venanzi
Professors	Grow, Gund, Kebbekus, Krasnoperov, Mitra
Associate Professor	Jackson
Assistant Professors	Cohen, Malhotra, Qiu
Research Professor	Iqbal
Special Lecturer	Skawinski

Rutgers-Newark Faculty

Professors	Axe, Kafkewitz, Weis
Associate Professor	
Assistant Professors	Hammerlynck, Hover, Slater

Federated Biology Faculty

Assistant Professors	Hahn

Degrees Offered: Master of Science in Environmental Science; Doctor of Philosophy in Environmental Science. Both degrees are offered jointly by NJIT and Rutgers-Newark.

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, 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 Hazardous Substance Management Research Center, the Northeast Hazardous Substance Research Center, the Particle Technology Center, and the Center for Membrane Technologies. Research grants involve collaborations with other universities including MIT, Princeton, Rutgers, UMDNJ, Utah, Karlsruhle (Germany), Bordeaux and Lille (France).

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.

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.

CORE:

15 credits:

EM 631	Legal Aspects in Environmental Engineering
EvSc 610	Environmental Chemical Science
EvSc 612	Environmental Analysis
EvSc 616	Toxicology for Engineers and Scientists

26:120:604 Microbiology: Principles and Applications

THESIS:

Required of those receiving departmental or research-based support; others may choose 6 credits of course work instead of thesis.

6 credits:

EvSc 701	Master's Thesis (6 credits)

ELECTIVE:

Courses are offered at NJIT and Rutgers-Newark and selected with the graduate advisor's (not thesis advisor's) approval.

9 credits if completing a master's thesis; 15 credits if not completing a master's thesis from:

26:120:551	Biology of Pollution
26:120:536	Multivariate Biostatistics
26:120:616	Topics in Biology
26:460:577	Seminar in Environmental Geology
CE 618	Applied Hydrogeology
ChE 685	Industrial Waste Control I
ChE 686	Industrial Waste Control II
ChE 687	Industrial Gas Cleaning
ChE 740	Biological Treatment of Hazardous Chemical Wastes
Chem 662	Air Pollution Analysis
Chem 664	Advanced Analytical Chemistry
EnE 660	Introduction to Solid Waste Problems
EnE 662	Site Remediation
EnE 664	Physical and Chemical Treatment
EnE 665	Solid Waste Disposal Systems
EnE 668	Air Pollution Control
EnE 671	Environmental Impact Analysis
EPS 613	Environmental Politics and Policy
EPS 614	Environmental Economics
EPS 660	Ethics and Environmental Policy
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	Master's Project
EvSc 702	Special Topics in Environmental Science II
EvSc 711	Advanced Environmental Analysis
EvSc 725	Independent Study I
EvSc 726	Independent Study II

IE 615	Industrial Hygiene and Occupational Health
ME 660	Noise Control
ME 661	Thermal Pollution of Water and Air
ME 662	Air Pollution Control and Design

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 and Degree 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.

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. A minimum of 36 credits of EvSc 790 Doctoral Dissertation, and registration every semester for EvSc 600 Environmental Science Seminar, are required. Should the 36 credits of EvSc 790 be completed before submission of the final dissertation document, students must register for a minimum of 3 credits of EvSc 790 per semester until it has been submitted and accepted. In addition, at least 24 credits of course work beyond the master's degree are required, of which 12 credits must be at the 700-level and chosen in consultation with the graduate advisor. No more than 6 credits may be in Independent Study (EvSc 725 or EvSc 726).

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.

Students must attain a minimum GPA of 3.0 in the required courses (EvSc 610, EvSc 612, EvSc 616, EM 631, and 26:120:604), and a minimum overall GPA of 3.0.

Admission and Degree 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.

Students must attain a minimum GPA of 3.0 in the required courses (EvSc 610, EvSc 612, EvSc 616, EM 631, and 26:120:604), and a minimum overall GPA of 3.0.

REQUIRED:

51 credits as follows:

26:120:604	Microbiology: Principles and Applications

EM 631	Legal Aspects in Environmental Engineering
EvSc 610	Environmental Chemical Science
EvSc 612	Environmental Analysis
EvSc 616	Toxicology for Engineers and Scientists

In addition, a minimum of 36 credits of EvSc 790 Doctoral Dissertation, and registration every semester for EvSc 600 Environmental Science Seminar, are required. Should the 36 credits of EvSc 790 be completed before submission of the final dissertation document, students must register for a minimum of 3 credits of EvSc 790 per semester until it has been submitted and accepted.

ELECTIVE:
27 credits as follows :

12 credits from 700-level courses chosen in consultation with the graduate advisor. No more than 6 credits may be in Independent Study(EvSc 725 or EvSc 726).

15 credits from any 600- or 700-level courses (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.

If students are unable to complete the requirements for the Ph.D. degree, they may become a candidate for the Master of Science in Environmental Science upon completion of requirements for that degree.

History

Administered By: Federated History Department of Rutgers-Newark and NJIT

Administration

Chairpersons	Richard Sher (NJIT), David Hosford (Rutgers-Newark)
Director, Graduate Programs (NJIT)	Jan E. Lewis Phone: (973) 353-5410 (ext. 15) Email: janlewis@andromeda.rutgers.edu
NJIT Graduate Coordinator	Neil Maher Phone: (973) 596-6348 Email: maher@njit.edu

NJIT Faculty

Distinguished Professor	R. Sher
Professor	O'Connor
Assistant Professors	Maher, D. Sher
Special Lecturer	Gumienny

Rutgers-Newark Faculty

Board of Governors Distinguished Service Professor	Price
Professors	Basch, Golden, Hosford, Hunczak, Lewis, Lurie, Samatar, Wou
Associate Professors	Carruthers, Cowans, Goodman, Russell, Satter
Assistant Professors	Caplan, Farney

Degrees Offered: Master of Arts in History, Master of Arts in Teaching (History). Both degrees are offered by NJIT and Rutgers-Newark.

Students interested in history of technology, environment and medicine should contact the graduate coordinator and apply to NJIT; students interested in American history, world history or the master's in teaching for history should contact the graduate programs director and apply to Rutgers-Newark.

The Federated History Department offers the master of arts 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 film, broadcasting, and print culture; 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.

Bridge Program: Students who lack appropriate undergraduate preparation for the program are required to make up deficiencies by taking a program of courses designed in consultation with the graduate advisor. Bridge courses are not counted toward degree credit.

Note: Students interested in history of technology, environment and medicine major field should apply to NJIT. Students interested in the American history or world history major field should contact the graduate programs director and apply to Rutgers-Newark.

Degree Requirements:

A minimum of 30 credits is required: 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 additional course work or a thesis. A comprehensive examination is also required. Students must have reading ability in a foreign language.

Seminar: In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll every semester in Hist 791 Seminar in History of Technology, Environment and Medicine.

Although faculty from NJIT and Rutgers-Newark teach in all three of the major fields offered, NJIT has primary administrative responsibility for history of technology, environment and medicine. Rutgers-Newark has primary administrative responsibility for the major fields in American history and world history.

History of Technology, Environment and Medicine is unique in its integration of three relatively new and increasingly important historical sub-disciplines. Their rapid growth in recent years reflects greater awareness among professional historians and the general public of the significance of broader issues concerning technology, the environment, and medicine in contemporary life. As these issues loom larger in the consciousness of society, so does the need to learn more about their historical origins, causes, and patterns of development. The department has a distinguished concentration of faculty in these areas, with particular strengths in American environmental history; urban environmental history; the social and cultural history of medicine and technology (including gender issues); military medicine; history of mental health; history of printing and communication; and technology and warfare.

American History Contact the graduate programs director for more information.

World History Contact the graduate programs director for more information.

The following is a sample curriculum for a student completing a major field of study in history of technology, environment and medicine. Those interested in completing a major in world history or American history should contact Rutgers-Newark for information.

MAJOR FIELD:
History of Technology, Environment and Medicine:

18 credits:

Hist 622	Culture and Science in the History of American Medicine
Hist 628	Gender, Science, and Technology in the Modern World
Hist 632	Technology, Culture and History
Hist 634	Environmental History of North America
Hist 635	History of Technology, Environment and Medicine: Theory and Method
Hist 638	Social History of Communication

MINOR FIELD:

6 credits of course work selected in consultation with a faculty advisor

THESIS (optional):

Hist 701	Master’s Thesis (6 credits)

ELECTIVE:

6 credits of course work if not completing a master’s thesis; selected in consultation with a faculty advisor

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 Rutgers Graduate School-Newark catalog for more information.

Industrial Engineering

Administered By: Department of Industrial and Manufacturing Engineering

Administration

Chairperson	Athanassios K. Bladikas
Associate Chairperson	George Abdou
Program Director	Sanchoy Das

Faculty

Professors	Abdel-Malek, Caudill, Das, Ranky, Sebastian, Tricamo, Wolf
Associate Professors	Abdou, Bengu, Bladikas, McDermott
Assistant Professors	Jeng, Yang
Graduate Advisor	Sanchoy Das Phone: (973) 596-3654 (Room 2513 GITC) Email: das@njit.edu

Degrees Offered: Master of Science in Industrial Engineering; Doctor of Philosophy in Industrial Engineering

The field of industrial engineering brings together the various sciences concerned with technology, the production of goods, performance of services and the way in which people work. Industrial engineers address the efficient utilization of resources to produce quality, as well as cost competitive goods and services in a healthy and efficient work environment. Industrial engineering covers a broad spectrum including production planning and control, manufacturing systems and processes, facilities design, human factors, occupational safety, quality control, systems reliability, and systems analysis and design with a strong emphasis on advanced computing.

MASTER OF SCIENCE IN INDUSTRIAL ENGINEERING

A program for individuals who seek professional advancement in the industrial engineering field.

Admission Requirements:

Applicants are expected to have an accredited undergraduate degree in industrial engineering or related fields. For further information, see Admissions in this catalog.

Bridge Program: Students who do not have a bachelor of science degree in industrial engineering may be admitted and required to complete the following bridge program. These courses do not count toward degree requirements:

EM 502	Engineering Cost Analysis
EM 602	Management Science
IE 501	Fundamentals of Industrial Engineering

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.

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.

CORE:

12 credits:

IE 604	Advanced Engineering Statistics

IE 618	Engineering Cost and Production Economics
IE 621	Systems Analysis and Simulation
IE 650	Advanced Topics in Operations Research

THESIS OR INDEPENDENT RESEARCH (optional):
The following optional courses are appropriate for all areas of specialization:

IE 701	Master's Thesis (6 credits) ***or***
IE 725	Independent Research (3 credits)

AREAS OF SPECIALIZATION:

The range of possible specializations is broad. Students should consult the graduate advisor in designing specializations and related degree requirements. The following is a list of possible specializations and suggested electives.

Courses are selected from an area of specialization with the approval of the graduate advisor as follows: 12 credits if completing a master's thesis, 15 credits if completing independent research, or 18 credits if not completing either a master's thesis or independent research.

Quality and Reliability Engineering:

EM 635	Management of Engineering Research and Development
EM 640	Distribution Logistics
IE 605	Engineering Reliability
IE 606	Maintainability Engineering
IE 608	Product Liability Control
IE 672	Industrial Quality Control
IE 674	Quality Maintenance and Support Systems
MnE 655	Concurrent Engineering

Cost Engineering:

EM 636	Project Management
EM 691	Cost Estimating for Capital Projects
EM 693	Managerial Economics
EM 771	Operations Cost and Management Control
IE 605	Engineering Reliability
IE 606	Maintainability Engineering
IE 618	Engineering Cost and Production Economics
IE 641	Operations Analysis
IE 651	Industrial Simulation
IE 653	Facility Maintenance
IE 672	Industrial Quality Control

Operations Research and Decision Sciences:

EM 714	Multicriteria Decision Making
IE 605	Engineering Reliability
IE 623	Linear Programming
IE 624	Heuristic Methods
IE 651	Industrial Simulation
IE 652	Facilities Location and Plant Layout
IE 672	Industrial Quality Control
IE 704	Sequencing and Scheduling
IE 705	Mathematical Programming in Management Science
IE 706	A Queuing Approach to Performance Evaluation

Human Factors/Ergonomics:

IE 605	Engineering Reliability
IE 614	Safety Engineering Methods
IE 615	Industrial Hygiene and Occupational Health
IE 665	Applied Industrial Ergonomics
IE 670	Industrial Work Physiology

IE 672	Industrial Quality Control
IE 675	Safety in Facility and Product Design
IE 760	Quantitative Methods in Human Factors Engineering
ME 660	Noise Control
ME 670	Introduction to Biomechanical Engineering
ME 671	Biomechanics of Human Structure and Motion
MnE 601	Manufacturing Systems
MnE 612	Robotic Manufacturing Systems

Production and Manufacturing Systems:

CIS 610	Data Structures and Algorithms
CIS 651	Data Communications
EM 655	Management Aspects of Information Systems
IE 618	Engineering Cost and Production Economics
IE 654	Design for Manufacturability
IE 655	Concurrent Engineering
ME 635	Computer-Aided Design
MnE 601	Manufacturing Systems
MnE 602	Flexible and Computer Integrated Manufacturing
MnE 603	Management of Manufacturing Systems
MnE 612	Robotic Manufacturing Systems

Service Systems:

CIS 632	Advanced Data Base System Design
EM 636	Project Management
HRM 606	Human Resource Management
IE 622	Simulation and Risk Analysis in Operations Management
IE 624	Heuristic Methods
IE 641	Operations Analysis
IE 651	Industrial Simulation
IE 652	Facilities Location and Plant Layout
IE 673	Total Quality Management
IE 674	Quality Maintenance and Support Systems
MIS 545	Management Information Systems

Systems Analysis:

CIS 505	Programming, Data Structures, and Algorithms
CIS 631	Data Management System Design
CIS 673	Software Design and Production Methodology
CIS 676	Requirements Engineering
EM 636	Project Management
EM 691	Cost Estimating for Capital Projects
IE 622	Simulation and Risk Analysis in Operations Management
IE 624	Heuristic Methods
IE 651	Industrial Simulation
IE 673	Total Quality Management
MnE 655	Concurrent Engineering

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.

Degree Requirements:

For students entering with an appropriate master's degree, a minimum of 60 degree credits is required as follows: 36 credits of dissertation and 24 credits of course work beyond the master's degree in an area of specialization, 12 credits of which must be at the 700 level and none at the 500 level. Of the 24 credits of course work, 12 credits are core courses and the other 12 credits are technical electives.

Registration for IE 791 Graduate Seminar is required each semester for all students.

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.

For students entering with bachelor's degrees, a minimum of 42 credits of course work and at least 36 credits of dissertation research is required.

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.

AREAS OF SPECIALIZATION:

Manufacturing Systems and Assurance Sciences:

CORE:

12 credits:

IE 704	Sequencing and Scheduling
IE 705	Mathematical Programming in Management Science
IE 706	A Queuing Approach to Performance Analysis
MnE 654	Design for Manufacturability

ELECTIVE:

12 credits, 3 credits of which must be at the 700 level and none at the 500 level
Courses selected from IE, ME, MnE, CIS, and Math.

Human Factors and Occupational Safety:
CORE:
12 credits:

IE 604	Advanced Engineering Statistics
IE 760	Quantitative Methods in Human Factors Engineering
IE 761	Advanced Studies in Human Factors
IE 762	Psychophysical Methods for Human Factors

ELECTIVE:
12 credits, 3 credits of which must be at the 700 level and none at the 500 level
Courses selected from IE, ME, MnE, CIS, and Math.

Information Systems

MSIS Program Web Site: http://is.njit.edu/msis/
Please check this site for any updates and additional information.

The field of Information Systems (IS) concerns the effective design and use of information technologies by individuals, groups and organizations. IS can be applied to many different areas, including support of business, science, engineering, community, social and education activities, both in the public and private sectors. Across all these areas, IS is broadly concerned with the effective use and integration of computing technologies into human endeavors; that is, with *human-centered* computing.

The study of Information Systems is based upon the concept that there is a growing body of knowledge on the relationships between people and computers that is independent of any specific application. Understanding of the total system involves both the human and the computing environment as an integrated whole. Students will master both the technology and the understanding of human behavior in the computing environment.

The MSIS program provides solid grounding in three principal areas, all of which are applicable to the areas described above:
- Systems analysis and software engineering
- Information and communication technologies
- Management of information systems

The program emphasizes the planning, investigation, design, development, application, management and evaluation of Information Systems. The program trains students to be integral members of application design and development teams.

The program also provides exposure to the state-of-the-art in IS research, so that students will be prepared to work with both emerging concepts and technologies. For students wishing to become directly involved in research, there are ample opportunities to participate in ongoing projects, as well as to write a master's thesis under faculty supervision. A number of master's-level courses are also included in the Ph.D. curriculum. The MSIS program is designed as a subset of the Ph.D. program in IS. The description here includes several notes for students considering continuing on with the Ph.D. program.

The program is offered both face-to-face and in a distance learning mode employing collaborative learning methods including team and project activities.

Admission Requirements:

The field of IS is broadly interdisciplinary. Applicants with degrees in any field are therefore welcome to apply for the MS IS 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.

Applicants with undergraduate degrees in Information Systems, Management Information Systems, Information Technology, Computer Science, Computer Engineering and similar areas usually are sufficiently prepared for entry. Requirements for entry include a working knowledge of the C++ programming language, at least one year of calculus, one course in calculus-based probability and statistics, and finally an additional advanced mathematics course such as discrete analysis.

Applicants must have a GPA of 3.0 or higher in their prior academic work. (Applicants not meeting this requirement, but who have significant work experience since their last degree may be considered on an individual basis.)

Applicants without a prior undergraduate or master’s degree from the United States must submit GRE, GMAT or MCAT scores for admission.

Bridge Program:

Computer and Information Systems Technology:

* CIS 505	Programming, Data Structures, and Algorithms (teaches C language programming; required for remaining bridge courses)
CIS 332	Principles of Operating Systems
CIS 350	Computers and Society
CIS 431	Database System Design and Management
CIS 465	Advanced Information Systems

Mathematics:

Math 111	Calculus I
Math 112	Calculus II
Math 226	Discrete Analysis
Math 333	Probability and Statistics

Students must get a B in all CIS bridge courses, and no grade lower than a C in the others.

Students without an excellent command of English may be required to take specific written and spoken English courses.

Final determination of bridge requirements can only be made from the examination of a completed formal application folder. Applicants with prior coursework covering the bridge topics should attach a note to their application clearly showing which courses correspond to these bridge requirements, if possible.

Off-Campus Programs: At the NJIT at Mount Laurel branch campus and 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 **Information Assurance, Internet Applications Development or Telecommunications Networking** 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.

Important Note: Students assigned to bridge courses or English courses must take these courses before taking before taking 600- and 700-level graduate courses. It is possible, however, to sign up for graduate courses (i) in the final semester in which bridge courses are taken and (ii) when prerequisites delay taking of a particular bridge course.

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* Note that CIS 505 is a concentrated, advanced level programming course. It is equivalent to CIS 113 and CIS 114 , and students may choose to take these two courses instead.

Degree Requirements:

The student is required to take 36 credits (12 courses).

The course planning form, posted on the MSIS Web site, lays out much of the information in this program description. Students should use it to plan out their courses for the MS IS degree. They should bring this (or email it) to the Program Director whenever they wish to discuss their progress.

The required courses are:

IS Core Courses (6 courses/18 credits)

All six IS core courses are required:

	CIS 677	Information Systems Principles
	CIS 663	Systems Analysis and Design
	CIS 675	Research Methods for Information Systems
**	CIS 679	Management of Information Systems
	CIS 634	Information Retrieval
	CIS 658	Multimedia Systems

We recommend that students start taking the core courses immediately. Note that one must take CIS 677 before CIS 675 or CIS 679.

Electives (6 courses/18 credits):

The remaining six courses are electives. All CIS courses at the 600- and 700-level are valid electives.

MS IS students may take no more than 2 non-CIS courses total. Not all courses at NJIT are valid electives. Be sure the check the Non-CIS Electives list on the MSIS website to determine which courses are valid electives! (Students with a CS or IS academic background or with several years work experience in IS or CS will be informed as part of the application process that they may take up to four courses outside the CIS area.) Students must have written approval from the IS Advisor to take more than two courses outside CIS.

Non-seminar CIS 785 and CIS 786 (special topics), and IS- or CS- related independent study courses in any department count as CIS electives, but are not mandatory.

We encourage Masters students doing well in the program to take electives at the 700-level.

******* *Students planning to continue with the IS Ph.D. program may take up to four non-CIS courses after gaining written approval from their MS IS Advisor. They also should check the Ph.D. program requirements and consider taking specific required courses as MS IS elective. They are advised to take as many 700-level courses as possible.*

Masters Project and Masters Thesis

We strongly encourage students to consider a one-semester Masters Project (CIS 700) or two-semester masters Thesis (CIS 701). The masters project provides the opportunity to apply knowledge and skills to develop an application system or solve a complex problem. The thesis option extends the project by conducting publishable research in the project area. Both courses count as IS electives, and are not mandatory for graduation.

**** Students planning to continue with the IS Ph.D. program may not take a CIS 700 implementation project for Ph.D. credit. Similarly, only 3 credits of CIS 701 will count towards the IS Ph.D. program. If you are doing a different kind of masters project or thesis, then please check with the Ph.D. program coordinator regarding Ph.D. credit.*

While we encourage people to partake in NJIT's Cooperative Program , it does not count as IS elective credit.

For further details, please see http://is.njit.edu/msis/

** Students who have taken CIS 455 as an undergraduate are not required to take CIS 679 and may substitute an elective CIS course.

AREAS OF SPECIALIZATION:

Select one of the following areas and choose two of the courses listed in that area. The student is responsible for checking with the program director to determine if the necessary course prerequisites have been met.

Interdisciplinary Information Systems:

The application of information systems in fields such as the physical or social sciences, engineering, the arts, humanities, and public administration.

6 credits from:

HRM 601	Organizational Behavior ***or***
HRM 655	Theory and Research in Organizational Behavior
Mgmt 691	Legal, Ethical and Privacy Issues in Computing ***or***
Eng 603	Cultural and Technological Change
IE 661	Human Design Factors in Engineering

Management Information Systems:

Traditional business and commercial applications of information systems.

6 credits from:

Acct 610	Internal Auditing Concepts and Procedures ***or***
Acct 615	Concepts of Strategic Cost Analysis
Fin 624	Financial Management
HRM 601	Organizational Behavior ***or***
HRM 655	Theory and Research in Organizational Behavior
Mrkt 631	Market Planning and Analysis ***or***
Mrkt 632	Marketing Strategy for Technology-Based Organizations

Electronic Enterprise Design:

The use of information systems methodologies and methods for redesigning organizations employing modern information technology and concepts.

6 credits from:

CIS 676	Requirements Engineering
CIS 634	Information Retrieval
CIS 684	Business Process Innovation ***or***
CIS 762	Computerized Information Systems for Planning and Forecasting

Multimedia Communication:
Use of multimedia data with regard to development, presentation, utilization and understanding by individuals and organizations.

6 credits from:

Eng 604	Communication Theory
Eng 605	Document Design and Electronic Publishing
Eng 610	Creating Hypertext Projects: A Task-Oriented Approach
Eng 613	Multimedia Presentations

Biomedical Informatics:
Application of information systems in the biomedical and health areas. Biomedical informatics is also available as a master`s and a doctoral degree. See "Biomedical Informatics" in the Degree Programs section of this catalog.

6 credits from:

BINF 602/BINF 5020	Biomedical Modeling and Decision-Making Systems
BINF 603/BINF 5030	Visualization in Biomedical Sciences
BINF 621/BINF 5210	Research Methods in Health Sciences

Students considering earning a doctorate or who are already enrolled in the Ph.D. in Computer and Information Science program in the information systems specialization should consider the following Rutgers-Newark courses for the area of specialization.

Interdisciplinary Information Systems:

26:620:555	Seminar in Organizational Behavior
26:620:556	Seminar in Organizational Theory
26:620:671	Management of Innovation and Technology
26:620:677	Culture and Organizations

Evaluation Methods and Tools:

26:630:660	Qualitative Research Methods
26:630:668	Causal Modeling
26:960:577	Introduction to Statistical Linear Models

Data Analysis and Modeling Tools:

26:630:576	Quantitative Methods in Marketing
26:630:625	Clustering Analysis
26:711:585	Control Models

ELECTIVES:
18 credits chosen from one or more elective areas. A minimum of two courses is required from any single area selected. The following are some representative specialty areas available in the computer and information science department. The student may propose any specialty set of courses desired including up to two additional courses in other departments. There are many possible specialty areas possible. Choices should be approved by the program director.

Advanced Information Systems Design:

CIS 634	Information Retrieval and Data Mining
CIS 658	Multimedia Systems
CIS 676	Requirements Engineering
CIS 684	Business Process Innovation
CIS 731	Applications of Database Systems

CIS 732	Design of Interactive Systems
CIS 735	Computer Mediated Communication Systems
CIS 762	Computerized Information Systems for Planning and Forecasting
CIS 767	Decision Support Systems

Information Systems Supporting Technology:

CIS 601	Object-Oriented Programming
CIS 602	Java Programming
CIS 610	Data Structures and Algorithms
CIS 631	Database Management System Design
CIS 635	Programming Languages
CIS 652	Computer Networks
CIS 661	Simulation

Communications and Networking:

CIS 651	Data Communications
CIS 652	Networks Architectures, Protocols, and Standards
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols

Artificial Intelligence, Expert Systems, and/or Knowledge-Based Systems:

CIS 670	Artificial Intelligence
CIS 671	Knowledge-Based Systems
CIS 672	Expert System Methods and Design
CIS 674	Natural Language Processing

Ph.D. in Computer Science

Bridge Program:

Applicants are expected to have backgrounds in computer science and mathematics equivalent to the bridge program courses listed below. Students who lack this background may be admitted and required to take these courses and attain a cumulative GPA of 3.0.

CIS 251	Computer Organization
CIS 332	Principles of Operating Systems
CIS 333	Introduction to UNIX Operating System
CIS 505	Programming, Data Structures, and Algorithms
CIS 510	Assembly Language Programming and Principles
Math 111	Calculus I
Math 112	Calculus II
Math 211	Calculus III
Math 226	Discrete Analysis
Math 333	Probability and Statistics

Core Requirements:

All Ph.D. Students are required to take qualifying examinations in the following areas:

CIS 610	Data Structures and Algorithms
CIS 611	Computability and Complexity
CIS 665	Algorithmic Graph Theory

Concentration Areas:

A Ph.D. 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.

Biomedical Informatics:

CIS 631	Data Management System Design
CIS 632	Advanced Database System Design
CIS 634	Information Retrieval
CIS 665	Algorithmic Graph Theory

CIS 667	Design Techniques for Algorithms
CIS 670	Artificial Intelligence
CIS 678	Medical Terminologies
CIS 734	Data Mining
BIOL 601	Foundations of Computational Biology
	Other 600/700-level courses as approved by advisor.

Computer Algorithms and Theory of Computing:

CIS 610	Data Structures and Algorithms
CIS 611	Introduction to Computability and Complexity
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 668	Parallel Algorithms
CIS 669	Computational Geometry
IE 704	Sequencing and Scheduling
	Other 600/700-level courses as approved by advisor.

Computer Systems, and Parallel and Distributed Processing:

CIS 630	Operating System Design
CIS 633	Distributed Systems
CIS 636	Compiling System Design
CIS 637	Real-Time Systems
CIS 650	Computer Architecture
CIS 668	Parallel Algorithms
CIS 750	High Performance Computing
ECE 658	VLSI Design I
ECE 758	VLSI Design II
ECE 689	Digital System Design for Machine Arithmetic
ECE 785	Parallel Processing Systems
	Other 600/700-level courses as approved by advisor.

Databases, Data Mining, and Knowledge-Based Engineering:

CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 632	Advanced Database System Design
CIS 634	Information Retrieval
CIS 658	Multimedia Systems
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 670	Artificial Intelligence
CIS 671	Knowledge-Based Systems
CIS 731	Applications of Database Systems
CIS 734	Data Mining
	Other 600/700-level courses as approved by advisor.

Image Processing and Computer Graphics:

CIS 630	Operating System Design
CIS 632	Advanced Database System Design
CIS 657	Principles of Interactive Computer Graphics
CIS 659	Image Processing and Analysis
CIS 665	Algorithmic Graph Theory
CIS 667	Design Techniques for Algorithms
CIS 682	Geometric Modeling
CIS 759	Advanced Image Processing and Analysis
CIS 780	Computer Vision
CIS 782	Pattern Recognition and Applications
ECE 601	Linear Systems
ECE 643	Digital Image Processing I
ME 635	Computer-Aided Design
	Other 600/700-level courses as approved by advisor.

Networking and Security:

CIS 604	Client/Server Computing
CIS 630	Operating System Design
CIS 651	Data Communications

CIS 652	Computer Networks-Architectures, Protocols and Standards
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 696	Network Management and Security
CIS 697	Principles of Broadband ISDN and ATM
CIS 741	Communication Network Design
CIS 752	Communication Protocol Synthesis and Analysis
	Other 600/700-level courses as approved by advisor.

Software Engineering:

CIS 601	Object-Oriented Programming
CIS 610	Data Structures and Algorithms
CIS 611	Introduction to Computability and Complexity
CIS 630	Operating System Design
CIS 635	Computer Programming Languages
CIS 636	Compiling System Design
CIS 641	Formal Languages and Automata
CIS 667	Design Techniques for Algorithms
CIS 673	Software Design and Production Methodology
CIS 676	Requirements Engineering
CIS 683	Object-Oriented Software Development
CIS 688	Programming for Interactive Environments
	Other 600/700-level courses as approved by advisor.

Systems Analysis, Simulation and Modeling:

CIS 605	Discrete Event Dynamic Systems
CIS 621	Numerical Analysis I
CIS 622	Numerical Analysis II
CIS 630	Operating System Design
CIS 631	Data Management System Design
CIS 637	Real-Time Systems
CIS 651	Data Communications
CIS 654	Telecommunication Networks Performance Analysis
CIS 661	Systems Simulation
CIS 662	Model Analysis and Simulation
CIS 741	Communication Network Design
	Other 600/700-level courses as approved by advisor.

DOCTOR OF PHILOSOPHY IN MANAGEMENT (Computer Information Systems Major only)

Administered By: Department of Computer and Information Science

contact Computer Information Systems Major Program Coordinator and Advisor: Murray Turoff (973) 596-3366 (Room 4106 GITC), e-mail turoff@vc.njit.edu

Ph.D. in Information Systems

Objectives:

The program in Information Systems is designed to produce scholars who possess a commanding knowledge of the nature of Information Systems, applications of and research on Information Systems, and the supporting technology in Computer Science.

The program seeks to develop individuals who can expand both the practice and theory of information systems for complex applications and/or organizational environments. It deals with integrated information, computer and communication systems that support and augment individuals and groups in any field of application: management, business, engineering and manufacturing, health and medicine, education, social sciences, arts and humanities, etc.

There have been dramatic developments in information systems, computing technology, economics, and related social sciences which have substantially affected the underlying methodological and scientific frameworks of business. The area of information systems has shown explosive growth as organizations have become increasingly complex, electronically integrated, and interdependent.

Graduates will be prepared for research, teaching, and/or practice in this field. The program also emphasizes the behavioral and organizational context of computer-based information systems, their requirements, design, implementation, user acceptance, management, and the evaluation of their effectiveness and consequences.

The program is designed to attract students from different disciplinary backgrounds and encourages an interdisciplinary approach to the concepts of information system design, utilization, and evaluation. It provides students with the ability to analyze and organize the information needs and resources of an application environment and to design and develop systems to respond to those needs.

Students are expected, as a result of the program, to be able to advance the state of the art of knowledge in information systems. They are prepared for research and/or development activities in either academia or industry. They are expected to be able to deal with the evolution and creation of systems to handle new application areas.

An outstanding student with a Bachelors or Masters in any field may apply and be accepted, conditional on accomplishing an appropriate set of bridge courses to make up necessary pre-requisites or knowledge deficiencies in such areas as Computers and Mathematics.

Program Admission Requirements:

A student seeking admission to this Doctor of Philosophy program must satisfy the following minimum admission requirements.

Students must have successfully completed a baccalaureate program from an accredited institution.

Submit:

1. Resume of Experience and Background (This should include details of experience, knowledge, and skills with respect to computer technology and information systems.)

2. Transcripts of academic record; GPA should be 3.5 or better on a 4.0 scale.

3. Three letters of recommendation by persons familiar with the student's academic work and/or related work experience

4. GRE, GMAT, or MCAT scores. The normal minimum GRE total score is 1850.

International students must demonstrate proficiency in the English language by scoring a minimum score required by the university (which is currently 550) on the TOEFL exam. However, those seeking support must demonstrate a level of spoken and written English proficiency sufficient for teaching activities (600 or over on the TOEFL). Students may be admitted below the minimum score but will be required to take English and retake the TOEFL to prove proficiency.

Applications should include documented aptitude, interest in and commitment to scholarly activities and research. This may be demonstrated by quality of papers or projects completed by the student or employee, and/or letters of recommendation by individuals qualified to judge your professional performance.

In addition, applicants must have demonstrated superior performance in the following areas/courses or their equivalents. Applicants who have not met all these course requirements prior to admission, may be provisionally accepted and then complete these requirements while in the program. Those seeking support must have satisfied this knowledge requirement.

Table of Undergraduate Prerequisites or demonstrated knowledge :

IS Technical Background				
Mathematics:	Calculus: two semesters Post Calculus Probability &Statistics Course Discrete Math Methods Course			
Computing:	Four undergraduate courses in Computer Science in such areas as programming, data structures, data bases, software engineering, communications, etc.	Appropriate work experience may be applicable to satisfying part or all of this requirement.	A working knowledge of one development oriented computer language such as C++ or JAVA.	Computers and Society may be required if no similar course has been taken.

Admission to Candidacy Requirements:

Admission to the doctoral program does not imply candidacy for a degree. To be admitted to

candidacy, the student must::

1. Qualifying exams The student must take the qualifying exam which will cover the IS core area. Full time Ph.D. students usually take the exam within 18 months of matriculation; e.g., if they enter in September of 2000, they should plan to take the exam by January of 2002. The exam is given every January, and if needed, in June.

Students will be provided with a reading list of all course materials that they are responsible for in the four courses involved in the qualifying exam. The objective of the qualifying exam is to determine if the student has mastered the basic knowledge in the field of Information Systems.

2. Maintain a grade average of 3.5 (B+) or better in the core courses. No graduate course may have a grade of less than B and count toward candidacy, this includes potential transfers. A grade of B or better in each core course is required in order to take the qualifying exam.

3. Successfully complete courses in Computing Systems technical foundations. Credits may be utilized for these requirements, with the approval of an advisor, from a prior master's degree, if the courses match these requirements.

4. Choose a Research Specialty within Information Systems that will be the focus of the Ph.D. dissertation. A total of at least 12 courses will be needed for this Specialty area; up to two may be Independent Study or the IS Ph.D. seminar, CCS788. At least 5 of these must be at the 700 level. Up to four may be in an application area track, for which credit may be applied from a previous master's degree, with the approval of the advisor.

5. Develop a state of the art paper in your specialty area under the guidance of a faculty member. The State of the Art Paper will usually form the basis for one or more publications and for the student's subsequent dissertation proposal. The state-of-the-art paper, once approved by the advisor, will be submitted to an exam committee approved by the program director but including the student's advisor. The examination committee will determine the nature of any additional comprehensive exam after careful review of the state-of-the-art paper.

After fulfilling these requirements, the student will be a candidate for the doctoral degree with all work but the dissertation completed (ABD).

6. Dissertation Proposal and Dissertation

This comprises the original research leading to a dissertation and demonstrating the student's ability to conceive and carry out independent research.

Six (6) credits of Pre-doctoral research allow the student to identify a research problem and to prepare a proposal for solving the problem in the dissertation. The proposal must be in writing and be defended orally in the presence of a formal review committee before it is accepted. The student is expected to successfully pass the proposal defense within a period of two (2) years after passing the qualifying examination. The committee, chaired by the student's research advisor, will contain at least four (4) faculty members, with at least one (1) committee member from outside CIS. The outside member may be from other institutions or industry provided he or she is currently engaged in relevant research. It is expected this committee will later become the thesis committee.

Dissertation and Defense:

At least twenty-four (24) credits of dissertation research is required. After the research is completed, the dissertation will be defended at an open meeting of the NJIT faculty, in the presence of the dissertation committee.

However, if the student does not successfully complete the dissertation within a period of four years after passing the qualifying examination, the student's ABD status will be removed and the state of the art paper must be redone and the examination must be taken and passed again to restore that status.

Summary of Academic credit requirements:

Area	Courses	Credits
IS & CS Core		24
Advanced courses: Application area and Research Specialty	12	36
		6
Thesis Research		24
Total	20	90

Those entering with a Masters degree are required to complete a minimum of 24 additional course credits. However, they must also satisfy the candidacy requirements. Up to 36 credits may be transferred from a Master's degree if the courses are appropriate for satisfying the Ph.D. requirements. The transferability of credits for specialty area courses must have the approval of both the program director and the student's research specialty advisor.

Other Requirements:

7. Participation in the Ph.D. IS graduate seminar for at least 4 semesters or credits (CIS 787/788).

8. Teaching or assistance in teaching at least one course in Information Systems or a related area, under the supervision of a faculty member.

9. Submission of at least one research paper for publication in a peer reviewed conference or journal.

10. Submission of the final draft of the dissertation in the format required by the university, with signed approvals of the dissertation committee.

Should twenty-four (24) credits of dissertation research be completed before submission of the final copy of the dissertation and its acceptance by the department, it will be necessary for the student to register for a minimum of six (6) additional dissertation credits per year until the dissertation has been submitted and accepted. The oral examination will be given only after the submission of the final draft of the dissertation.

We encourage part time students to take part in this program but most thesis advisors will require a full time effort after successful completion of the qualifying exam, during the period when the dissertation proposal is being developed and the dissertation research begun.

Many of the courses are available in distance mode, but a period of on campus study will be necessary to complete advanced courses and dissertation proposal requirements.

Core Requirements:

An extensive foundation of twelve courses (36 credits) which are intended to establish a core of expertise in computing, information systems, and management is required: four courses in Computing Sciences tools and methodologies; four courses in Information Systems; and four courses in an application area or environment. Most of these courses are already core courses or options in the MS in Information Systems. The Ph.D. student is expected to maintain a B+ average in the 12 core courses.

Computing Sciences Tools and Methodologies:

To ensure a strong technical foundation, Ph.D. students should choose four courses (to be selected from at least four of the five areas below); MS students should choose a minimum of two courses (selected from at least two of the five areas). Additional courses from this list can be included as electives.

Programming languages and Methodologies: CIS 601, CIS 602, CIS 603, CIS 604, CIS 635, CIS 683

Database Design: CIS 631, CIS 632, CIS 731

Communications and Networks: CIS 633, CIS 651, CIS 652, CIS 654, CIS 656, CIS 696, CIS 697, CIS 741

Artificial Intelligence: CIS 670, CIS 671, CIS 672, CIS 674

Simulation: CIS 605, CIS 661, CIS 662

Information Systems Core:

CIS 663 Advanced Systems Analysis (OR, for those who entered before fall 2002, CIS 673 Software Design and Production Methodology)

CIS 677 Information System Principles

CIS 675 Information System Evaluation

CIS 679 Management of Computer and Information Systems

Advanced Courses (12 courses, 36 credits):

At least five of these courses must be at the 700 level.

A. (Optional)Application Environment or "Track":

A student program of study may support an application area with a two to four-course concentration of courses focusing on a specific type of information systems environment. The courses are usually taken outside an area of IS or CS, and must be approved by the Ph.D. advisor This may be a specific application area for Information Systems or an interdisciplinary area that supports the development of improved Information systems. Those entering the program with a masters may have satisfied this requirement as part of their master's degree. Areas that might be included are any management area, health and medical applications, sciences, advanced analysis, engineering, etc. Alternatively, the student may concentrate all advanced courses within the College of Computing Sciences.

Examples of four-course concentrations or "application track" areas include:

Management Track (two to four of the following):
FIN 624 Financial Management

HRM 601 Organizational Behavior or HRM 655 Theory and Research in Organizational Behavior or 26:620:555 Theory and Research in Organizational Behavior (Rutgers)

MRKT 631 Market Planning and Analysis or MRKT 632 Marketing Strategy for Technology Based Organizations or 26:630:576 Quantitative Methods in Marketing (Rutgers)

ACCT 610 Internal Auditing Concepts and Procedures or ACCT 615 Concepts of Strategic Cost Analysis

Management IS Track (two to four of the following):
MIS 645 Operations Management, Planning, and Control

MIS 655 Information Systems Audit, Control and Security

MIS 665 Electronic Commerce

Mgmt 630 Design Analysis, or Mgmt 685 Operations Research and Decision Making, or EM 714 Multicriteria Decision Analysis, or MIS 648 Decision Support Systems, or MIS 690 Executive Information Systems

MIS 654 Design of Accounting Information Systems

Industrial Engineering Track (two to four of the following):
EM 636 Project Management

IE 621 Systems Analysis and Simulation

IE 661 Man-Machine Systems, or IE 669 Human Design Factors in Engineering

IE 760 Quantitative Methods in Human Factors, or IE 761 Advanced Studies in Human Factors, or IE 762 Psychophysical Methodsin Human Factors

Multimedia Communications (two to four of the following):
ENG 604 Communication Research and Theory

ENG 605 Electronic Publishing and Design

ENG 613 Multimedia Presentations

ENG 710 Creating Hypertext Projects: A Task Oriented Approach

Biomedical Informatics (Courses offered at UMDNJ):
BINF 5010 Bioinformatics Database Systems

BINF 602/BINF5020 Biomedical Modeling and Decision Making Systems

BINF 603/BINF5030 Visualization in Biomedical Sciences

BINF 621/BINF5210 Research Methods in Health Sciences

IS Research Methods Track:
HRM 655 Theory and Research in Organizational Behavior or 26:620:555 Theory and Research in Organizational Behavior (Rutgers)

MGMT 760 Research Methods and Multivariate Analysis or 26:960:577 Introduction to Statistical Linear Models (Rutgers) or 26:630:576 Quantitative Methods in Marketing (Rutgers)
- An Advanced Qualitative Research Methods course from NJIT or Rutgers

- One additional advanced research methods course For a list of "pre-approved" graduate courses outside of the College of Computing Sciences that may be applied towards graduate degrees in IS, please follow the "quick link" from http://is.njit.edu/msis/. The student and advisor may also design a custom "application track."

B. Research Area Studies:

Upon successful completion of the qualifying examinations the student must select a research specialty area under the approval of an advisor. These 24 to 30 credits (8-12 courses, depending on the number of application track courses) must constitute a coherent body of knowledge in support of the student's expected area of specialization and research. This may include courses eligible for transfer credit from a prior program beyond the Bachelor's. This planned program of study will be filed with the program director, but may be changed later with the consent of the advisor. It should be updated at least once every academic year. Course choices must be focused and include both the beginning and advanced course or courses in a given topic.

State of the Art Paper and Comprehensive Exam:

The state of the art paper is a product the student works on with an advisor towards the end of the period when he or she is taking the 36 credits of advanced study. It focuses on summarizing the students' command and understanding of the current research issues and activity in the specialty area and important related findings from all of the coherent set of courses in the advanced study. The student may include in the advanced study an independent study or seminar course (CIS 776) with the advisor to allow for the compilation of the State of the Art paper under the advisor's guidance.

The State of the Art Paper will usually form the basis for the student's subsequent dissertation proposal. It will summarize literature in the specialty area, carefully exposing related research areas from relevant topics making up the specialty area. The objective of this requirement is to insure the student has obtained a solid understanding of the research issues in the chosen area of study. Full time students should plan to complete the state of the art paper within one semester of passing the qualifying examination on the IS core areas; e.g., if the student takes the qualifying exam in January 2002, he or she should complete the state of the art paper by September of 2002.

The state-of-the-art paper, once approved by the advisor, will be submitted to an exam committee approved by the program director but including the student's advisor, who will also make recommendations as to other members. The examination committee will determine the nature of any additional comprehensive exam after careful review of the state-of-the-art paper.

Dissertation Proposal and Dissertation:

This comprises the original research leading to a dissertation and demonstrating the student's ability to conceive and carry out independent research.

Dissertation Proposal and Defense:

The purpose of the six (6) credits of Pre-doctoral research is to allow the student to identify a research problem and to prepare a proposal for solving the problem in the dissertation. The proposal must be in writing and be defended orally in the presence of a formal review committee before it is accepted. Our objective is to have the full time student successfully defend the dissertation proposal approximately one year after passing the qualifying exam; e.g., if the student takes the exam in January 2002, he or she should try to defend a dissertation proposal by the spring semester of 2003. Students entering with only a bachelor's degree or who are attending part time may take somewhat longer. In any case, the student is expected to successfully pass the proposal defense within a period of two (2) years after passing the comprehensive examination.

The thesis proposal review committee will be made formal when the student has passed the comprehensive examination. The committee, chaired by the student's research advisor, will contain at least four (4) faculty members, with at least one (1) committee member from outside the CIS department. The outside member may be from other institutions or industry provided he or she is currently engaged in relevant research. The members of the committee will be appointed by the student's research advisor with the agreement of the student and the Program Director. It is expected this committee will later become the thesis committee.

Dissertation and Defense:

With the approval of the dissertation proposal, the student may conduct research under the guidance of the research advisor. At least twenty-four (24) credits of dissertation research is also required. However, if the student does not complete the dissertation within the twenty-four (24) credits, the student must continue to register for at least three (3) credits of dissertation research each semester until the dissertation is accepted by the dissertation committee as completed. After the research is completed, the dissertation will be defended at an open meeting of the NJIT faculty, in the presence of the dissertation committee.

The formal dissertation committee will be formed after the student has successfully defended the dissertation proposal. The purpose of the dissertation committee is to guide the student to carry out high quality research and to evaluate the student's progress during the research. The primary dissertation research advisor must be a member of the tenure-track faculty of CIS. The Committee, chaired by the student's research advisor, will contain at least four(4) faculty members and at least one(1) committee member from outside of NJIT. The members of the committee will be nominated by the student's research advisor for the Ph.D. Program director's approval. The Ph.D. Program director will formally appoint the examination committee.

Dismissal from the Program:

Any student failing any part of the qualifying examination or comprehensive examination including the state-of- the-art paper, or any course work may petition the Ph.D. Program Director for a second try presenting, in conjunction with the Program Director, a plan for rectifying any deficiencies. The student may be required to retake the entire examination or only selected parts. The plan to rectify deficiencies may require the completion of additional course work.

Students failing the qualifying examination or comprehensive examination, including advanced course work, a second time will be dismissed from the program. Students may be denied permission to take a second qualifying examination or comprehensive and be dismissed from the program. Students failing the qualifying examination, comprehensive examination, or advanced course work may, with the approval of the department, elect to complete all requirements for the master's degree in Information Systems or the masters degree in Computer Science provided they do not already have such a degree.

Part-time students:

The program welcomes part time students. A great many of the required courses are being offered in a distance learning mode as well as the normal face to face offerings.

It should be recognized that after completing the courses and exams and entering the phase of dissertation work most Ph.D. students need to invest a minimum full time effort for six months to a year to insure success.

Industry Collaborative Doctor of Philosophy:

Individuals currently engaged in relevant research areas in industry or other organizations should check the Industry Collaborative Doctor of Philosophy program (See Graduate Catalog) offered by NJIT which allows the waver of residency requirements and more specific tailoring of requirements.

Admissions &Support:

Outstanding full time Ph.D. students are encouraged to apply for support. There may be either Teaching Assistantships or Research Assistantships available. Current minimum requirements for consideration for support are GRE scores of 2100 or above, a GPA of 3.7 or above, and work experience or outstanding accomplishments. However, a student accepting such an appointment will be asked to sign a commitment to pay back the tuition part of their Assistantship if they choose to leave the program for a full time job before becoming ABD. This does not apply when the student is asked to leave the program for poor performance or in the case of medical reasons. The forms for applying for the above programs may be obtained from the Office of University Admissions (NJIT, University Heights, Newark NJ 07102, Tel: 973 596 3300), Forms for admission also appear on the NJIT website (http://www.njit.edu). A non refundable fee is required with the actual application for admission. Those seeking work experience credit for admission prerequisites for technical knowledge in computers should include in the application package a detailed resume with specific details of various related job experiences.

Program Director for IS Ph.D. Degree:

Those interested in the Ph.D. in Information Systems who have specific questions may contact the program director Starr Roxanne Hiltz (Email: hiltz@adm.njit.edu, homepage: http://eies.njit.edu/~hiltz/). However, it is impossible to express (before the complete application is reviewed) any specific opinions about admission, support, and or transfer credits. If you do wish to visit, please arrange via email first and/or check on office hours with the department secretaries (973-596-3366). There are no office hours during the summer.

Other Information:

The **NJIT web site** is http://www.njit.edu and one may find there web pages for the College of Computing Science Information Systems Department and the **School of Management.** One can at those sites, and related ones, learn about the faculty, many of the courses and some of the current research taking place. Applications for graduate admission may be found at the web site for the **NJIT Office of Admission.**

Related Programs:

NJIT currently offers M. S. degree in Computer Science and the M. S. degree in Information Systems through the Department of Computer and Information Science. In addition an M. S. degree in Management offered by the School of Management includes concentrations in both Information Systems Management and Information Systems Auditing. The IS degrees at the master levels train individuals to be part of application development teams and to posses a high degree of computer skills for the development of applications. The management degrees are meant to train managers knowledgeable in the utilization of computers in a commercial organization but do not require the same degree of technical capability.

There is also a B. S. in Computer Science and a B. A. in Information Systems offered by the CIS Department at NJIT. While these are adequate preparatory programs for entering the Masters or Ph.D. program in Information Systems, they are not the only path that may be taken.

The M. S. in Information Systems is a subset of the requirements for the Ph.D. program and the student who is unsure about a full commitment to a Ph.D. program should consider that option. Also one may obtain the M. S. in IS along the way to the Ph.D. in IS.

There is also a Ph.D. in Biomedical Informatics offered jointly by NJIT and UMDNJ, New Jersey's University of the Health Sciences. Students may enroll with either NJIT or UMDNJ. The NJIT enrolled students are required to meet the requirements for the IS Ph.D. with only slight differences. They may also obtain the NJIT MS in Information Systems as part of this program.

The CIS department also offers the Computer Information System concentration in the Ph.D. in Management offered by the Rutgers Graduate School of Management at the Rutgers Newark campus. Ph.D. Students have the right to choose their research areas and advisors. This is explained in the referenced IS policy document on student rights.

Infrastructure Planning

Administered By: New Jersey School of Architecture

Administration

Program Director and Graduate Advisor	Antonio de Souza Santos Phone: (973) 596-3078 (Room 349 WES) Email: mip@admin.njit.edu
Associate Program Director	Darius Sollohub
Graduate Program and Admissions Coordinator	Fred Little

Faculty

Distinguished Professor	Mostoller
Professors	Celik, Dresnack, Ehrenkrantz, Elliot, Franck, Gauchat, Goldman, Hawk, Papademetriou, Santos
Associate Professors	Greenfeld, Schuman
Assistant Professors	Anyanwu, Mouskos

Degrees Offered: Master in Infrastructure Planning

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 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.

Degree Requirements:

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:

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; degree credits are in parentheses.

Semester 1:

MIP 601	Interdisciplinary Infrastructure Studio I (6)
MIP 612	Introduction to Environmental Policy Studies (3)
MIP 615	Introduction to Transportation Studies (3)
MIP 631	History and Theory of Infrastructure (3)
MIP 675	Elements of Infrastructure Planning (3)

Semester 2:

MIP 602	Interdisciplinary Infrastructure Studio II (6)
MIP 618	Public and Private Financing of Urban Areas (3)
MIP 652	Geographic Information Systems (3)
MIP 655	Land Use Planning (3)
MIP 673	Infrastructure Planning in Practice (3) ***or***
MIP 674	Infrastructure and Architecture (3)

Internet Engineering

Administered By: Department of Electrical and Computer Engineering (ECE).

Administration

Graduate Advisor	Prof. Nirwan Ansari Phone: (973) 596-3670 Email: Nirwan.Ansari@njit.edu

Degrees Offered: MASTER OF SCIENCE IN INTERNET ENGINEERING

The objective of this program is to educate students in the field of internet engineering, with emphasis on computer internetworking and relevant applications.

MASTER OF SCIENCE IN INTERNET ENGINEERING

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. 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 Math 333 (Probability and Statistics), or EE 321 (Random Signal and Noise), or another equivalent course; EE 333 (Signals and Systems); and CIS 112 (Introduction to Computing or equivalent proficiency in C++ programming).

Bridge Program: The curriculum requires a basic knowledge of computer and communications fundamentals, such as signals and systems (EE 333), basic communication systems (EE 481), programming (CIS 112 or C++ programming), data structures and algorithms (CIS 505), and computer organization (CoE 251). The bridge courses are usually selected from this list, but some additional bridge courses, appropriate to each student's background, may be required.

Degree Requirements:

Candidates must complete a minimum of 30 credits, 9 in core courses and 21 in elective 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.

Core Courses (9 Credits):

ECE 637	Introduction to Internet Engineering
ECE 683	Computer Network Design and Analysis
CIS 602	Java Programming

*** Electives (21 Credits):

Select 15 credits if completing a master's thesis; 18 credits if completing a master's project; 21 credits if not completing either a master's project or a thesis.

ECE 673	Random Signal Analysis
ECE 685	Computer Network Interface Design
ECE 638	Security & Network Management
ECE 639	Principles of Broadband ISDN and ATM
ECE 649	Compression in Multimedia Engineering
ECE 645	Wireless Networks
ECE 636	Computer Networking Laboratory
CIS 604	Client/Server Computing
Mgmt 620	Management of Technology
MIS 625	Management Strategies for E-Commerce
MIS 636	Telecommunications: Policies & Regulations

ECE 783	Computer Communication Networks
ECE 745	Advanced Wireless Networks
ECE 738	Communications Network Routing
ECE 788	Selected Topics in Internet Engineering

Project, Thesis (optional):

ECE 700	Master's Project in Internet Engineering (3 Credits)
ECE 701	Master's Project in Internet Engineering (6 Credits)

*** Other (new) courses related to Internet Engineering may be selected as electives with approval from the Graduate Advisor.

Management

Administered By: School of Management

Administration

Dean	Mark Somers
Associate Dean	Barbara Tedesco
Sponsored Chairs	Alok Chakrabarti (management of technology), Murray Turoff(Hurlburt Professor), William Rapp (Henry J. Leir Chair in International Business)
Director, Executive Program	Frank Koe Phone: (973) 642-7499 (Room 3008 CAB) Email: Koe@adm.njit.edu
Director, Graduate Program	Stuart Lipper Phone: (973) 596-6378 (Room 3006 CAB) Email: lipper@njit.edu

Faculty

Distinguished Professors	Chakrabarti, Kirchhoff, Turoff+
Professors	Hasan, Hawk++, Lawrence, Rotter, Schachter, Somers, Spasovic
Associate Professors	Anandarajan, Bonitsis, Cordero, Fjermestad, Gopalakrishnan, Mehta, Sylla
Assistant Professors	Gagnon, Kudyba, Schneider
Visiting Professors	Gurstein, Sau
Special Lecturers	Bogui, Dine, Patten, Walsh
Professional/Instructional Staff	Casal

\+ Joint appointee with the Department of Computer and Information Science

++ Joint appointee with the School of Architecture

Degrees Offered: Master of Business Administration in Management of Technology; Master of Science in Management; Ph.D. in Management

MASTER OF BUSINESS ADMINISTRATION IN MANAGEMENT OF TECHNOLOGY

NJIT's MBA in the Management of Technology is designed to prepare students for the challenges ahead by providing students with the knowledge and the skills to achieve success. The MBA curriculum focuses on the major sectors in the field of Management in order to provide students with a thorough understanding of how to approach the challenges they will face every day in the business world. Topics covered in the core management courses include accounting, marketing, human resources management, finance, economics, and information technology. NJIT’s focus on the Management of Technology provides students with the skills necessary to compete in this new, knowledge-based economy and trains students to recognize new trends and integrate emerging technology into business solutions. Recognizing the impact of the Internet and the field of Electronic Commerce on businesses of the future, the School of Management has established a specialization in E-Commerce as part of the Master of Business Administration in the Management of Technology. Students may also choose to specialize in Infrastructure Management, Financial Management, Management Information Systems, Operations Management or Transportation and Logistics.

Admission Requirements:

Prerequisite to the degree program is a common body of knowledge of management disciplines: managerial accounting, managerial economics, finance, management information systems, operations research and marketing. Students with satisfactory grades in undergraduate course in these areas are not required to take them again. Students are required to complete the GMAT prior to being accepted into the program; however, students with a master’s degree or higher from an accredited U.S. institution are not required to take the GMAT. A student may transfer up to nine credits from a graduate program from another school, providing they were not used to obtain another degree.

Off-Campus Programs: At Howmedica Corporation, Chubb Institute, National Starch and Chemical Corporation, Raritan Valley Community College and Telcordia Technologies, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see Extension Programs in this catalog. In addition, there are 12-credit graduate certificates in Business Management Fundamentals, Management of Technology and Pharmaceutical Management. See Graduate Certificates for more information on these programs. 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; email cpe@njit.edu.

Degree Requirements:

Students must complete a minimum of 48 degree credits, accumulated in four different areas—Fundamental Management Knowledge (27 credits), Managing Data-Centric Organizations (6 credits), Managing Technology and Technological Change (6 credits) and an area of concentration that requires 9 credits. Students who lack the appropriate Management background may be required to take up to 12 credits of basic bridge courses in marketing, MIS, finance or economics.

BRIDGE: MANAGEMENT BACKGROUND COURSES:

ECON 565	Managerial Economics
FIN 516	Principles of Financial Management
MIS 545	Management of Information Systems
MRKT 530	Principles of Marketing

MODULE 1: FUNDAMENTAL MANAGEMENT KNOWLEDGE (27 credits):

ACCT 615	Management Accounting
FIN 600	Financial and Economic Environment
FIN 624	Financial Management
HRM 601	Organizational Behavior
MRKT 620	Competing in Global Markets
MIS 680	Management Science
MGMT 645	Managing I.T. for Competitive Advantage
MGMT 660	Managing Supply and Value Chains
MGMT 680	Entrepreneurial Strategy ***or***
MGMT 692	Strategic Management

MODULE 2: MANAGING DATA-CENTRIC ORGANIZATIONS (Choose two courses for 6 credits):

MIS 648	Decision Support Systems for Managers
MGMT 635	Data Mining and Analysis for Managers
MGMT 650	Knowledge Management
MGMT 710	Forecasting Methods for Business Decisions

MODULE 3: MANAGING TECHNOLOGY AND TECHNOLOGICAL CHANGE (Choose two courses for 6 credits):

HRM 630	Managing Technological and Organizational Change
MGMT 620	Management of Technology
MGMT 676	Managing the Digital Firm
MGMT 710	Electronic Communities in Organizations

MODULE 4: CONCENTRATIONS (Choose one area):

Electronic Commerce (choose 3 courses):

MIS 620	E-Commerce Technologies
MIS 625	Management Strategies for E-Commerce
MIS 635	Telecommunications Management
MGMT 676	Managing the Digital Firm
MGMT 690	Electronic Communities in Organizations
MRKT 645	Internet Marketing Strategies

Financial Management (choose 3 courses):

Fin 626	Financial and Investment Institutions
Fin 627	International Finance
Fin 631	Working Capital Management and Credit Analysis
Fin 632	Financial Valuation of Technology-Based Companies
Fin 634	Mergers, Acquisitions, and Restructuring

MGMT 630	Decision Analysis

Management Information Systems (choose 3 courses):

MIS 625	Management Strategies for E-commerce
MIS 635	Telecommunications Management
MIS 690	Executive Information Systems
CIS 631	Data Management and Systems Design
CIS 632	Advanced Database Systems Design
CIS 675	Information Systems Evaluation
EM 636	Project Management
MGMT 630	Decision Analysis

Infrastructure Management (choose 3 courses):

ARCH 650	Economy of Building
ARCH 651	Real Estate Analysis
ARCH 652	Architectural Project Management
EM 636	Project Management
HRM 605	Managing High Performance Work Teams

Operations Management (choose 3 courses):

IE 674	Quality Maintenance and Support Systems
MGMT 630	Decision Analysis
MNE 601	Manufacturing Systems
MNE 602	Flexible and Computer Integrated Manufacturing
MNE 603	Management of Manufacturing Systems

Transportation and Logistics (choose 3 courses):

MGMT 630	Decision Analysis
MGMT 710	Business Forecasting Methods
TRAN 603	Introduction to Urban Transportation Planning
TRAN 740	Management of Transportation Carriers
TRAN 765	Multi-level Freight Transportation Systems Analysis

The Master of Science in Management

The Master of Science in Management is a diverse graduate program that offers students an unusual opportunity to specialize in a variety of Management and Information Systems areas, or in the specialist programs in Electronic Commerce and Organization Management. Courses are offered at NJIT's Newark campus, as well as at extension campuses. The School also offers an extensive evening and weekend schedule.

Usually consisting of 15 credits, each specialization offers students broad flexibility in completing their academic requirements. In addition, they may meet course requirements by completing 15 credit hours of core courses. The core courses (totaling 15 credits) are chosen from a wide variety of subjects including organizational behavior, financial management and accounting and business strategy. If there is sufficient demand, at least one course in each area of specialization will be available during the summer. In addition, up to 12 credits may be required as background courses to provide students with an understanding of fundamental management issues, including courses on economics, financial management, management information systems, and marketing.

Admission Requirements:

Prerequisite to the degree program is a common body of knowledge of management disciplines: managerial accounting, managerial economics, finance, management information systems, operations research and marketing. Students with satisfactory grades in undergraduate course in these areas are not required to take them again. Students are required to complete the GMAT prior to being accepted into the program; however, students with a master's degree or higher from an accredited U.S. institution are not required to take the GMAT. A student may transfer up to nine credits from a graduate program from another school, providing they were not used to obtain another degree.

Degree Requirements:

Students must complete a minimum of 30 degree credits: 15 credits of core Management courses and 15 credits in the area of specialization. Students who lack the appropriate Management background may be required to take up to 12 credits of basic bridge courses in marketing, MIS, finance or economics.

MANAGEMENT BACKGROUND COURSES (Bridge courses):

Econ 565	Managerial Economics
Fin 516	Principles of Financial Management
MIS 545	Management Information Systems
Mrkt 530	Principles of Marketing

MANAGEMENT CORE:

Acct 615	Management Accounting
Fin 624	Financial Management
HRM 601	Organizational Behavior
Mrkt 620	Competing in Global Markets
MGMT 680	Entrepreneurial Strategy ***or***
MGMT 692	Strategic Management

SPECIALIZATIONS:

Management Information Systems:

Required

MIS 645	Managing Information Technology for Competitive Advantage
MIS 648	Decision Support Systems for Managers

Electives (9 credits)

CIS 631	Data Management and Systems Design
CIS 632	Advanced Database Systems Design
CIS 671	Management of Computer and Information Systems
CIS 675	Information Systems Evaluation
CIS 679	Network Management and Security
EM 636	Project Management
MGMT 650	Knowledge Management

Electronic Commerce:

Required

MIS 620	E-Commerce Technologies
MIS 625	Management Strategies for E-Commerce

Electives (9 credits)

CIS 652	Computer Networks-Architectures, Protocols and Standards
CIS 656	Internetworking and Higher Layer Protocols
CIS 679	Network Management and Security
CIS 688	Programming for Interactive Environments
MGMT 635	Data Mining and Analysis for Managers
MGMT 690	Electronic Communities in Organizations
MRKT 645	Internet Marketing Strategies

Organization Management:

Required

HRM 605	Managing High Performance Work Teams
HRM 606	Human Resource Management

Electives (9 credits)

HRM 610	Seminar on Leadership Skills
HRM 630	Managing Technological and Organizational Change
HRM 640	Seminar in Cultures in Organizations
HRM 685	Cross Cultural Management Issues
MGMT 650	Knowledge Management
MGMT 690	Electronic Communities in Organizations

Manufacturing Systems Engineering

Administered By: Department of Industrial and Manufacturing Engineering

Administration

Chairperson	
Associate Chairperson	George Abdou
Program Director	Sanchoy Das

Faculty

Professors	
Associate Professors	Abdou, Bengu, Bladikas, McDermott
Assistant Professor	Jeng, Yang
Graduate Advisor	Sanchoy Phone: (973) 596-3654 (Room 2513 GITC) Email: das@njit.edu

Degrees Offered: Master of Science in 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.

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.

Bridge Program: Students who lack appropriate undergraduate preparation for the program are required to make up deficiencies by taking a program of courses that are designed in consultation with graduate advisors. These courses are taken in addition to the degree requirements and may include undergraduate courses.

Degree Requirements:

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 Manufacturing Engineer Seminar.

CORE:

12 credits:

MnE 601	Manufacturing Systems
MnE 602	Flexible and Computer Integrated Manufacturing
MnE 603	Management of Manufacturing Systems
MnE 654	Design for Manufacturability

PROJECT, THESIS, INDEPENDENT STUDY (optional):

The following optional courses are appropriate for all areas of specialization:

MnE 700	Master's Project (3 credits)
MnE 701	Master's Thesis (6 credits)
MnE 725	Independent Study in Manufacturing (3 credits)

AREAS OF SPECIALIZATION:

The range of possible specializations is broad. Students should consult the program director in designing specializations and related degree requirements. Some examples follow.

Design for Manufacturability:

18 credits from:

CE 736	Finite Element Methods in Structural and Continuum Mechanics
IE 675	Safety in Facility and Product Design
ME 620	Stress Methods in Mechanical Design
ME 621	Energy Methods in Mechanical Design
ME 622	Finite Element Methods in Mechanical Engineering
ME 635	Computer-Aided Design
ME 636	Mechanism Design: Analysis and Synthesis
MnE 655	Concurrent Engineering

System Automation:

18 credits:

CIS 651	Data Communications
CIS 652	Computer Networks — Architecture, Protocols and Standards
ECE 686	Instrumentation Systems and Microprocessors
ME 638	Computer-Aided Machining
ME 735	Advanced Topics in Robotics
MnE 612	Robotic Manufacturing System

Computer Control of Manufacturing Systems:

18 credits from:

ECE 601	Linear Systems
ECE 660	Control Systems I
ECE 664	Discrete-Time Control Systems
ECE 666	Control Systems II
IE 624	Heuristics Methods
ME 655	Introduction to Modern Control Methods
ME 755	Adaptive Control Systems

Manufacturing Systems Analysis and Design:

18 credits from:

CIS 631	Data Management System Design
CIS 651	Data Communications
ECE 683	Computer Network Design and Analysis
IE 616	Planning and Control of Products and Processes
IE 621	Systems Analysis and Simulation
IE 622	Simulation and Risk Analysis in Operations Management
IE 651	Industrial Simulation
IE 652	Facilities Location and Plant Layout
MnE 655	Concurrent Engineering

Management of Manufacturing Systems:

18 credits from:

EM 602	Management Sciences
EM 635	Management of Engineering Research and Development
EM 636	Project Management
EM 640	Distribution Logistics

EM 653	Facility Maintenance
EM 660	Financing an Industrial Enterprise
EM 691	Cost Estimating of Capital Projects
EM 771	Operations Cost and Management Control
IE 618	Engineering Cost and Production Economics
IE 673	Total Quality Management
IE 674	Quality Maintenance and Support Systems

Materials Science and Engineering

Administered By: Committee for the Interdisciplinary Program in Materials Science and Engineering

Administration

Acting Program Director and Graduate Advisor	Ken K. Chin Phone: (973) 596-3297 (Room 466 TIE) Email: chin@admin.njit.edu

Degrees Offered: Master of Science in Materials Science and Engineering; Doctor of Philosophy in Materials Science and Engineering

The interdisciplinary M.S. and Ph.D. in Materials Science and Engineering programs focus on the properties and applications of modern engineering materials, bridge academic research and industrial development, and serve New Jersey's technology-intensive economy. Three areas of specialization are emphasized: electronic and photonic materials, polymer and biomaterials, and composite and structural materials.

MASTER OF SCIENCE IN MATERIALS SCIENCE AND ENGINEERING

This degree program is intended for individuals with a strong background in science and/or engineering.

Admission Requirements:

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.

Bridge Program: Students who lack appropriate undergraduate preparation for the program may be admitted and required to make up deficiencies by taking a program of 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.

Degree Requirements:

Candidates must complete a minimum of 30 credits, including 12 credits of required materials science courses and 18 credits in an area of specialization, which are selected in consultation with the 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.

REQUIRED:

9 credits:

MtSE 605	Fundamentals of Engineering Materials
MtSE 610	Mechanical Properties of Materials
MtSE 630	Thermodynamics of Materials

3 credits from:

CE 635	Fracture Mechanics of Engineering Materials
Chem 640	Polymer Chemistry
ME 675	Mechanics of Fiber Composites
Phys 687/26:755:687	Physics of Materials

PROJECT OR THESIS:

Required of all students receiving program or research-based awards; optional for all others.

MtSE 700	Master's Project (3 credits) *or*
MtSE 701	Master's Thesis (6 credits)

AREAS OF SPECIALIZATION:

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 below.

Electronic and Photonic Materials:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis, from:

Chem 611	Solid-State Inorganic Chemistry
Chem 626	Chemistry of Contemporary Materials
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
MtSE 615	Composite Materials
MtSE 625	Introduction to Ceramics
MtSE 627	Glass Science and Engineering
MtSE 702	Characterization of Solids
MtSE 737	Transport of Electrons and Phonons in Solids
MtSE 757	Defects in Solids
MtSE 765	Science and Technology of Thin Films
Phys 661/26:755:661	Solid-State Physics
Phys 667/26:755:667	Modern Experimental Techniques for Materials Processing and Characterization
Phys 762/26:755:762	Electronic Structure of Solids
Phys 763/26:755:763	Surface and Interface Physics
Phys 771/26:755:771	Quantum Electronics
Phys 781/26:755:781	Physics of Advanced Semiconductor Devices
Phys 789/26:755:789	Physics of Advanced Semiconductor Device Processing

Polymer and Biomaterials:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis, from:

BME 669	Quantitative Physiology for Engineers
BME 672	Biomaterial
ChE 627	Introduction to Biomedical Engineering
Chem 640	Polymer Chemistry
Chem 643	Polymer Laboratory I
Chem 645	Polymer Laboratory II
Chem 661	Instrumental Analysis

Biochemistry:

ECE 667	Systems Studies in Bioengineering
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
MtSE 615	Composite Materials
MtSE 625	Introduction to Ceramics
MtSE 702	Characterization of Solids
MtSE 737	Transport of Electrons and Phonons in Solids
MtSE 757	Defects in Solids
MtSE 765	Science and Technology of Thin Films

Courses in metallic biomaterials and polymeric biomaterials offered at UMDNJ and courses in biosciences offered at Rutgers-Newark may be taken as electives. See the graduate advisor for information about these courses and registration.

Composite and Structural Materials:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis, from:

CE 631	Advanced Reinforced Concrete Design
CE 632	Prestressed Concrete Design
CE 634	Structural Dynamics
CE 635	Fracture Mechanics of Engineering Materials
CE 636	Stability of Structures
Chem 611	Solid-State Inorganic Chemistry
Chem 654	Corrosion
Chem 655	Electrochemistry: Principles and Applications
Chem 661	Instrumental Analysis
Math 661	Applied Statistics
Mech 540	Advanced Strength of Materials
Mech 630	Theory of Elasticity
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
ME 776	Dynamics of Polymeric Liquids
ME 785	Theory of Deformable Solids in Mechanical Engineering I
ME 786	Theory of Deformable Solids in Mechanical Engineering II
MtSE 615	Composite Materials
MtSE 625	Introduction to Ceramics
MtSE 627	Glass Science and Engineering
MtSE 650	Physical Metallurgy
MtSE 655	Diffusion and Solid State Kinetics
MtSE 702	Characterization of Solids
MtSE 725	Crystallography and Diffraction
MtSE 757	Defects in Solids
Phys 667/26:755:667	Modern Experimental Techniques for Materials Processing and Characterization

DOCTOR OF PHILOSOPHY IN MATERIALS SCIENCE AND ENGINEERING

This is a 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, polymer and biomaterials, and composite and structural materials.

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.

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: 24 credits of course work, 12 of which must be at the 700 level and none at the 500 level, and no less than 12 are materials science and engineering or related courses. A minimum of 36 credits of doctoral dissertation research is required. 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 or related 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.

REQUIRED:

For those entering with a master's degree:

24 credits of course work beyond the master's degree

36 credits of MtSE 790 Doctoral Dissertation

MtSE 791	Graduate Seminar, every semester

For those entering with a bachelor's degree:

9 credits:

MtSE 605	Fundamentals of Engineering Materials
MtSE 610	Mechanical Properties of Materials
MtSE 630	Thermodynamics of Solids

3 credits from:

CE 635	Fracture Mechanics of Engineering Materials
Chem 640	Polymer Chemistry
ME 675	Mechanics of Fiber Composites
Phys 687/26:755:687	Physics of Materials

30 credits of course work beyond the master's degree core requirements listed above

36 credits of MtSE 790 Doctoral Dissertation

MtSE 791	Graduate Seminar, every semester

Qualifying Examination: The student must pass a written and an oral qualifying examination. The written qualifying exam 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.

Formation of Dissertation Committee: Within six months 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.

Mathematics

Administered By: Department of Mathematical Sciences

Administration

Chairperson	Daljit S. Ahluwalia
Associate Chairperson	Robert M. Miura
Director(Undergraduate Program)	
Director(Statistics Program)	Manish C. Bhattacharjee
Director(Graduate Program)	Demetrius T. Papageorgiou
Departmental Coordinator	Padma Gulati

Faculty

Foundation Chair	Kriegsmann
Distinguished Professors	Aubry[*], Goldberg, Kriegsmann
Professors	Ahluwalia, Andrushkiw, Bhattacharjee, Blackmore, Lacker[**], Levy, Luke, Milojevic, Miura[**], Papageorgiou, Perez, Stickler, Tavantzis
Associate Professors	Bechtold, Booty, Bose, Bukiet, Chase, Dhar, Dios, Golowasch[‡], Kappraff, Katzen, Kondic, Lieb, Michalopoulou[†], Nadim[‡], Petropoulos, Plastock, Siegel, Sran
Assistant Professors	Berliner, Connell, Elmer, Goldman[**], Goodman, Horntrop, Lott, Matveev, Muratov, Raymond, Tao
Special Lecturer	Ratnaswamy
Lecturers	Abdeljaber, Berkowitz, Hunter, Mohebbi, Talwar, Zaleski
Post Doctoral Fellows	Baran, Volkov
Research Professors	Booth, Erneux, Mauri, Spencer, Vanden-Broeck

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† Joint appointee with the Department of Electrical and Computer Engineering

‡ Joint appointment with the Federated Department of Biology

* Joint appointment with Department of Mechanical Engineering

** Joint appointment with Department of Biomedical Engineering

Degrees Offered:

Master of Science in Applied Mathematics
Master of Science in Applied Statistics
Doctor of Philosophy in 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, collects and interprets data in order 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 3.0 on a 4.0 scale or equivalent is normally required. Submission of GRE scores is encouraged but not required. However, GRE scores are required for those students applying for financial support. Applications are considered on a case-by-case basis.

Bridge Program: 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 courses that may include undergraduate courses before proceeding to the graduate curriculum. Such courses do not count towards a graduate degree.

Degree Requirements:

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.

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.

CORE:

15 credits:

	Math 613	Advanced Applied Mathematics I: Modeling
	Math 631	Linear Algebra
***	Math 645	Analysis I
	Math 656	Complex Variables I
	Math 689	Advanced Applied Mathematics II: ODEs

PROJECT, THESIS (optional):

ME 700	Master’s Project (3 credits)
ME 701	Master’s Thesis (6 credits)

*** Students specializing in applied mathematics or computational mathematics may take Math 545 Advanced Calculus I and Math Math 546 Advanced Calculus II , instead of Math 645 and 3 credits of elective.

REQUIRED COURSES IN AREAS OF SPECIALIZATION:

6 credits:

Analysis:

Math 745	Analysis II
Math 756	Complex Variables II

Appied Mathematics:

Math 614	Numerical Methods I
Math 690	Advanced Applied Mathematics III: PDEs

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

ELECTIVE:
9 credits selected with approval of graduate advisor.

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. Courses offered by appropriate departments at NJIT, UMDNJ, 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.

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 3.0 on a 4.0 scale or equivalent is normally required. Submission of GRE scores is encouraged but not required. However, GRE scores are required for those students applying for financial support. 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.

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.

CORE:
21 credits:

Math 611	Numerical Methods for Computation ***or***
Math 630	Linear Algebra and Applications
Math 644	Regression Analysis Methods
Math 646	Time Series Analysis
Math 661	Applied Statistics
Math 662	Probability Distributions
Math 664	Methods for Statistical Consulting
Math 762	Statistical Inference

PROJECT, THESIS (optional):

ME 700	Master's Project (3 credits)
ME 701	Master's Thesis (6 credits)

ELECTIVE:
9 credits selected with approval of 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. Students are encouraged to choose courses in application areas. Courses offered by appropriate departments at NJIT, UMDNJ, 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.

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 (i) solving modern scientific, technological and industrial problems, and (ii) 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, nonparametric 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.

Degree Requirements:

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

Math 599	Teaching in Mathematics
Math 613	Advanced Applied Mathematics I
Math 631	Linear Algebra
Math 645	Analysis I

Semester II

Math 614	Numerical Methods I
Math 656	Complex Variables I

Math 689	Advanced Applied Mathematics II
Math 745	Analysis II

Semester III

Math 671	Asymptotic Methods I
Math 690	Advanced Applied Mathematics III
Math 712	Numerical Methods II
Math 756	Complex Variables II

Semester IV

Math 676	Advanced Ordinary Differential Equations
Math 707	Advanced Applied Mathematics IV: Special Topics
Math 713	Advanced Scientific Computing
Elective	Course from Natural Sciences or Engineering Relevant to Student's Interests

In addition to these courses, there are advanced courses in:

asymptotic methods
calculus of variations
computational neuroscience
mathematical biology
probability
statistics.

Also, there are special topics courses in:

electromagnetics
fluid dynamics
integral equations
materials science
mathematical biology
microwave processing of materials
wave propagation.

Qualifying Examination: The qualifying examination for the applied mathematics track consists of three components: Analysis, Linear Algebra - Numerical Methods, and Applied Mathematics. Students must achieve a grade of A in each component to pass the qualifying examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Analysis and Linear Algebra - Numerical Methods (August and January), Applied Mathematics (January and May).

The following courses will be useful in helping the students to prepare for the qualifying examinations : Math 645, Math 656, and Math 745 for Analysis; Math 614 and Math 631 for Linear Algebra – Numerical Methods; and Math 613, Math 689, and Math 690 for Applied Mathematics. It should be noted that taking the above courses are 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 these examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. Within six months of passing the qualifying examination a dissertation committee must be formed according to the regulations specified in this catalog.

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.

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

Math 599	Teaching in Mathematics
Math 631	Linear Algebra
Math 645	Analysis I
Math 662	Probability Distributions

Semester II

Math 644	Regression Analysis Methods
Math 668	Probability Theory
Math 745	Analysis II
Math 762	Statistical Inference

Semester III

Math 646	Time Series Analysis
Math 699	Design and Analysis of Experiments
Math 707	Special Topics (Linear Models)
Math 786	Large Sample Theory and Inference

Semester IV

Math 664	Methods for Statistical Consulting
Math 698	Sampling Theory
Math 787	Nonparametric Statistics
Math 761	Statistical Reliability Theory and Applications

Qualifying Examination: The qualifying examination for the applied probability and statistics track consists of three components: Analysis, Linear Algebra, and Statistics. Students must achieve a grade of A in each component to pass the qualifying examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Real Analysis - Probability; Linear Algebra - Distribution Theory and Statistical Inference (August and January); Topics in Statistics (January and May).

The following courses will be useful in helping the students to prepare for the qualifying examinations : Math 645, Math 668, and Math 745 for Real Analysis and Probability; Math 631, Math 662, and Math 762 for Linear Algebra, Distribution Theory and Statistical Inference; Math 644, Math 699, and Math 707 (Linear Models) for Topics in Statistics. The scope of the "Topics in Statistics" examination may include additional advanced courses in statistics that the students may have taken. It should be noted that taking the above courses are 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 these examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. Within six months of passing the qualifying examination a dissertation committee must be formed according to the regulations specified in this catalog.

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.

Students interested in the Pure Mathematics track should contact the Department of Mathematics and Computer Science at Rutgers-Newark.

Mechanical Engineering

Administered By: Department of Mechanical Engineering

Administration

Chairperson	Nadine N. Aubry
Associate Chairperson	
Associate Chairperson for Graduate Studies	Rajpal Sodhi

Faculty

Distinguished Professors	Altenkirch, Aubry (F. Leslie and Mildred Jacobus Chair)
Professors	Chen, Dave, Fischer, Geskin, Harnoy, Koplik, Rosato
Associate Professors	Dreizin, Dubrovsky, Florio, Ji, Khusid, Narh, Singh, Sodhi
Assistant Professors	Rao, Zhu
Special Lecturers	Giorgioni, Kountouras, Serico, Surjanhata

Degrees Offered: Master of Science in Mechanical Engineering; Doctor of Philosophy in 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, 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 accredited 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.

Bridge Program: Students who lack appropriate undergraduate preparation may be admitted and 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 may include undergraduate courses.

** **Degree Requirements:**

The program shown below offers numerous areas of specialization, each with its own list of required and elective courses. Once the specialization is chosen, 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.

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.

PROJECT, THESIS:

Thesis is required of all students who receive departmental or research-based awards. For all others, a project or thesis is optional.

ME 700	Master's Project (3 credits)
ME 701	Master's Thesis (6 credits)

** **AREAS OF SPECIALIZATION:**

The range of possible areas of specialization is broad. Students should consult with the graduate advisor in designing specialization and related degree requirements. With the approval of the advisor, students may take courses from other departments to enhance areas of specialization after completion of 12 credits in mechanical engineering. Some example areas of specialization and the courses for each follow. The number of elective credits for each area of specialization will vary according to the number of required course credits and also if a student enrolls in ME 700 or ME 701.

Biomechanical Engineering:

REQUIRED:

15 credits:

ME 616	Matrix Methods in Mechanical Engineering
ME 620	Stress Methods in Mechanical Design
ME 622	Finite Element Methods in Mechanical Engineering
ME 635	Computer-Aided Design
ME 671	Biomechanics of Human Structure and Motion

ELECTIVE:

Select 9 credits if completing a master's thesis; 12 credits if completing a master's project; 15 credits if not completing either a master's project or thesis.

BME 669	Quantitative Physiology for Engineers
ME 670	Introduction to Biomechanical Engineering
ME 672	Biomaterials — Characterization

Other suitable courses selected with approval of the graduate advisor.

Particle Technology:

REQUIRED:

12 credits:

ME 616	Matrix Methods in Mechanical Engineering
ME 620	Stress Methods in Mechanical Design
ME 624	Microlevel Modeling in Particle Technology
ME 664	Experiments and Simulations in Particle Technology

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 628	Machine Vision Principles and Applications

Other suitable courses selected with approval of the graduate advisor.

Robotics and Controls:

REQUIRED:

12 credits:

ME 616	Matrix Methods in Mechanical Engineering
ME 620	Stress Methods in Mechanical Design
ME 625	Introduction to Robotics
ME 655	Introduction to Modern Control Methods

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 628	Machine Vision Principles and Applications
ME 633	Dynamics of Machinery
ME 635	Computer-Aided Design
ME 735	Advanced Topics in Robotics
ME 755	Adaptive Control Systems

Other suitable courses selected with approval of the graduate advisor.

Design and Mechanisms:

REQUIRED:

12 credits:

ME 616	Matrix Methods in Mechanical Engineering

ME 620	Stress Methods in Mechanical Design
ME 621	Energy Methods in Mechanical Design
ME 637	Kinematics of Spatial Mechanisms

ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 615	Advanced Mechanical Vibrations
ME 630	Analytical Methods in Machine Design
ME 633	Dynamics of Machinery
ME 635	Computer-Aided Design
ME 636	Mechanism Design: Analysis and Synthesis
ME 736	Advanced Mechanism Design

Other suitable courses selected with approval of the graduate advisor.

CAD/CAM:

REQUIRED:

12 credits:

ME 616	Matrix Methods in Mechanical Engineering
ME 620	Stress Methods in Mechanical Design
ME 622	Finite Element Methods in Mechanical Engineering
ME 635	Computer-Aided Design

ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 625	Introduction to Robotics
ME 628	Machine Vision Principles and Applications
ME 630	Analytical Methods in Machine Design
ME 638	Computer-Aided Machining
ME 734	Analysis and Synthesis for Design
ME 736	Advanced Mechanism Design

Other suitable courses selected with approval of the graduate advisor.

Thermal Systems:

REQUIRED:

12 credits:

ME 607	Advanced Thermodynamics
ME 610	Applied Heat Transfer
ME 611	Dynamics of Incompressible Fluids
ME 616	Matrix Methods in Mechanical Engineering

ELECTIVE:
Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 641	Refrigeration and Air Conditioning
ME 644	Building Environmental Control Principles
ME 711	Convection Heat Transfer
ME 712	Mechanics of Viscous Fluids

Other suitable courses selected with approval of the graduate advisor.

Fluid Dynamics:

REQUIRED:

12 credits:

ME 611	Dynamics of Incompressible Fluids
ME 616	Matrix Methods in Mechanical Engineering
ME 712	Mechanics of Viscous Fluids
* ME 713	Non-Newtonian Fluid Dynamics

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 609	Dynamics of Compressible Fluids
ME 610	Applied Heat Transfer
ME 631	Bearings and Bearing Lubrication
Math 611	Numerical Methods for Computation

Other suitable courses selected with approval of the graduate advisor.

Materials and Processing:

REQUIRED:

12 credits:

ME 610	Applied Heat Transfer
ME 616	Matrix Methods in Mechanical Engineering
ME 675	Mechanics of Fiber Composites
ME 678	Engineering Design of Plastic Products

ELECTIVE:

Select 12 credits if completing a master's thesis; 15 credits if completing a master's project; 18 credits if not completing either a master's project or thesis.

ME 624	Microlevel Modeling in Particle Technology
ME 680	Polymer Processing Equipment
ME 776	Dynamics of Polymeric Liquids
MtSE 605	Fundamentals of Engineering Materials
MtSE 610	Mechanical Properties of Materials
MtSE 615	Composite Materials
MtSE 650	Physical Metallurgy

Other suitable courses selected with approval of the graduate advisor.

** Note: Before registering for courses, all students must see the graduate advisor to obtain the latest version of the brochure, "Graduate Programs in Mechanical Engineering." All new students must obtain approval from the graduate advisor before registering for courses.

* pending

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.

Degree Requirements:

Specific degree requirements and dissertation topics are approved by the department on an individual basis. Before being permitted to register for dissertation research, students must complete courses specified by the department, pass qualifying examinations and demonstrate that there are facilities and a faculty member available to supervise the research. Should dissertation research not be completed within the normal 36 credits of ME 790, students must register for a minimum of 3 credits per semester until the dissertation is completed and approved. An oral defense of the dissertation is required after submission of the final document to the department for approval.

REQUIRED:
24 credits of course work beyond the master's degree

ME 794 Mechanical Engineering Colloquium; required every semester for all doctoral students

36 credits of ME 790 Doctoral Dissertation

REQUIRED:
24 credits of course work beyond the master's degree

ME 794 Mechanical Engineering Colloquium; required every semester for all doctoral students

36 credits of ME 790 Doctoral Dissertation

Qualifying Examination — Once admitted to the program, candidates are expected to pass a two-part written qualifying examination. It is given at least once a year. Students must apply in writing to the graduate advisor for permission to take qualifying examinations. From the time of formal admission into the program, the examination must be taken by the second time it is offered, except students with departmental or research-based assistantships who must take the examination the first time it is offered. At the discretion of the department, an additional oral examination may be required.

Part I Applied Mathematics (ordinary and partial differential equations, vector analysis, complex variables, numerical methods, and boundary value problems)

Part II Two parts selected from engineering mechanics, fluid mechanics, heat transfer, stress analysis, system dynamics, thermodynamics.

Pharmaceutical Engineering

Administered By: Department of Chemical Engineering

Administration

Program Director and Graduate Advisor	Piero M. Armenante Phone: (973) 596-3548 Email: piero.armenante@njit.edu

Degrees Offered: Master of Science in Pharmaceutical Engineering

The Master of Science Program in Pharmaceutical Engineering is an interdisciplinary program jointly developed by the Department of Chemical Engineering and the Department of Industrial and Manufacturing Engineering at NJIT. 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. The Pharmaceutical Engineering program 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 Pharmaceutical Engineering

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 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.

Admission Requirements:

An undergraduate degree in either chemical engineering or industrial 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 industrial engineering, or (3) a GPA below 3.0 but at least 2.8, may be conditionally admitted to the program. Conditions involve completion of a bridge program designed on a case-by-case basis, and typically requiring taking extra bridge courses, as further explained below. These courses are not counted toward degree credit.

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. Applicants for the Pharmaceutical Operations Track may submit Graduate Management Aptitude Test scores in lieu of GRE scores. 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 is required (paper score) or 220 (computer score).

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 program has been designed so that people with different backgrounds can be admitted to the program. 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. This implies that people who have a science background (e.g., a chemistry or pharmacy B.S. degree) or an engineering degree in a discipline other than chemical engineering may be required to take a bridge program. 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 (PhEn 500, PhEn 501 and PhEn 502) specifically designed to provide non-chemical engineers with the necessary prerequisites to enter the program. These bridge courses cover a variety of topics, such as differential equations, statistics and business math (PhEn 500), mass balances, thermodynamics, and chemical kinetics (PhEn 501), and fluid flow, heat transfer and mass transfer (PhEn 502). These courses do not count toward degree credit. Some regular PhEn courses (e.g., PhEn 601 and PhEn 604) can be taken concurrently with the bridge program courses.

Off-Campus Programs: At Wyeth Pharmaceuticals, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see Extension Programs in this catalog. In addition, there are 12-credit graduate certificates in Pharmaceutical Management and Pharmaceutical Technology. See Graduate Certificates for more information on these programs. 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; email cpe@njit.edu.

Degree Requirements:

The Master of Science in Pharmaceutical Engineering is a 30-credit program structured along two different tracks. Applicants have to specify the track they seek admission to. The two tracks have a common 9-credit core. Each track has an additional 9-credit track-core, as described below. Each track has 12 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 12 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.

Students are certified for graduation if they maintain an overall cumulative grade point average of at least 3.0, as well as a grade point average of 3.0 in the required six core courses.

Program of Study:

The program has two tracks, i.e.:

- Pharmaceutical Production and Development Track
- Pharmaceutical Operations Track

The required core courses depend on the track selected, although the total number of core courses (6) and corresponding core credits (18) are the same for both tracks, and 3 of the core courses (9 credits) are common to both tracks. A number of concentration areas are available within each track.

Course Requirements:

- Three (3) core courses (3 credits each) common to both tracks (9 credits total), as follows:

PhEn 601	Principles of Pharmaceutical Engineering
PhEn 603	Pharmaceutical Processing and Manufacturing
PhEn 604	Validation & Regulatory Issues in the Pharmaceutical Industry

- Three (3) additional core courses (3 credits each) specific to the track selected (9 credits total), as follows:

Pharmaceutical Production and Development Track:

PhEn 612	Pharmaceutical Reaction Engineering
PhEn 614	Pharmaceutical Separation Processes
PhEn 618	Principles of Pharmacokinetics and Drug Delivery

Pharmaceutical Operations Track:

EM 602	Management Science
PhEn 602	Pharmaceutical Facility Design
PhEn 605	Pharmaceutical Packaging Technology

- Four (4) additional elective courses (3 credits each) from the list of available pharmaceutical engineering courses or courses from other departments, to be selected in consultation with the program advisor (12 credits total).

M.S. Thesis:

Students who are required, or choose, to do a thesis must take 6 credits of:

PhEn 701	Master's Thesis(in lieu of 6 credits worth of elective courses).

Student Involvement in Research:

Students who choose to complete a Master's thesis 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.

Qualified and research oriented students interested in completing a thesis while working full-time in industry can conduct their research work, including the experimental component, at their company, provided that an industrial supervisor is available and willing to oversee their work at the company. In such a case, the student must first select a faculty member at NJIT as the primary advisor coordinating the overall research project, and have the approval of the program director.

Professional and Technical Communication

Administered By: Department of Humanities and Social Sciences

Administration

Acting Chairpersons	Norbert Elliot, Robert Lynch
Program Director	Nancy W. Coppola
Program Administrator and Graduate Advisor	Michele Collins Phone: (973) 596-3371 Email: ptc@njit.edu

Faculty

Professors	Elliot, Lynch
Associate Professors	Coppola, Kimmelman, Steffen-Fluhr
Assistant Professors	Funkhouser
Visiting Faculty	Johnson
Adjunct Faculty	King, Myre

Degrees Offered: Master of Science in Professional and Technical Communication

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 communications professionals who want to develop abilities in
- digital layout and graphics
- information design and development
- usability testing and knowledge management
- advanced communication theory and research methods
- technical editing
- multimedia presentations and hypertext design
- writing and speaking in teams, in corporations, and in technology

MASTER OF SCIENCE IN PROFESSIONAL AND TECHNICAL COMMUNICATION

Please see our website 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. Professional experts will provide strong theoretical foundations within a practical framework. The MSPTC is entirely available online (in distance learning format), onsite (in traditional face-to-face classrooms on the Newark campus), or in a combination of both.

Admission Requirements:

Students must have an undergraduate degree in a field of science, computer science or engineering, or have an undergraduate degree in another area with experience or strong interest in science and technology.
- a statement outlining how the degree will meet personal and professional objectives;
- a current resume;
- two letters of recommendation;
- a portfolio of work (writing, web development, CD-Rom or other appropriate showcase of work).
- Application for Admission to Graduate Study form
- 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 have no prior work experience in the field. For those prospective applicants with significant work experience, the GRE may be waived on an individual basis.)
- TOEFL scores (required of all international applicants).

Graduate Certificate Program: A 12-credit graduate certificate in Practice of Technical Communications 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.

Degree Requirements:

Students are required to complete a total of 30 graduate course credits within one of the two options:

Option I: 24 credits of course work, plus 6 credits of thesis, **or**

Option II: 27 credits of course work, plus 3 credits of project.

CORE:

12 credits:

Eng 601	Advanced Professional and Technical Communication
Eng 603	Cultural and Technological Change
Eng 604	Technical Communication Theory and Methods
Eng 605	Information Design and Publishing

THESIS OR PROJECT(required):

Option I:

Eng 701	Thesis in Professional and Technical Communication

Option II:

Eng 700	Project in Professional and Technical Communication

ELECTIVE:

12 credits from:

Eng 610	Creating Hypertext: User and Task Analysis
Eng 612	Theory and Practice of Test Encoding
Eng 613	Multimedia Presentations
Eng 620	Proposal Writing
Eng 622	Working in Teams: Collaborative and Interpersonal Communication
Eng 624	Professional and Technical Editing
ENG 626	Hypertext Design Studio: Language, Image, Linking, Thinking
ENG 631	Communication and Environmental Problem Solving
ENG 632	Knowledge Management: Tools for the Workplace
ENG 642	Corporate Communication
ENG 650	Web Based Training Design
Eng 698	Special Topics in Professional and Technical Communication
Eng 725	Independent Study in Professional and Technical Communication
CIS 675	Information System Evaluation
CIS 677	Information System Principles
CIS 732	Design of Interactive Systems

Public Health

Administered By: Department of Humanities and Social Sciences, Rutgers-Newark, UMDNJ–NJMS

Administration

Acting Program Director (UMDNJ–NJMS)	Anthony J. Garro
Associate Program Director (UMDNJ–NJMS)	Marian R. Passannante
MPH Administrative Director (UMDNJ–NJMS)	Yvette Holding-Ford

NJIT Faculty

Distinguished Professors	Lewandowski, Turoff
Professors	Beaton, Elliot, Perl, Trattner
Associate Professors	Deek, Geller, Recce
Assistant Professors	Hodge, Linton, Markowitz

Rutgers-Newark Faculty

Professors	Dubnick, Holzer
Associate Professors	Canino, Olshfski, Schofer, Stark
Assistant Professors	Burbridge, Gelobter

UMDNJ Faculty

Professors	H. Baker, S. Baker, Bogden, Chinard, Evans, Haque, Johanson, Lavenhar, Louria, Najem, Oleske, Reichman, Wedeen
Associate Professors	Caine, Guttman, Holland, Passannante, Sheffet, Skurnick, Weiss
	Aloi, Brachman, Kennedy, Touger-Decker, Von Hagen, Wenger
Adjunct Professor	Kantor
Adjunct Instructor	Gause
Track Coordinators (NJIT)	Norbert Elliot Phone: (973) 596-6487 (Room 431 CUL) Email: elliot@admin.njit.edu
(UMDNJ–NJMS)	Marvin A. Lavenhar Phone: (973) 972-4686 (MSB F-594) Email: lavenhma@umdnj.edu
(UMDNJ–NJMS)	Marian R. Passannante Phone: (973) 972-4775 (MSB F-594) Email: passanna@umdnj.edu
(Rutgers-Newark)	Evan Stark (Room 701 Hill Hall) Email: EDS203@juno.com

Degrees Offered: Master of Public Health offered jointly with Rutgers-Newark and UMDNJ

The Master in Public Health (M.P.H.) degree program, established by UMDNJ–NJMS, Rutgers-Newark and NJIT, addresses critical issues surrounding the nation's health, especially that of high-risk, urban, and under-served populations. The program in public health develops and applies knowledge from multiple disciplines for the promotion and protection of the health of the human population, giving due consideration to cultural perspectives that abound in our multicultural world. This program is part of the UMDNJ–School of Public Health.

Program participants carry out research, and formulate policies that answer local needs and provide models for similar nationwide and worldwide problems. The three universities collaborate with community-based practitioners and researchers in Newark and in northern New Jersey. Student projects and placements are designed to maximize problem solving in large urban settings.

MASTER IN PUBLIC HEALTH

The program is designed to prepare existing professionals to assume new and expanded analytical and administrative roles in the planning and organization of efficient and cost-effective health services, health education, and health policy; to increase the number of public health professional qualified to assist and conduct original community-based research that will lead to advances in health promotion and disease prevention; and to provide systems thinking about public health and social values that relate to physical and mental well being.

Admission Requirements:

Applicants must meet one of these criteria: hold degrees or positions in the health or health-related professions; be graduates of baccalaureate or post-baccalaureate programs with formal training and/or experience in the health field; be candidates for joint degree programs (M.D./M.P.H., D.M.D./M.P.H.); hold exceptionally strong credentials from baccalaureate; post-baccalaureate programs outside of the health field.

Applicants must supply scores from the GRE or its equivalent (e.g., MCAT, GMAT, or LSAT) from within the last five years. Those with a doctoral degree from a U.S. or Canadian university may seek a waiver of test scores by providing supporting documentation with the application. Test score waivers for individuals with other graduate degrees are decided on a case-by-case basis. Contact the administrative director. International students applying for admission must show a TOEFL score of at least 550. All applicants must supply official academic transcripts; an essay/statement addressing career goals, how the course offerings would help meet them, and how previous experience has contributed to personal and professional growth; and three letters of recommendation.

An application may be obtained from Newark Public Health Program at Science Park, UMDNJ-New Jersey Medical School, 185 South Orange Ave., MSB F-506, Newark, N.J. 07103-2714 or by calling (973) 972-7212.

Degree Requirements:

The MPH program requires the successful completion of 45 credits. The credits are divided into 18 credits in core courses, 6 to 12 credits in required courses in one of three tracts, 9 to 15 credits of electives and 3 credits each in fieldwork and thesis.

Three general tracks are available. While they share a common core, each is designed to suit various interests:

Urban and Environmental Health brings a multi-disciplinary perspective to bear on the identification, assessment, and remediation of stressors specific to health problems in the urban environment.

Quantitative Methods: Biostatistics and Epidemiology develops quantitative, analytic, and research skills for public health practitioners.

Health Policy and Administration teaches the concepts, principles, and scientific skills necessary for health services management, policy development, and program evaluation.

CORE:

18 credits:

BINF 601/BINF 5005	Health Care Information Systems
	??xicology for Engineers and Scientists
Hist 634	Environmental History of North America
Hist 635	History, Technology and Medicine: Theory and Method
MPH 650	Medical Geography

Quantitative Methods: Epidemiology and Biostatistics:

Select either epidemiology or biostatistics.

REQUIRED:

6 credits:

QM 611	Design of Epidemiological Studies and Clinical Trials
QM 612	Linear Models: Regression and Analysis of Variance

Epidemiology:

6 credits:

EPI 615	Introduction to Epidemiology and Control of Chronic and Infectious Diseases
EPI 616	Advanced Topics in Infectious and Chronic Disease Epidemiology

9 credits from:

BINF 7570	Health Care Outcomes Measurement and Research
EPI 621	Survey Research Methods/Questionnaire Design
EPI 625	Community-Based Epidemiological Research
EPI 626	Emerging and Re-Emerging Infections
EPI 627	Innovations in Public Health

EPI 628	Pharmacoepidemology
EPI 629	Oral Epidemiology of Chronic and Infectious Diseases

The following courses are in development: genetic epidemiology, and environmental and occupational epidemiology

Biostatistics:

6 credits:

BIO 613	Life Tables and Survival Analysis
BIO 614	Categorical Data Analysis

9 credits from:

BIO 618	Nonparametric Statistical Methods
BIO 619	Biosatistical Consulting

The following courses are in development: advanced topics and sampling design

Health Policy and Administration:

Select either health policy or health care administration.

REQUIRED:

6 credits:

26:834:582	Health Care Management
26:834:585	Health Care Policy

Health Policy:

15 credits from:

26:790:501	Policy Making in the American Political System
26:790:512	Ethical Issues in Public Policy and Administration
26:790:516	Urban Public Policy
26:834:541	Political Economy and Public Administration
26:834:562	Policy and Program Assessment
26:834:586	Public Health and Violence
26:834:587	Environmental Politics and Policy
26:834:602	Decision Making and Policy Analysis
MPH 660	Health Economics

The following courses are in development: law, health care and public policy; advanced policy analysis; human rights in health care; public health and family; privatization and public health; comparative health care; and quality assurance in health.

Health Care Administration:

12 credits from:

26:705:534	Community Health Nursing Theory II
26:834:521	Technology and Public Administration
26:834:523	Human Resources Administration
26:834:524	Strategic Planning and Management
26:834:527	Cases in Public and Non-Profit Productivity
26:834:584	Health Care Finance
26:834:542	Government Budgeting Systems

The following courses are in development: accounting and financial analysis; public budgeting; managing managed care; health services research; fundamentals of human resource administration; cases in public sector productivity.

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 support 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.

Telecommunications

Administered By: Department of Electrical and Computer Engineering(ECE) and Department of Computer Science(CS)

Administration

Chairpersons	
Graduate Advisors	Email: Nirwan.Ansari@njit.edu Dennis Karvelas Phone: (973) 596-2987 (Room 4211 GITC) Email: karvelas@cis.njit.edu

Faculty

programs in this catalog

Degrees Offered: Master of Science in 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 CIS 333, EE 321 and EE 333 (or their equivalents) or ECE 501 . 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.

Bridge Program: 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.

CIS 251	Computer Organization ***or***
CoE 353	Advanced Computer Architecture ***or***
EE 352	Microprocessors
CIS 332	Principles of Operating Systems
CIS 333	Introduction to UNIX Operating Systems
CIS 505	Programming, Data Structures, and Algorithms
* ECE 501	Linear Systems and Random Signals
EE 321	Random Signals and Noise
EE 333	Circuits and Systems III
EE 481	Communications Systems

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

* EE 321 and EE 333 may be substituted for ECE 501

Degree Requirements:

Candidates must complete a minimum of 30 credits: 15 in core courses and 15 in elective courses in an area of specialization with a minimum overall GPA of 3.0. In addition, a minimum cumulative 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 from the CIS Department or ECE Department is required.

CORE:

15 credits:

CIS 630	Operating System Design
CIS 651	Data Communications
CIS 652	Computer Networks-Architectures Protocols and Standards ***or***
ECE 683	Computer Network Design and Analysis
ECE 642	Communication Systems I
ECE 644	Introduction to Wireless and Personal Communication Systems

ELECTIVE:

Select 9 credits if completing a master's thesis; 12 credits if completing a master's project; 15 credits if not completing either a master's project or thesis. These courses are to be used in an area of specialization.

CIS 604	Client/Server Computing
CIS 631	Data Management System Design
CIS 633	Distributed Systems
CIS 637	Real-Time Systems
CIS 650	Computer Architecture ***or***
ECE 690	Computer Systems Architecture
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 658	Multimedia Systems ***or***
ECE 649	Compression in Multimedia Engineering
CIS 665	Algorithmic Graph Theory
CIS 668	Parallel Algorithms ***or***
ECE 785	Parallel Processing Systems
CIS 679	Management of Computer and Information Systems
CIS 696	Network Management and Security ***or***
ECE 638	Network Management and Security
CIS 697	Principles of Broadband ISDN and ATM ***or***
ECE 639	Principles of Broadband ISDN and ATM
CIS 752	Communication Protocol Synthesis and Analysis
ECE 673	Random Signal Analysis
ECE 685	Network Interface Design
ECE 742	Communication Systems II
ECE 755	Advanced Topics in Digital Communication
ECE 757	Wireless Communications
ECE 783	Computer Communication Networks
MIS 635	Management of Telecommunications
MIS 636	Telecommunications: Policies and Regulations

PROJECT, THESIS (optional):

3 credits:

CIS 700	Master's Project ***or***
ECE 700	Master's Project

6 credits:

CIS 701	Master's Thesis
ECE 701	Master's Thesis

AREAS 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:

CIS 696	Network Management and Security ***or***
ECE 638	Network Management and Security
CIS 679	Management of Computer and Information Systems
MIS 635	Management of Telecommunications
MIS 636	Telecommunications: Policies and Regulations

and one additional course

Communication Systems:

CIS 697	Principles of Broadband ISDN and ATM ***or***
ECE 639	Principles of Broadband ISDN and ATM
CIS 658	Multimedia Systems ***or***
ECE 649	Compression in Multimedia Engineering
ECE 673	Random Signal Analysis I
ECE 742	Communication Systems II
ECE 755	Advanced Topics in Digital Communication
ECE 757	Wireless Communications
ECE 685	Network Interface Design

Networking:

CIS 604	Client/Server Computing
CIS 633	Distributed Systems
CIS 637	Real-Time Systems
CIS 650	Computer Architecture ***or***
ECE 690	Computer Systems Architecture
CIS 654	Telecommunication Networks Performance Analysis
CIS 656	Internetworking and Higher Layer Protocols
CIS 665	Algorithmic Graph Theory
CIS 668	Parallel Algorithms ***or***
ECE 785	Parallel Processing Systems
CIS 696	Network Management and Security ***or***
ECE 638	Network Management and Security
CIS 697	Principles of Broadband ISDN and ATM ***or***
ECE 639	Principles of Broadband ISDN and ATM
EE 673	Random Signal Analysis I
EE 783	Computer Communication Networks

Information Technologies:

	CIS 604	Client/Server Computing
	CIS 631	Data Management System Design
{	CIS 658	Multimedia Systems ***or***
	ECE 649	Compression in Multimedia Engineering
{	CIS 696	Network Management and Security ***or***
	ECE 638	Network Management and Security

one additional course

Other CIS and ECE courses related to telecommunications may be selected as elective courses with the written approval of the corresponding graduate advisor.

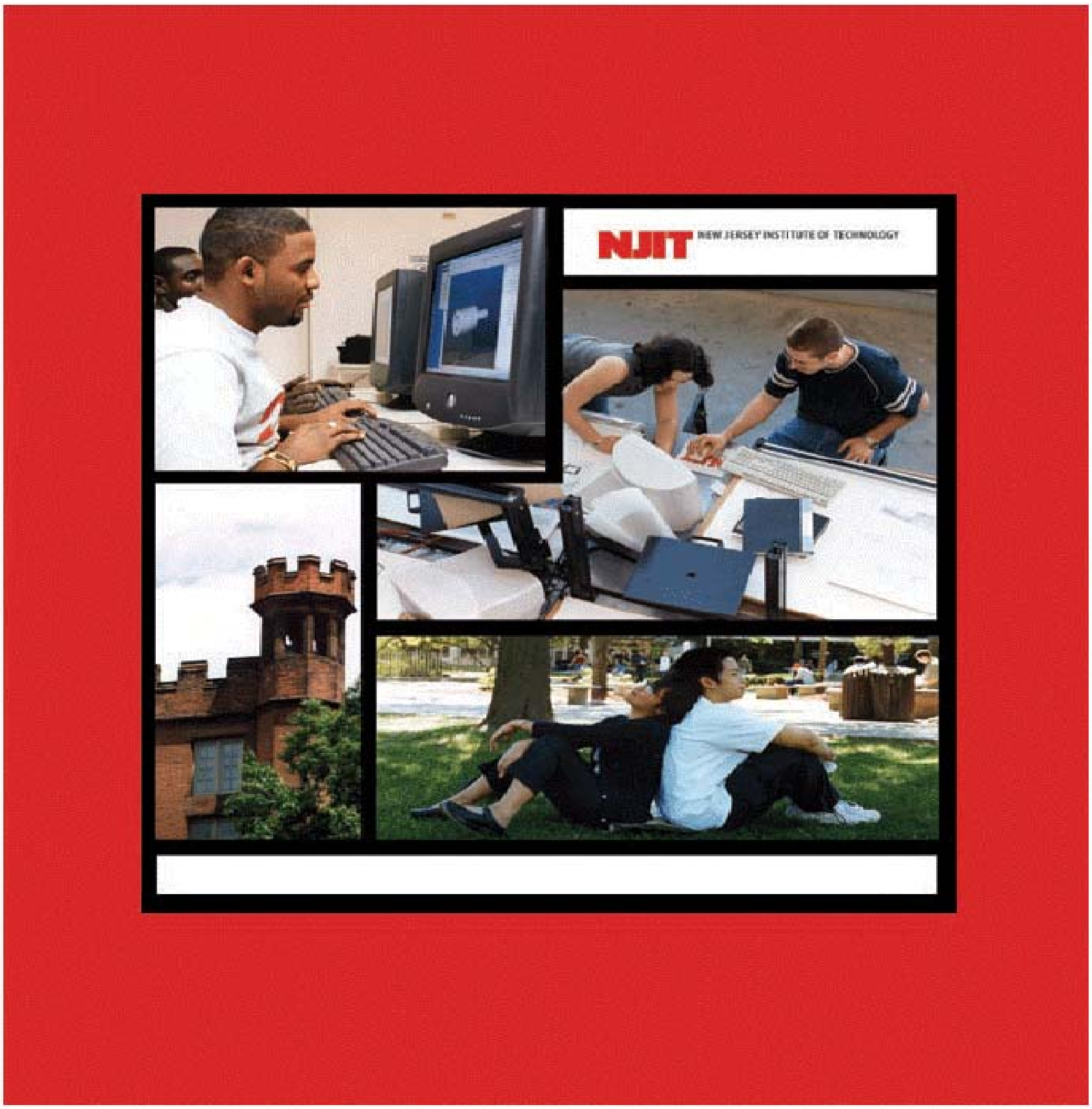
Urban Systems

http://www.umdnj.edu/urbsyweb/

NJIT NEW JERSEY INSTITUTE OF TECHNOLOGY

2003-2004 Graduate Catalog

Courses



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Occupational Safety and Industrial Hygiene 126
Operations Management 128
Optical Science and Engineering 129
Pharmaceutical Engineering 130
Physics 133
Political Science 138
Public Administration 139
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Quantitative Methods 143
Statistics 144
Transportation 145

Accounting

Offered by the School of Management. See Management course list for faculty.

Acct 515 - Accounting for Managerial Control 3 credits (3 credits)
Case study approach to accounting issues that have an impact on management decision making: nature of managerial accounting, cost behavior, cost-volume-profit analysis, full costing and its use, standard costs, variances, differential cost analysis, and responsibility accounting.

Acct 610 - Internal Auditing Concepts and Procedures (3 credits)
The entire internal audit function including planning, surveying, audit performance, work paper documentation, reporting, standards, controls, sampling, and fraud detection.

Acct 615 - Concepts of Strategic Cost Analysis 3 credits (3 credits)
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.

Acct 630 - Concepts and Applications of Control (3 credits)
Examines the need for and implementation of internal controls to protect corporate assets. Emphasizes the role of the controller in the organization.

Acct 650 - Operational Auditing (3 credits)
Stresses the functions of the auditor in assessing the effectiveness and efficiency of operations. Includes such areas as environmental auditing, auditing the human resource management function, auditing OSHA, psychological impact on internal auditors, auditing in a just-in-time environment, ethics, and auditing for fraud. Financial areas are discussed only to the extent of their operational impact.

Acct 670 - Seminar in Accounting Theory (3 credits)
Focuses on contemporary areas relating to accounting theory. Taught from the viewpoint of the corporate controller.

Acct 680 - Seminar in Auditing (3 credits)
Discusses contemporary auditing topics as they impact on management control and decisions.

Acct 690 - Seminar in Taxation (3 credits)
Focuses on contemporary issues in taxation as they impact on the corporate decision making process.

Architecture

Offered by the New Jersey School of Architecture

Arch 500G - Computer Programming and Graphics Problems (2 credits)
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 (5 credits)
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 (5 credits)
Prerequisites: Arch 501G, Arch 521G, Arch 528G, 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. 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 503G - Architectural Design III (5 credits)
Prerequisites: Arch 502G, Arch 511G, Arch 522G, Arch 529G, 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 (5 credits)
Prerequisites: Arch 503G, Arch 512G, Arch 523G. Arch 500G, Core Studio. Second semester intermediate design studio. Design of buildings and integration.

Arch 505G, Arch 506G, Arch 507G - Advanced Design Options I, II, III (6 credits each)
Prerequisites: completion of all core courses or their equivalent. 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 511G - Structures I (3 credits)
Prerequisites: graduate level standing, college level physics and calculus or equivalent, Arch 521G. Introduces structural statics through timber and steel design. Analysis and selection of building materials and structural systems related to their impact on building design.

Arch 512G - Structures II (3 credits)
Prerequisites: Arch 511G, Arch 522G. Builds on information presented in Arch 511G. Emphasizes details and methods of concrete design, mixing, pouring and testing. Methods and details of steel design are summarized.

Arch 513G - Structures III (3 credits)
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 521G - Construction I (3 credits)
Prerequisite: graduate level standing. Introduction to the construction process and how it relates to architecture. Compatibility of materials and methods of construction are studied with respect to wood, heavy timber, steel and masonry construction. Emphasis is placed on materials compatibility, construction technology, and the role of architectural documents in the construction process.

Arch 522G - Construction II (3 credits)
Prerequisite: Arch 521G. Continuation of 521G. Construction practices and details of steel, precast and poured-in-place concrete construction. Review of testing methods, procedures for setting standards, forces of determination, and new materials research. Emphasis is on materials and systems selection criteria.

Arch 523G - Building Performance (3 credits)
Prerequisites: Arch 522G, college level physics or equivalent. Impact on building design of heat, air movement, and thermal mass in an array of climatic conditions. Also covered are dynamic thermal and passive solar analysis for energy-conscious architectural design.

Arch 524G - Environmental Control Systems (3 credits)
Prerequisite: Arch 523G. Analysis of different configurations of building equipment systems related to building design and life cycle costs. Relationships among mechanical, electrical, plumbing and transport systems are examined. The role of the architect and other professionals in equipment design and selection are studied, with an emphasis on criteria for system selection.

Arch 528G - History of Architecture I (3 credits)
Prerequisite: 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)
Prerequisite: Arch 528G. Continuation of Arch 528G. Introduces concepts of modernism and brings the history of western architecture to the contemporary period.

Arch 555G - Architectural Graphics (3 credits)
Prerequisite: 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 569G - Building and Development (3 credits)
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 579G - Professional Architectural Practice (3 credits)
Prerequisite: 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 619 - Architectural Photography (3 credits)
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)
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)
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)
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)
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)
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)
Prerequisites: Arch 528G, Arch 529G. Examination of major architectural traditions and styles of China, Japan, Southeast Asia, India and the Middle East.

Arch 631F - Thresholds of Architectural Theory (3 credits)
Prerequisites: Arch 528G, Arch 529G. Seminar on Western architectural theory dating from Vitruvius to the present time. Examines critical texts and studies related building and projects.

Arch 631H - History and Theory of Infrastructure (3 credits)
Prerequisites: Arch 528G, Arch 529G. 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 MIP 631.

Arch 632 - Problems and Methods in Architectural Preservation (3 credits)
Prerequisites: Arch 528G, Arch 529G. Theory and practice of preservation planning. Compares American and European preservation concepts, problems and techniques. Also covers theories on continuity and change in urban environments, and preservation-planning for community development and neighborhood conservation.

Arch 633 - Case Studies in Architectural Creativity (3 credits)
Prerequisite: Arch 528G, Arch 529G. 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 634 - History of Architectural Technology (3 credits)
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 640 - Acoustics (3 credits)
Prerequisites: 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)
Prerequisites: 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 643 - Lighting (3 credits)
Prerequisites: Arch 501G, Arch 502G, Arch 503G, Arch 523G, Arch 524G. 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 644 - Systems Approach to Design and Construction (3 credits)
Prerequisite: completion of core sequence. Lectures, case studies and student projects on understanding human aspirations and needs through design. Topics include land, finance, management, technology and labor.

Arch 645 - Case Studies in Architectural Technology (3 credits)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisites: completion of core sequence and Arch 579G. 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 661 - Directed Studies of Architecture (3 credits)
Prerequisites: completion of core and 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)
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)
Prerequisite: Arch 523G. 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)
Prerequisite: Arch 523G. 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)
Prerequisite: Arch 523G. 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)
Prerequisite: Arch 523G. 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)
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 673 - Infrastructure Planning in Practice (3 credits)
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 MIP 673.

Arch 674 - Infrastructure and Architecture (3 credits)
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 MIP 674.

Arch 675 - Elements of Infrastructure Planning (3 credits)
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)
Prerequisite: 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)
Prerequisite: 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 680 - Graduate Co-op Work Experience I (3 additive credits)
Prerequisites: 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 681/682 - Graduate Co-op Work Experience II and III (3 additive credits)
Prerequisites: 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 686 - Research Methods for Environmental Design (3 credits)
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 770 - Development of the American City (3 credits)
Prerequisite: 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)
Prerequisite: 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 (6 credits)
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.

MSAS 701 - Master of Science in Architectural Studies Thesis (6 credits)
Prerequisites: completion of required courses, electives, Arch 661 and approval from MSAS advisor. Under supervision of a thesis advisor, independent, in-depth examination of a subject in the student's area of concentration developed during Arch 661.

Biology

Offered by the Federated Department of Biological Sciences at NJIT and Rutgers-Newark

Biol 794 - Computational Biology Colloquium (1 credit)
Prerequisite: graduate standing. Students and outside speakers present and discuss current research activities in computational biology and related scientific areas.

26:120:501 - Neuroanatomy (3 credits)
Equivalent to 26:112:501. Overview of the neuroanatomical systems of the mammalian nervous system.

26:120:503 - Plant Morphology (3 credits)
Prerequisites: undergraduate ecology or botany, or permission of instructor. A study of the major groups of vascular plants: lycopods, ferns, gymnosperms, and angiosperms. Emphasis on their morphology, anatomy, and reproductive biology with discussion of evolutionary trends and occurrence in the fossil record.

26:120:504 - Plant Physiology (3 credits)
Prerequisites: 26:120:503, organic chemistry, and physics, or permission of instructor. Survey of modern aspects of plant physiology with emphasis on recent literature. Topics include photosynthesis, nitrogen metabolism, transport, development, and physiological genetics.

26:120:505 - Biostatistics and Computer Methodology (3 credits)
Prerequisite: college algebra. Advanced introduction to computer programming and biometry with some use of common mathematical procedures useful to the biologist.

26:120:506 - Quantitative Plant Ecology (3 credits)
Prerequisite: 26:120:503 or permission of instructor. A survey of plant autecology, synecology, plant geography, and analytical techniques and methods useful in studying the relationships between plants and their environment.

26:120:509,510 - Advanced Problems in Biology (1 to 6 credits by arrangement)
Advanced studies to meet the needs of individual students.

26:120:512 - Mammalian Physiology (3 credits)
Prerequisites: introductory courses in anatomy, physiology, and biochemistry, or permission of instructor. The function, regulation, and interrelationships of the different organs and organ systems of mammals, particularly the nervous, cardiovascular, respiratory, excretory, and digestive systems.

26:120:515 - Molecular Biology of Eukaryotes (3 credits)
Prerequisite: biochemistry. First-year graduate course providing an accelerated review of eukaryotic molecular biology. Introduces critical reading and discussion of current journal articles. Nucleic acid biochemistry, molecular technology, transcription, RNA processing, chromosomal structure, molecular anatomy of the genome, genomic rearrangements, gene control signals, DNA-protein binding, carcinogenesis and oncogenes.

26:120:517 - Developmental Neurobiology (3 credits)
Prerequisite: 21:120:342 (see the Rutgers-Newark undergraduate catalog for description). Developmental processes in vertebrate nervous systems with a critical analysis of current theories.

26:120:518 - Nucleic Acids (3 credits)
Prerequisites: 21:115:403,404 (see the Rutgers-Newark undergraduate catalog for descriptions) or 26:120:571 or equivalent, or molecular biology, or permission of instructor. An advanced seminar emphasizing current research in selected topics in nucleic acid biochemistry and molecular biology.

26:120:519 - Microbial Metabolism (3 credits)
Prerequisites: 21:115:403,404 or equivalent. Biology of procaryotic organisms. Emphasis on those physiological, biochemical, and ecological aspects that are unique to bacteria.

26:120:523 - Biogeography (3 credits)
Prerequisite: permission of instructor. Historical and ecological factors determining the geographical distribution of animals as exemplified by vertebrates.

26:120:526 - Cell Biology (3 credits)
Prerequisites: upper-level undergraduate courses in biochemistry, genetics, and cell structure and function. A detailed study of the structure and function of cells and their organelles; the composition, organization, and functioning of various membrane systems; investigative techniques.

26:120:530 - Biophysical Membrane Physiology (4 credits)
Prerequisites: differential and integral calculus, physical chemistry, or permission of instructor. Basic biophysical principles as applied to membrane transport in animals, plants, and microbes. Special emphasis on compartmental ion flux analyses, the thermodynamics of irreversible processes, and electrophysiology.

26:120:532 - Evolution (3 credits)
Prerequisite: genetics. A critical examination of theories and mechanisms of evolution of animal groups. Emphasis on gene pool dynamics, models of speciation, and adaptive radiations. Consideration of evolutionary relationships of major invertebrate and vertebrate groups.

26:120:536 - Multivariate Biostatistics (3 credits)
Prerequisite: biostatistics. Covers a variety of statistical techniques useful in ecological and behavioral research. Includes sampling methods, multiple regression, discriminant analysis, weighted regression, and multidimensional chi-square. Emphasis on a conceptual understanding of the uses, assumptions, and limitations of each technique.

26:120:538 - Topics in Molecular Genetics (3 credits)
Prerequisites: microbiology and biochemistry. A review of current journal literature in the field of mechanisms of gene expression, recombinant DNA methods, and current application.

26:120:551 - Biology of Pollution (3 credits)
Prerequisite: ecology or permission of instructor. Survey of major environmental pollutants, their occurrence in the environment, their effect on biota at the cellular and physiological levels, as well as their effects at the population, community, and ecosystem levels. Emphasis on aquatic pollution.

26:120:552 - Paleobotany (4 credits)
Survey of evolutionary trends in the plant kingdom; comparative study of the morphology, anatomy, and reproduction of fossil plants and their survivors, with emphasis on the vascular plants.

26:120:561 - Quantitative and Analytical Light Microscopy (4 credits)
Laboratory intensive course with lectures and discussion covering the physical principles governing eukaryotic cell function. Emphasis placed on electrical properties of excitable cells and model membrane systems. Introduction to the principles underlying light and electron microscopy.

26:120:563 - Developmental Plant Physiology (3 credits)
Prerequisite: 26:120:504 or permission of instructor. An analysis of physiological and environmental factors controlling growth and differentiation in vascular plants with emphasis on recent advances in the biochemistry of plant growth regulators.

26:120:564 - Techniques in Developmental Botany (2 credits)
Prerequisite: permission of instructor. Presentation of the major procedures used in plant tissue culture, including suspension culture, callus culture, organ culture, and protoplast isolation and culture. Emphasis on independent study.

26:120:565 - Medical Mycology (3 credits)
Prerequisite: 26:120:503 or permission of instructor. The taxonomy, morphology, and symptomatology of pathogenic fungi. Emphasis on common mycoses, fungi as allergens, toxic fungi, and recent progress in medical mycology.

26:120:566 - Neurophysiology and Behavior (3 credits)
Prerequisites: comparative or mammalian anatomy and organic chemistry. Aspects of the nervous system and the endocrine system as they relate to the organization of behavior and the physiological analysis of such phenomena as hunger and thirst, and learning. Lecture is 2 hours, recitation is 1 hour.

26:120:568 - Neuroendocrinology and Behavior Laboratory (3 credits)
Prerequisite: permission of instructor. Gross stimulation of nervous system; brain lesions and their effects; hormone implants. Recording of brain activity. Laboratory is 6 hours.

26:120:571 - Biochemistry (4 credits)
Prerequisite: one year of organic chemistry. A detailed examination of the chemistry and metabolism of biological compounds; structure and function of macromolecules, biosynthetic pathways; bioenergetics; photosynthesis and other sequential biological processes.

26:120:584 - Plant Responses to the Environment (3 credits)
Prerequisite: ecology and plant physiology. Examination of the anatomical, morphological and physiological responses of plants to environmental variability and stress; utilization of current instrumentation; physiological mechanisms underlying higher-scale ecological processes.

26:120:585 - Behavioral Ecology (3 credits)
Prerequisite: ecology or animal behavior. The behavior of vertebrates and insects in their natural environments; sociobiology and the evolution of communication, foraging, and mating systems. Lectures, student seminars.

26:120:586 - Landscape Ecology (3 credits)
Prerequisite: one ecology and one course in statistics. Study of how spatial and spatio-temporal configurations of resources, influences, and constraints shape ecological patterns and processes at local, regional, and global scales.

26:120:587 - Systems Ecology: Ecosystems in the Landscape (3 credits)
Prerequisite: one ecology course. Ecological energetics; soil-plant-atmosphere continuum; effect of spatial pattern on ecological process; landscape ecology.

26:120:588 - Topics in Advanced Ecology (3 credits)
Prerequisite: graduate course(s) in ecology. A discussion of selected topics in advanced ecology. Current literature and newly developing approaches and theories stressed.

26:120:589 - Chemical Bases of Neural Function (3 credits)
Prerequisites: undergraduates, one year of chemistry and biology; graduate students, baccalaureate degree. Recommended: organic chemistry and biochemistry. An interdisciplinary course on biochemical bases of nervous system activity. Special emphasis on developmental neurochemistry, genomic and nongenomic mechanisms of hormone action, and membrane proteins involved in neurotransmitter action.

26:120:593 - Physiological Ecology (3 credits)
Prerequisites: ecology and physiology. The physiological and ecological factors that permit and facilitate the adaption of animal populations to diverse environments.

26:120:594 - Systematics (3 credits)
Prerequisites: genetics, vertebrate or invertebrate zoology, and permission of instructor. Present theory of the nature of the Mendelian species: theories of species origin, polytypic species content; isolating mechanisms; the reduction of interspecific competition and mechanisms of evolution above the species level.

26:120:601 - Human Molecular Genetics (3 credits)
Prerequisites: genetics and molecular biology or permission of instructor. In-depth introduction to the study of human molecular genetics, with emphasis on the methods and stategies used to identify genetic defects associated with illness. Classical and molecular genetics. Laboratory techniques in current use. Examples of different types of known genetic defects, with particular attention to the experimental strategies used in each example.

26:120:604 - Microbiology: Principles and Applications (3 credits)
Restricted to NJIT students only. An introduction to microorganisms for graduate students in Environmental Sciences or Chemical Engineering. Emphasis is on the growth, physiology, and environmental effects of bacteria.

26:120:616 - Topics in Biology (1 to 3 credits by arrangement)

26:120:640 - Topics in Immunology (3 credits)
Prerequisite: 21:120:443 (see the Rutgers-Newark undergraduate catalog for description) or permission of instructor. Discussion of selected, up-to-date topics in immunology. Current literature, student discussions, and presentations stressed.

26:120:651,652 - Biology Colloquium (1 credit each)
Open to all graduate students in good standing in the biology graduate program and by permission to students in other graduate programs. Various biological topics of current interest discussed by a series of experts in the field.

26:120:697 - Neuroendocrinology (3 credits)
Prerequisite: permission of instructor. Equivalent to 26:112:567. Central nervous system effects on the endocrine system, including neural pathways in pituitary control and behavioral effects; endocrine control mechanisms and the effects of hormones on the nervous system.

Biomedical Engineering

Offered by the Department of Biomedical Engineering

BME 601 - Seminar (3 credits)
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 627 - Introduction to Biomedical Engineering (3 credits)
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 the blood and its flow in the cardiovascular system; 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. Same as ChE 627.

BME 667 - Systems Studies in Biomedical Engineering (3 credits)
Prerequisite: undergraduate or graduate course in linear systems. Basic techniques of simulation including digital simulation languages. Physiologic systems of current interest using systems analysis techniques leading to formulation of mathematical, digital computer, or electric circuit models. Systems examined include the circulatory, respiratory or hormonal control systems. Basic techniques of signal processing are explored which are necessary to analyze data from physiologic systems. Same as ECE 667.

BME 670 - Introduction to Biomechanical Engineering (3 credits)
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. Same as ME 670.

BME 671 - Biomechanics of Human Structure and Motion (3 credits)
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.

BME 672 - Biomaterials (3 credits)
Prerequisite: Mech 232 (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)
A studio-based course with several projects that serve as the primary learning scaffold. Projects will be supplemented by lectures and readings. Topics include biomimetic design (why nature and humans design differently), sensors (touch, stereo and position), actuators (muscles, smart materials), and intelligent (neural and computer controlled) systems.

BME 674 - Biomechatronics (3 credits)
A design approach to biomechanical devices. The integration of biologically-inspired design with computational and electromechanical technologies. An exploration of electromechnaical manipulators, haptic interfaces and walking machines as approaches to the design of prostheses and virtual technologies.

BME 675 - Principles of Tissue Engineering (3 credits)
Prerequisite: Undergraduate or graduate course in biomaterials or materials science (BME 672 or MTSE 320 or equivalent). This course is an introduction to the field of tissue engineering. It is rapidly emerging as a therapeutic approach to treating damaged or diseased tissues in the field of medicine. 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, material science and their relationship towards developing novel tissue engineered materials.

BME 681 - Medical Imaging (3 credits)
The basic principles of medical imaging: physical basis, signal acquisition, image formation and image processing. Image modalities include x-rays, computed tomography CT), magnetic resonance imaging (MRI), ultrasound, positron image tomography (PET), and functional MRI (fMRI).

BME 683 - BioMicroElectroMechanical Systems (3 credits)
Prerequisites: Knowledge of mechanics, optics, electromagnetism and general chemistry. Micro- and nanosystems used in advanced analytical techniques for microfluidic devices, implantable chips, non-invasive biomedical sensors, DNA chips and microelectronic array systems. Microelectronic processing design for micromaching and piezoelectric materials for biomedical applications. Biomedical sensors and actuators. BioMEMS active ultrasonic transducers for medical imaging, for micro-valves and for implantable medication delivery systems are studied.

BME 685 - Neural Engineering (3 credits)
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 687 - Design of Medical Instrumentation (3 credits)
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 700 - Master's Project (3 credits)
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 701 - Master's Thesis (6 credits)
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 710 - Foundations of Biomedical Research (3 credits)
This course provides an overview of biomedical research issues as they relate to biomedical engineering. The course provides students with a working knowledge of the fundamental tools of: 1) a critical literature review, 2) research design, 3) bioethics, 4) statistical analysis of data, 5) protection of animal and human subjects, 6) patent protection and 7) FDA regulations.

BME 725 - Independent Study I (3 credits)
Prerequisite: 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)
Prerequisite: 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 788 - Selected Topics in Biomedical Engineering (3 credits)
Prerequisites: as announced with each offering. Special area course given when suitable interest develops. Advance notice of forthcoming topics will be given.

BME 790 - Doctoral Dissertation (Credits as designated)
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 792 - Pre-Doctoral Research (3 credits)
Prerequisite: 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.

Biomedical Informatics

Offered by UMDNJ and the Department of Computer and Information Science. Courses are taken at UMDNJ.

BINF 600/BINF 5100 - Introduction to Biomedical Informatics (3 credits)

Introduction to mainframe and microcomputer interactive computing environments: overview of computer applications for medical records; clinical, laboratory, pharmacy, education, and medical database management; patient care and hospital information systems using software for spreadsheets, database management, telecommunication, and literature retrieval. Also covers a decentralized hospital computer program, and computer-stored ambulatory record systems. Programming environment in relation to existing databases is discussed. Students complete small hands-on projects.

BINF 601/BINF 5005 - Health Care Information Systems (3 credits)

General systems theory applied to health care systems and information technology. Computer-based information system operation and management functions in the context of various professional settings, and the impact of information technology on health care management. Demonstrations of current health information systems emphasizing design, system components, data structures and database management. Costs and benefits of current applications, justification, specification and evaluation of computer systems, and the capacity for future modification and development of existing systems in various health care settings.

BINF 602/BINF 5020 - Biomedical Modeling and Decision-Making Systems (3 credits)

Introduction to use of differential equations and relevant mathematical concepts to describe health care and physiological systems. Methods and resources of computer simulation and modeling for analyzing and solving medical and health-care problems related to both organization and treatment, including decisions for effective information transfer, productivity and resource utilization, as well as physiological systems such as drug dosage, pulmonary transport, cardiac output, kidney function, and others.

BINF 603/BINF 5030 - Visualization in Biomedical Sciences (3 credits)

Fundamentals of biomedical signal and image processing including image digitization, display, and processing algorithms with emphasis on computer systems, processing methodologies, and display of images. Visualization procedures, tools and technologies for 3-D representation of images, animation and image manipulation are provided.

BINF 612/BINF 5125 - Clinical Problem Solving and Decision Making (3 credits)

An overview of computer methodology for clinical decision making. Application of decision trees for clinical and health care problems, estimation and revision of probabilities. Artificial intelligence, expert systems and decision-making techniques and their implementation as decision support systems in clinical and HIS settings. Examination of quantitative and symbolic approaches to medical decision making including application of statistical methods (discriminant and Bayesian statistics), decision analysis and utility theory.

BINF 613/BINF 5130 - Health Care Decision Support Systems (3 credits)

Overview of methods of decision support in health sciences, including artificial intelligence, Bayesian methods, classical multivariate analysis, dynamic screening (Markov) models, and theoretical and empirical limitations of these decision methods. Discussion of literature on human perception and judgment as well as practice on database management software and expert system tools to design decision support prototype systems for clinical, health care finance and patient management systems.

BINF 614/BINF 5135 - Clinical Systems Interface Design (3 credits)

Prerequisites: BINF 5100, BINF 5005 and BINF 4000 or equivalent. Practice of principles of interface design, data exchange, program-to-program communication, and knowledge-based systems using Windows-based GUI design packages. Exposure to application development tools with expert system shell capabilities and system integration tools with good communication interfacing between various hardware platforms from PCs to minicomputers and mainframes. Exploration of a wide array of user interface system design and development techniques. Term project using the GUI package required.

BINF 615/BINF 5150 - Seminar: Biomedical Teaching Systems Design (1 credits)
Based on knowledge gained from courses in biomedical informatics, students engage in serious discussion and analysis of the various aspects of computer-based instructional systems. Examples of technologies covered include: microcomputer courseware, CD/ROM, CD-I, DVI, instructional television, interactive microcomputer and videodisc systems, multimedia intelligent tutoring and expert systems, and instructional games and simulations.

BINF 621/BINF 5210 - Research Methods in Health Sciences (3 credits)
Use of computer as a tool for scientific inquiry including techniques for searching computer databases of research literature, and formulating problems and hypotheses for statistical analysis of educational, health services, laboratory and clinical data. Use of computers in management and analysis of health science data. Laboratory instruction in use and application of software packages for micro- and mainframe computers. Issues in the design, organization and operation of randomized controlled clinical trials and intervention studies, and analysis of qualitative and quantitative data.

BINF 622/BINF 5220 - Topics in Bioinformatics (3 credits)
Prerequisites: BINF 5005 or BINF 5010, and Chem 673 or equivalent. An extensive review of computational biology necessary to understand research and developments in bioinformatics. Topics include: covalent bonding, quantum mechanical basis of bond formation, 3-D structure of molecules, reaction mechanisms, catalysis, polymers, enzymes, thermodynamics and kinetics, metabolic pathways, and sequence and structure of macromolecules. Extensive use of computer approaches and computer graphical techniques to enhance interpretation of results.

BINF 623/BINF 5230 - Advances in Molecular and Cellular Genetics (3 credits)
Prerequisites: BINF 5005 or BINF 5010, and Chem 673 or equivalent. Extensive use of computer approaches to cover the following important areas: cell structure, intracellular sorting and signaling; structure and function of proteins; and nucleic acid; enzymology, membrane structure and function; DNA-replication, transcription and recombinant DNA molecules; genetic mutation, cell fusion, chromosomal mapping and gene transfer; and immunological principles applied to genetics.

BINF 631/BINF 5311 - Intelligent Instructional Systems (3 credits)
Current developments and trends in instructional technology applied to knowledge and learning in health science: processes of perception, learning, motivation, problem-solving and decision making in relation to the design of intelligent tutoring and educational expert systems. The students will work with knowledge engineering, expert system and authoring tools to develop intelligent tutorials and expert system models on selected/assigned topics.

BINF 632/BINF 5312 - Interactive Learning Systems for the Health Sciences (3 credits)
Introduction to use of interactive videodisc and CD-ROM technology for health sciences instructional software. Students try existing interactive software and videodiscs on biomedical subjects, and then design, edit and evaluate an interactive videodisc learning module of their own.

BINF 700/BINF 6000 - Directed Research/Project (6 credits)

BINF 7910 - Research and Developments in Medical Informatics: Colloquium (1 credits)
This is a required course for all doctoral students. These seminar series prepare students for advanced research in biomedical informatics. Invited lecturers, experts in their various research domains, present major advances in biomedical informatics research. The lecturers are from within and outside the UMDNJ academic community as well as the health industry in general and affiliated industries.

Biostatistics

Offered by the UMDNJ-New Jersey Medical School

BIO 613 - Life Tables and Survival Analysis (3 credits)

Prerequisites: biostatistics core course; a thorough knowledge of pre-calculus mathematics is assumed; calculus is strongly recommended but not required. Introduction to theory and applications. Recognition of situations that call for life table methods. Selection and application of methods and analysis. Explanation and interpretation of analyses.

BIO 614 - Categorical Data Analysis (3 credits)

Prerequisites: biostatistics core course or equivalent. A practical introduction to methods for analysis of frequency tabulations commonly used in public health research. Exercises are based on public health literature. Evaluate relationships between categorical factors by which frequency data are cross-classified. Apply principles of study design and sample size planning. Provide statistically valid interpretation of results from categorical data analysis. A statistical computer package such as SAS, STATA or SPSS is used for computation.

BIO 618 - Nonparametric Statistical Methods (3 credits)

Prerequisites: biostatistics core course or equivalent. Choose and apply the most appropriate parametric or nonparametric test or procedure for analyzing a given set of research data, taking into consideration the manner in which the sample was drawn, the nature of the population from which it was drawn, and the kind of measurement or scaling that was employed to define the variables in the study.

BIO 619 - Biostatistical Consulting (2 credits)

Prerequisites: biostatistics, epidemiology, and health information systems core courses. Provides skills needed for statistical consulting in public health.

Chemical Engineering

Offered by the Department of Chemical Engineering, Chemistry and Environmental Science

ChE 501 - Fundamentals of Chemical Engineering I (6 credits)
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)
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 503 - Introduction to Polymer Science and Engineering (3 credits)
Prerequisite: Undergraduate degree in science or engineering. The course is intended for students whose prior undergraduate degree did not include study of polymer science or engineering. The course provides introductory concepts in four main areas: fundamentals of polymeric material including structural and chemical aspects; synthesis reactions of polymers; polymer properties including an introduction to viscoelastic behavior; and polymer technology including processing and shaping methods for specific products.

ChE 551 - Principles of Mass Transfer (3 credits)
Prerequisites: undergraduate thermodynamics and integral calculus. An introductory course in basic concepts of mass transfer. Special emphasis is placed on mass transfer concepts applicable to stage and continuous operations. Topics covered include evaporation, gas absorption, and distillation. Cannot be used for degree credit in Chemical Engineering.

ChE 590 - Graduate Co-op Work Experience I (3 additive credits)
Prerequisite: 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 additive credits)
Prerequisite: permission from department and Division of Career Development Services.

ChE 592 - Graduate Co-op Work Experience III (3 additive credits)
Prerequisite: permission from department and Division of Career Development Services.

ChE 599 - Methods for Teaching Assistants and Graduate Assistants (3 credits)
Prerequisite: 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)
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in chemical engineering.

ChE 611 - Thermodynamics (3 credits)
Prerequisites: 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)
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 624 - Transport Phenomena I (3 credits)
Prerequisites: 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)
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)
Prerequisite: undergraduate course in differential equations. The purpose of the course is to emphasize the importance of mathematics to chemical engineering practice. Applications of non-linear regression, series solution of ordinary differential equations, Sturm-Liouville problems in partial differential equations, and numerical methods. It is suggested that students take this course before taking ChE 624.

ChE 627 - Introduction to Biomedical Engineering (3 credits)
Prerequisites: 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)
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 629 - Biological Engineering Analysis (3 credits)
Prerequisite: undergraduate degree in chemical engineering. Emphasis is on chemical engineering reactor design employing microbial populations. The dynamics of microbial interactions are described mathematically, as are cell attachment and reactor stability.

ChE 634 - Chemical Process Dynamics and Control (3 credits)
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 645 - Fundamentals of Rheology (3 credits)
Prerequisite: ChE 626 or permission of the instructor. Rheology of polymer melts and polymer solutions. Various types of time-dependent and time-independent non-Newtonian fluids are classified. Experimental techniques used to characterize these materials are discussed.

ChE 656 - Catalysis (3 credits)
Prerequisite: ChE 612. Introduction of mass transfer and physical characterization of catalysts: the effectiveness factor; absorption; surface reaction; catalytic reactor design.

ChE 662 - Chemical Processing of Electronic Materials (3 credits)
Prerequisite: undergraduate degree in chemical engineering. Processes necessary for manufacturing electronic materials into semiconductor devices and systems including single crystal growth, chemical vapor deposition, ion implantation, dry etching, and other considerations.

ChE 664 - Experiments and Simulations in Particle Technology (3 credits)
Prerequisites: graduate standing and consent of the instructor. Covers particle size analysis using sieves as well as laser diffraction technique, size reduction with ball mill, measurement of powder flow properties and internal angle of friction, measurement of angle of repose, design of mass flow hoppers using Jenike direct shear tester, measurement of minimum sintering temperature of powders, particle sedimentation, powder mixing, dry particle coating, and fluidized beds. Simulations involve various dry and fluid based particle systems, focusing on particle-particle and fluid-particle interactions. Same as ME 664.

ChE 671 - Chemical Process Safety (3 credits)
Prerequisite: graduate standing. Chemical and physical principles in chemical process safety and fire and explosion hazard evaluation. Emphasis is on materials, their reactions, and effect on surroundings. Course intended for students in the master's program in occupational safety and health engineering, and may not be taken for credit by ChE graduate students.

ChE 675 - Statistical Thermodynamics (3 credits)
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)
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 and introduction to applicable characterization methods.

ChE 682 - Polymer Structures and Properties (3 credits)
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 adn mechanical properties, rubbers, polymer blends and composite, biological polymers, and special applications. New areas and innovative applications of polymers will be introduced.

ChE 683 - Polymer Processing (3 credits)
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 prodcuts . Structural and residual stresses are examined.

ChE 684 - Materials and Process Selection for Polymer Product Design (3 credits)
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 685 - Industrial Waste Control I (3 credits)
Prerequisite: undergraduate degree in chemical engineering or permission of the instructor. Physical/chemical treatment of industrial wastewaters: ionic equilibria; surface characterization; thermodynamic applications; transport phenomena; and sludge treatment.

ChE 686 - Industrial Waste Control II (3 credits)
Prerequisite: undergraduate degree in chemical engineering or permission of the instructor. Biological treatment of industrial wastewaters: biological mechanisms; kinetics; vapor-liquid equilibria; and settling phenomena.

ChE 687 - Industrial Gas Cleaning (3 credits)
Prerequisite: undergraduate degree in chemical engineering, or permission of the instructor. Review of available tools for cleaning atmospheric effluents from manufacturing facilities and power plants; use of a systems approach to minimize gas cleaning costs; alternatives involving combinations of process modification and effluent clean-up; methods for estimating key design parameters for cyclones, baghouses, electrostatic precipitators and scrubbers. Applications of design parameters through the solution of extensive problem-sets.

ChE 701 - Master's Thesis (6 credits)
Prerequisite: matriculation for the master's degree in chemical 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 department, 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.

ChE 702 - Selected Topics in Chemical Engineering II (3 credits)
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in chemical engineering.

ChE 705 - Independent Study (3 credits)
Prerequisites: permission from the graduate advisor (not dissertation advisor) in chemical engineering, as well as courses prescribed by a supervising faculty member (who is not the student's dissertation 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.

ChE 711 - Phase Equilibrium (3 credits)
Prerequisite: ChE 611 or equivalent. Low-pressure and high-pressure vapor-liquid equilibrium and liquid-liquid equilibrium. Among the topics covered are experimental methods, consistency tests of the data, expressions for the dependence of the activity coefficient on composition and temperature, and prediction of multicomponent vapor-liquid and liquid-liquid equilibrium from binary data. Prediction methods of vapor and liquid phase nonidealities, based on equations of state and solution theories, are discussed.

ChE 725 - Transport Phenomena II (3 credits)
Prerequisite: ChE 624 or equivalent. Transport in laminar and turbulent flow: in solids, between phases, and macroscopic transport in flow systems.

ChE 740 - Biological Treatment of Hazardous Chemical Wastes (3 credits)
Prerequisite: ChE 686 or the permission of the instructor. A doctoral level seminar on the limitations of biological treatment for hazardous wastes that looks at the fundamental processes taking place.

ChE 790 - Doctoral Dissertation (Credits as designated)
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 791 - Graduate Seminar (Non-credit)
Required of all chemical engineering or 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.

Chemistry

Offered by the Department of Chemical Engineering, Chemistry and Environmental Science

Chem 552 - Laser Chemistry and Technology (3 credits)
Prerequisites: one year of chemistry, one year of physics, and calculus. An introduction to the underlying chemical and physical principles of lasers, their operation and uses and the related optoelectronic technology. Analysis of classes of laser; pumping mechanisms; detection of light; absorption and emission of radiation and current industrial and state-of-the-art uses.

Chem 599 - Methods for Teaching Assistants and Graduate Assistants (3 credits)
Prerequisite: 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)
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in chemistry.

Chem 602 - Advanced Organic Chemistry II: Reactions (3 credits)
Prerequisite: undergraduate organic chemistry. The study of organic syntheses including principles underlying chemical reactions; chemical thermodynamics, structural theory, rates of reaction, mechanisms and stereochemistry; IR, UV, and NMR spectroscopy; organic synthesis; formation of aliphatic carbon-carbon bonds; pericyclic reactions; carbon-nitrogen bonds; electrophilic and nucleophilic aromatic substitution, molecular rearrangements; photochemical and free-radical reactions; oxidation and reduction; and organometallic reagents containing phosphorous, boron, sulfur, and silicon.

Chem 603 - Advanced Organic Chemistry Laboratory (3 credits)
Prerequisite: undergraduate organic chemistry. More advanced syntheses than those normally carried out in the undergraduate laboratory are emphasized including current analytical techniques and methods of separation. Both small and large scale preparations are assigned.

Chem 605 - Advanced Organic Chemistry I: Structure (3 credits)
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)
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)
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 611 - Solid-State Inorganic Chemistry (3 credits)
Prerequisite: undergraduate physical chemistry or physics. Structure, physical and chemical properties of solid-state materials, and their formation.

Chem 617 - Mass Spectrometry and Interpretation of Mass Spectra (3 credits)
Prerequisite: CHEM125 and CHEM126 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 626 - Chemistry of Contemporary Materials (3 credits)
Prerequisite: one year of general chemistry. An introduction to the structure and chemical, electrical, and mechanical properties of metallic, ceramic, and polymeric materials and their use in science and engineering.

Chem 629 - Heterogeneous Catalysis (3 credits)
Prerequisites: Undergraduate course in Organic Chemistry or Physical Chemistry or the equivalent. Basic principles of catalysis, catalyst preparation, and catalyst action; mechanisms and applications. Methods of catalyst preparation; effect on absorption, transport phenomenon, and reaction mechanisms and review of industrial examples.

Chem 640 - Polymer Chemistry (3 credits)
Prerequisites: undergraduate organic and physical chemistry. Kinetics of polymerization; properties of polymer solutions; characterization of molecular size and shape.

Chem 641 - Polymer Properties (3 credits)
Prerequisite: undergraduate organic and physical chemistry. Forces between polymer molecules and their relation to crystal structure; fundamentals of rheology and viscoelastic properties of polymers; polymer crosslinking, reinforcement, and aging from a chemical viewpoint.

Chem 643 - Polymer Laboratory I (3 credits)
Prerequisites: Chem 440

Chem 644 - Fundamentals of Adhesion (3 credits)
Prerequisite: Undergraduate organic and physical chemistry. Adhesion phenomena; intermolecular and interatomic forces; surface chemistry; absorption of polymers on surfaces; mechanisms of adhesion; bulk properties of adhesives; and rheology of polymers used as adhesives.

Chem 645 - Polymer Laboratory II (3 credits)
Prerequisite: Chem 643. Experiments illustrating contemporary methods of polymer characterization including osmometry, viscometry, laser light scattering, vapor pressure osmometry, differential thermal analysis, dilatometry, x-ray diffraction, birefrigence, polymer factionation/gel permeation chromatography, extrusion, swelling crosslinking, molding, viscoelasticity, and infrared, ultraviolet, and NMR spectroscopy.

Chem 654 - Corrosion (3 credits)
Prerequisite: one year of general 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.

Chem 655 - Electrochemistry: Principles and Applications (3 credits)
Prerequisites: one year of general chemistry and a course in physical chemistry or equivalent. Principles governing electrochemical methods such as conductance, emf, polarography, cyclic voltammetry, chronopotentiometry, coulometry, and their application to electric energy storage and conversion, corrosion, electroplating, pollution monitoring, electrochemical sensors, and electrochemical synthesis.

Chem 658 - Advanced Physical Chemistry (3 credits)
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 659 - Atomic and Molecular Structure (3 credits)
Prerequisite: Chem 658 or equivalent. Application of quantum chemistry and molecular structure; techniques for calculation of physical properties of molecules; and use of state-of-the-art computer graphics.

Chem 661 - Instrumental Analysis (3 credits)
Prerequisite: One year of 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 UV-VIS, FTIR, AA and NMR; HPLC, GC, and ion chromatography and mass spectrometry. One hour of lecture and three hours of laboratory per week.

Chem 661 - Instrumental Analysis Laboratory (3 credits)
Prerequisite: 1 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 UV-VIS, FTIR, AA, and NMR; HPLC, GC, and ion chromatography and mass spectrometry.

Chem 662 - Air Pollution Analysis (3 credits)
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 664 - Advanced Analytical Chemistry (3 credits)
Prerequisite: undergraduate physical 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 670 - Environmental Toxicology for Engineers and Scientists (3 credits)
Prerequisite: Chem 673 or equivalent. Toxicology at the molecular level, including methods of evaluation and quantification, as well as mechanisms of absorption, distribution, metabolism, and excretion of toxicants. Discussions of systemic toxicology (e.g., liver, kidneys, nervous system) and survey of toxic agents. Particular emphasis placed on environmental toxicology including air, water and soil pollutants, food additives, and contaminants.

Chem 671 - Industrial Toxicology Workshop (3 credits)
Prerequisite: Chem 670 or equivalent. A case study approach that applies basic theory and methods of toxicology to real-life problems related to hazardous materials transport, toxic commercial products and by-products, chemical industrial fires, unsafe landfills and illegal dumping.

Chem 673 - Biochemistry (3 credits)
Prerequisites: 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 - Master's Project (3 credits)
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 701 - Master's Thesis (6 credits)
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 702 - Special Topics in Chemistry II (3 credits)
Prerequisite: Graduate standing. Topics of current interest in chemistry.

Chem 717 - Mass Spectrometry and Mass Spectral Interpretation (3 credits)
Prerequisites: CHEM125 and CHEM126 or equivalent. Chem 717 and Evsc 617 are comprised of Chem/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 725 - Independent Study I (3 credits)
Prerequisites: 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)
Prerequisite: 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)
Prerequisite: 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)
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)
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 791 - Graduate Seminar (Non-credit)
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.

Civil Engineering

Offered by the Department of Civil and Environmental Engineering

CE 501 - Introduction to Soil Behavior (3 credits)
Prerequisites: CE 320, Mech 235 and Mech 236 (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 506 - Remote Sensing of Environment (3 credits)
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)
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)
Prerequisite: 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)
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)
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 additive credits)
Prerequisites: 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 additive credits)
Prerequisites: permission from the civil engineering department and the Division of Career Development Services.

CE 592 - Graduate Co-op Work Experience III (3 additive credits)
Prerequisites: permission from the civil engineering department and the Division of Career Development Services.

CE 601 - Advanced Remote Sensing (3 credits)
Prerequisite: a first course in remote sensing. Principles of computer processing of satellite and aircraft remote sensing data as well as image enhancement, image transformation and image classification techniques using

advanced image analysis system ERDAS in the interactive mode. Multiple applications on land use/land cover, water quality assessment and terrain evaluation will be emphasized. During final weeks of the semester students will apply the acquired techniques to specific projects.

CE 602 - Geographic Information System (3 credits)
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. Introduces this emerging technology and its applications. Same as MIP 652 and Tran 602.

CE 603 - Introduction to Urban Transportation Planning (3 credits)
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 Tran 603.

CE 604 - Environmental Modeling in Remote Sensing (3 credits)
Prerequisites: CE 602 and CE 605. Advanced course consisting of three main components: review of current research and literature dealing with environmental RS/GIS, applied and computer modeling of land and oceans; case studies in RS/GIS applications, emphasizing real world's environmental problems presented by outside experts; and presentation of student projects.

CE 605 - Research Methods in Remote Sensing (3 credits)
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 610 - Construction Management (3 credits)
Prerequisite: 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)
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)
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)
Prerequisites: 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)
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 618 - Applied Hydrogeology (3 credits)
Prerequisites: 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)
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)
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)
Prerequisites: 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)
Prerequisites: 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 625 - Public Transportation Operations and Technology (3 credits)
Prerequisite: graduate standing in a cross-listed department 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 Tran 625.

CE 626 - Sediment Transport (3 credits)
Prerequisites: CE 341or CE 501; CE 620 or consent of the instructor. Unified treatment of sediment transport over a wide range of conditions; basic theory and application to engineering problems. Sediment transport problems associated with the analysis and design aspects of hydraulic and environmental structures, including channel stability, scouring, dredging, reservoir sedimentation, and wastewater solids are presented.

CE 631 - Advanced Reinforced Concrete Design (3 credits)
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)
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)
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)
Prerequisites: 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)
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)
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)
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)
Prerequisites: CE 332 and CIS 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)
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)
Prerequisites: 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)
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)
Prerequisites: undergraduate courses in soil mechanics and geology. Review of the fundamentals of physical geology and discussion of the theory and the applications of geophysical methods with emphasis on geoenvironmental engineering. Presentation of concepts pertaining to natural hazards such as earthquakes, mass wasting, and well logging and coastal geology. Students are expected to prepare and present at least one relevant case history. Not recommended for those with backgrounds in geology.

CE 645 - Rock Mechanics II (3 credits)
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 646 - Geosynthetics and Soil Improvement (3 credits)
Prerequisite: CE 341 (see undergraduate catalog for description). Includes engineering properties of geosynthetics and their application in civil engineering, such as filtration, seepage, and erosion control; subgrade and slope stabilization. Soil improvement topics include preloading, electrokinetic stabilization, soil modification, admixtures and grouting.

CE 647 - Geotechnical Aspects of Solid Waste (3 credits)
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)
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 650 - Urban Systems Engineering (3 credits)
Prerequisites:B.S. degree in engineering or in the physical or social with some computer programming background. Identifies the various urban problems subject to engineering analysis, and modern techinques for their solution, including inductive and deductive mathematical models, mathematical modeling and simulation, and decision making under uncertainty. Same as Tran 650.

CE 653 - Traffic Safety (3 credits)
Prerequisite: CE 660. 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 Tran 653.

CE 655 - Land Use Planning (3 credits)
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 MIP 655 and Tran 655.

CE 659 - Flexible and Rigid Pavements (3 credits)
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 660 - Traffic Studies and Capacity (3 credits)
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 the highway capacity software (HCS) and SIDRA. Same as Tran 615.

CE 661 - Analysis and Design of Shell Structures (3 credits)
Prerequisite: undergraduate course in structural analysis. Methods of analysis and design of shell structures for building. Topics include: domes, hyperbolic paraboloids, folded plates, and cylindrical shells. Materials considered include reinforced and prestressed concrete.

CE 700 - Civil Engineering Project (3 credits)
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 701 - Master's Thesis (6 credits)
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 702 - Special Topics in Civil Engineering (3 credits)
Prerequisite: advisor's approval. Topics of special current interest in civil engineering.

CE 705 - Mass Transportation Systems (3 credits)
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 710 - Systems in Building Construction (3 credits)
Requirements and benefits of various building construction systems. Preliminary examination of the interrelation between design and construction. Topics include lift slab and tilt-up construction, slipforming, precasting, joist systems, modular construction, and mechanical and electrical systems.

CE 711 - Methods Improvement in Construction (3 credits)
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)
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)
Prerequisites: 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)
Prerequisites: 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)
Prerequisites: 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)
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)
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)
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)
Prerequisites: a working knowledge of computer programming, and Mech 630 and CE 630. 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)
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 738 - Advanced Matrix Analysis of Structures (3 credits)
Prerequisite: CE 639. Advanced topics from structural analysis, including nonlinear analysis of trusses, frames and membrane finite elements, collapse by buckling, analysis and design of fabric structures.

CE 739 - Structural Optimization (3 credits)
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 741 - Theoretical Soil Mechanics (3 credits)
Prerequisite: CE 641. An advanced graduate course for Ph.D. students and interested M.S. students in Civil Engineering. Explains the fundamentals of constitutive models for soils and their use in the solution of boundary value problems. Covers the theory of elasticity and theory of plasticity as tools in developing constitutive models for soils. Introduces critical state concept for soils. The triaxial experimental behavior of soils is discussed to introduce the concept of soil flow and strength. Critical state concept and elastoplastic material concepts are incorporated in the constitutive models, models predictions will be compared with experimental results for sands and for clays. Constitutive models will incorporated into finite element codes to analyze boundary value problems such as stability of slopes and performance of footings.

CE 742 - Geotechnology of Earthquake Engineering (3 credits)
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 743 - Contaminant Transport in Soils (3 credits)
Prerequisites: CE 618, CE 623 and CE 648. An advanced graduate course for Ph.D. students and interested M.S. students in civil, environmental, and chemical engineering. Explains the fundamental mechanisms involved in the organic chemical flow and transport in soils. Includes new concepts and recent findings associated with leaking underground storage tanks. First half deals with flow of nonaqueous phase liquids (NAPL) through a soil-water-air system. The second half discusses the sorption and dissolution of organics in the soil-water-air system, and transport of organics in the dissolved phase.

CE 751 - Transportation Design (3 credits)
Prerequisite: CE 603. Design problems for airports, terminals, and highway intersections and interchanges are undertaken. Same as Tran 751.

CE 752 - Traffic Control (3 credits)
Prerequisite: CE 660. 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 Tran 752.

CE 753 - Airport Design and Planning (3 credits)
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 754 - Port Design and Planning (3 credits)
Prerequisites: Tran 610 or EM 693 and CE 660. 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 IE 754 and Tran 754.

CE 765 - Multi-modal Freight Transportation Systems Analysis (3 credits)
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 - Doctoral Dissertation (3 credits)
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 791 - Graduate Seminar (Non-credit)
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.

Computer and Information Science

CCS Departments: Department of Computer Science, Department of Information Systems and the Information Technology Program

CIS 500 - Introduction to Systems Analysis (3 credits)

Prerequisites: statistics and differential equations. Covers a wide variety of systems oriented approaches to solving complex problems. Illustrative examples are chosen from a wide variety of applications. Mathematical tools are only introduced to the extent necessary to understand the technique and its application to the problem. Topic areas include probabilistic and decision theory models, simulation, morphological analysis, cluster analysis, structural modeling, Delphi and dynamic system models. The role for the computer in applying these techniques to complex problems will be discussed. The student will be exposed to some of the fundamental controversies concerning the appropriateness or validity of systems approaches to human problem solving.

CIS 505 - Programming, Data Structures, and Algorithms (3 credits)

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.

CIS 506 - Foundations of Computer Science (3 credits)

Prerequisite: knowledge of C/PASCAL. Corequisite: CIS 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.

CIS 510 - Assembly Language Programming and Principles (3 credits)

Prerequisite: knowledge of at least one procedure-oriented language such as PASCAL, C, or C++. Computer Science students cannot use this course for graduate degree credit. An intensive course in assembly language programming including basic machine organization, the structure of instruction sets, program linkage, macros and macro libraries. Extensive programming assignments are included.

CIS 515 - Advanced Computer Programming for Engineers (3 credits)

Prerequisite: knowledge of at least one procedure-oriented language such as PASCAL, C, or FORTRAN. Students specializing in computer science may not take this course for credit. This course is designed for engineering students who require an extensive knowledge of programming for their project or thesis work. Topics include review of basic programming techniques, treatment of algorithm design, error analysis and debugging. As time permits, problem-oriented languages are examined.

CIS 540 - Fundamentals of Logic and Automata (3 credits)

Prerequisite: Math 226 or equivalent (see undergraduate catalog for description). Theory of logic and automata and their influence on the design of computer systems, languages, and algorithms. Covers the application of Boolean algebra to design of finite state machines; formal systems, symbolic logic, computability, halting problem, Church's thesis, and the main ideas of the theory of computation.

CIS 565 - Aspects of Information Systems (3 credits)

Co-requisite: CIS 431 or permission of the department. 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.

CIS 590 - Graduate Co-op Work Experience I (3 additive credits)

Prerequisite: 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.

CIS 591 - Graduate Co-op Work Experience II (3 additive credits)
Prerequisite: 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.

CIS 592 - Graduate Co-op Work Experience III (3 additive credits)
Prerequisites: 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.

CIS 601 - Object-Oriented Programming (3 credits)
Prerequisite: basic knowledge of C++. Covers the fundamentals of object-oriented programming. Includes object-oriented concepts such as data abstractions, encapsulation, inheritance, dynamic binding, and polymorphism, and uses C++ as the vehicle for illustrating and implementing these concepts. The object-oriented paradigm is systematically employed in the design of all concepts. Effects of this methodology on software maintenance, extensibility, and reuse. Significant programming/design projects.

CIS 602 - Java Programming (3 credits)
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 Java Development Kit version 1.1 (JDK1.1), both deprecated methods and newly introduced features are discussed.

CIS 603 - Advanced Programming Environments and Tools (3 credits)
Prerequisite: CIS 601. Introduction to Graphical User Interface (GUI) Programming in the X Windows System environment. Design and implementation of the GUI at various levels of abstraction using industry standard software tools. Trade-offs between flexibility and ease of use inherent in GUI building tools. Best suited for the advanced programmer.

CIS 604 - Client/Server Computing (3 credits)
Prerequisites: CIS 333 and CIS 432 or instructor approval (see undergraduate catalog for descriptions). Fundamentals of client/server architecture as applied to the development of software systems. Concepts of distributed systems such as open systems, middleware, software reengineering, and distributed computing environments. Components of distributed client/server technologies such as X Windows Systems, DCE, CORBA, NFS, and ODBC. Case studies are used to illustrate how client/server techniques can be used in a variety of applications. The importance of standards and their role in client/server architecture, such as Posix, DCE, and COS. Requires creation of distributed applications.

CIS 605 - Discrete Event Dynamic Systems (3 credits)
Prerequisite: Math 630 or EE 601 or MnE 603 or equivalent. Covers discrete event dynamic system theory and its 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.

CIS 608 - Cryptography and Security (3-1-3)
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.

CIS 610 - Data Structures and Algorithms (3 credits)
Prerequisite: CIS 505 or CIS 335 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.

CIS 611 - Introduction to Computability and Complexity (3 credits)
Prerequisites: mathematics bridge requirements. 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.

CIS 621 - Numerical Analysis I (3 credits)
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.

CIS 622 - Numerical Analysis II (3 credits)
Prerequisite: Math 511 (see undergraduate catalog for description) or an introductory course in numerical methods. This course covers the theory and design of computer solutions to mathematical equations. Included are iterative methods for solving systems of linear and nonlinear equations, the numerical eigenvalue-eigenvector problem, and methods for solving ordinary and partial differential equations. Emphasis is on the control of errors generated by the computer.

CIS 623 - Qualitative Research on Information Systems (3 credits)
Prerequisites: CIS 350 (or equivalent covering basics of research in IS) or CIS 675. A review of major qualitative research methods in Information Systems research, including interviews, content analysis, participant observation (ethnography), case and field studies, group techniques, and selected other methods. Students read and make experiential use of articles providing examples of the use of these methods in the IS journal literature.

CIS 630 - Operating System Design (3 credits)
Prerequisites: CIS 332, CIS 432 (see undergraduate catalog for descriptions) and CIS 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.

CIS 631 - Data Management System Design (3 credits)
Prerequisites: 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.

CIS 632 - Advanced Database System Design (3 credits)
Prerequisites: CIS 631 and knowledge of C++. Covers the concepts and principles of object-oriented data modeling and database systems, parallel and distributed database systems, database machines, real time (database) systems, multimedia and text databases, and imprecise information retrieval systems. Emphasis is on advanced data modeling, query optimization, indexing techniques, concurrency control, crash recovery, distributed deadlock detection, real-time scheduling, vague retrieval and system performance.

CIS 633 - Distributed Systems (3 credits)
Prerequisites: 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.

CIS 634 - Information Retrieval (3 credits)
Prerequisites: CIS 631. Covers the concepts and principles of information retrieval systems design. Techniques essential for building text databases, document processing systems, office automation systems, and other advanced information management systems.

CIS 635 - Computer Programming Languages (3 credits)
Prerequisites: CIS 505 and CIS 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.

CIS 636 - Compiling System Design (3 credits)
Prerequisite: CIS 635. Compiler organization; interaction of language and compiler design. The front end scanning, parsing, and syntax-directed translation: theory, standard approaches, and techniques; front-end tools such as Lex and Yacc. Attribute grammars. Code generation, register allocation, and scheduling; interaction with the run-time environment. Introduction to static analysis and optimization. As time permits, topics in modern compilers: compiling for object-oriented languages such as C++ or Java, memory hierarchies, pipelining, parallelism. Includes a significant programming component.

CIS 637 - Real-Time Systems (3 credits)
Prerequisites: completion of bridge requirements. Theory and principles that govern real-time systems design, and mechanisms and methodologies that enable their construction and operation. All aspects of such systems will be covered, including scheduling, device and resource management, communications, machine architecture, kernel software, language design and implementation, specification and user interfaces, and performance analysis and verification techniques.

CIS 640 - Recursive Function Theory (3 credits)
Prerequisite: CIS 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.

CIS 641 - Formal Languages and Automata (3 credits)
Prerequisite: Math 226 or equivalent (see undergraduate catalog for description). Fundamentals of automata and formal languages: hierarchy of abstract machines and languages; nondeterministic finite state machines; tape and pushdown automata; context-free and context-sensitive grammars.

CIS 650 - Computer Architecture (3 credits)
Prerequisites: CIS 251 (see undergraduate catalog for description) and CIS 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.

CIS 651 - Data Communications (3 credits)
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.

CIS 652 - Computer Networks-Architectures, Protocols and Standards (3 credits)
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 Interconnection (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.

CIS 653 - Microcomputers and Applications (3 credits)
Prerequisite: familiarity with an assembly level and higher-level language. An investigation of the personal computer based on the WinTEl architecture. Programming and use of the various input/output devices via operating system constructs. Use of computer in stand-alone (control) applications and networked applications. Investigation of non-Intel architectures and non-Windows systems as time permits.

CIS 654 - Telecommunication Networks Performance Analysis (3 credits)
Prerequisites: CIS 651, CIS 652, or instructor approved equivalents. Modeling and analysis of telecommunication networks; with emphasis on Local Area Networks (LANs) and Metropolitan Area Networks (MANs). Case studies will be presented and discussed, and the need for modeling and analysis will be established. Various types of LANs, and MANs will be modeled and analyzed. Problem sets and case studies will be assigned to facilitate understanding of the covered material.

CIS 656 - Internetworking and Higher Layer Protocols (3 credits)
Prerequisite: CIS 652 or instructor approved equivalents. Intensive study of the architecture of interconnected networks and corresponding protocols that make interconnected architectures function as a single unified communication system. Topics include: Internet services (archie, gopher, veronica, wais, netfind, world wide web, mosaic, etc.), the address resolution protocol (ARP) and reverse ARP, the Internet protocol, transparent gateways and subnetting, the domain name system, routing and multicasting in the Internet, the User Datagram Protocol (UDP), the Transmission Control Protocol (TCP), the socket interface, the client-server model of interaction, TCP/IP and OSI application level protocols.

CIS 657 - Principles of Interactive Computer Graphics (3 credits)
Prerequisites: CIS 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.

CIS 658 - Multimedia Systems (3 credits)
Prerequisites: CIS 610 and CIS 657, or CIS 631 or equivalent. Introduction to multimedia information systems; the nature of multimedia data types including text, image, audio, video and animation; multimedia data models and system architectures; design of multimedia systems including interfaces, storage models and structures, filtering, browsing and composing paradigms, query processing and information retrieval. Students will develop applications in multimedia authoring environments.

CIS 658 - Multimedia Systems (3 credits)
Prerequisite: CIS 601 (Object-Oriented Programming) or equivalent. Multimedia software systems incorporate various media, such as text, images, video and audio, to provide rich experiences for users. This is a course in the design, implementation and evaluation of multimedia systems. The course has three major content areas and goals: (1) multimedia data types-the goal being to understand the development and use of various multimedia data types; (2) usability and user modeling-the goal being to incorporate theories of human perception and cognition into the design and evaluation of multimedia systems; and (3) multimedia design and software tools-the goals being to

plan and develop multimedia projects and to be aware of ways in which multimedia is being used in the public and private sectors.

CIS 659 - Image Processing and Analysis (3 credits)
Prerequisite: CIS 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.

CIS 661 - Systems Simulation (3 credits)
Prerequisites: 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.

CIS 662 - Model Analysis and Simulation (3 credits)
Prerequisite: introductory course in simulation. Advanced topics in simulation methodology, including design of simulation experiments, variance reduction techniques, estimation procedures, validation, and analysis of simulation results. Queueing systems. Implementing a simulation with the SIMSCRIPT language. Models of continuous systems with applications to elementary socio-economic and industrial systems. Utilization of the DYNAMO II language.

CIS 663 - Advanced System Analysis and Design (3 credits)
This course focuses on the systems analysis and design techniques employed in the development of software applications. Topics include software process and process models (e.g. Rational Unified Process), project management, structured and object oriented analysis, system design, quality systems, system and software architecture, design patterns, re-use and component-based design, change control and configuration managemnet. Analysis and design will be covered primarily from an object oriented perspective. Students will read selected material from the literature, actively participate in discussions, labs and exercises in addition to participating in projects that involve analysis and design for real-world problems.

CIS 665 - Algorithmic Graph Theory (3 credits)
Prerequisite: CIS 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.

CIS 667 - Design Techniques for Algorithms (3 credits)
Prerequisite: CIS 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.

CIS 668 - Parallel Algorithms (3 credits)
Prerequisites: CIS 610 and CIS 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.

CIS 669 - Computational Geometry (3 credits)
Prerequisite: CIS 610 or permission of the instructor. Intensive study of the fundamentals of computational geometry data structures and algorithms. Emphasis is on the design of efficient algorithms and data structures, proofs of their correctness and complexity analysis. Fundamental topics including geometric searching, convex hull computation, nearest/farthest searching, Voronoi diagrams, Euclidean minimum spanning trees, planar triangulation, planar point location, arrangement of lines.

CIS 670 - Artificial Intelligence (3 credits)
Prerequisite: CIS 610 and CIS 631. 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.

CIS 671 - Knowledge-Based Systems (3 credits)
Prerequisite: CIS 670 or equivalent. Deals with the underlying architectures of classical knowledge-based systems, i.e., systems based on a knowledge representation formalism that are built by knowledge acquisition from a domain expert; and advanced database systems, especially object-oriented and deductive databases.

CIS 672 - Expert System Methods and Design (3 credits)
Prerequisite: CIS 670. Deals with expert systems, expert system shells, programming of rule-based systems, selection of shells, verification and validation of expert systems, and knowledge acquisition techniques for extracting knowledge from domain experts.

CIS 673 - Software Design and Production Methodology (3 credits)
Prerequisite: CIS 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.

CIS 674 - Natural Language Processing (3 credits)
Prerequisite: CIS 670. Deals with techniques of natural language understanding. Topics are syntax and parsing (top down and bottom up), semantics, pragmatics and use of world knowledge in language understanding. Augmented Transition Networks will be used as programming tool set. Good knowledge of LISP or PROLOG.

CIS 675 - Information System Evaluation (3 credits)
Prerequisites: a course in statistics and CIS 677. Theoretical perspectives and methodological approaches to evaluate information systems within the context of the user and organizational environment. Topics include qualitative techniques such as protocol analysis and interviews; quantitative techniques such as sample surveys and controlled experiment; cost-benefit analysis, and analyses of data gathered by these approaches by methods such as regression, correlation, and analysis of variance. Emphasis on the application of these approaches to improve functionality, interface, and acceptance of information systems in organizations.

CIS 676 - Requirements Engineering (3 credits)
Prerequisites: completion of bridge requirements, CIS 673 or equivalent project experience in the field. Theory, principles, and practical application of the methodologies and tools of 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 will be covered, including problem analysis, requirements specification techniques and tools, and specification of functional and non-functional requirements. Related technologies like domain analysis and pre-planned systems integration are also discussed.

CIS 677 - Information System Principles (3 credits)
Prerequisites: familiarity with the organization of a computer system and knowledge of at least one higher-level language. Reviews the role of information systems in organizations and how they relate to organizational objectives and organizational structure. Identifies basic concepts such as the systems point of view, the organization of a system, the nature of information and information flows, the impact of systems upon management and organizations, human information processing and related cognitive concepts. Introduces various types of applications that are part of information systems. The course focus is on management information systems.

CIS 678 * - Medical Terminologies (3 credits)
Describes in depth a number of medical terminologies in common use in the U.S. health care system, such as ICD-9-CM, SNOMED, HL7, MeSH, and especially the UMLS of the National Library of Medicine. Conduct hands-on work with the UMLS and write programs to extract and display information from the UMLS. Also covers European systems such as GALEN/SMK.

CIS 679 - Management of Computer and Information Systems (3 credits)
Prerequisite: CIS 675. Management of the development, planning, and utilization of information systems within organizations. Focuses on the current literature in the management of information systems. Topics include the

approval and decision process for the development of systems, use of steering committees and various approaches to user involvement. Utilizes a number of Harvard University case studies. Project utilizing professional literature required.

CIS 681 - Computer Security Auditing (3 credits)
Prerequisites: CIS 601 or CIS 631 or permission of the instructor. Security control risks and issues. Information protection concepts, elements of security systems, computer crime and legal issues, controls and auditing systems, firewall configuration.

CIS 682 - Geometric Modeling (3 credits)
Prerequisite: CIS 610. The techniques required to describe the shape of an object and to simulate dynamic processes; parametric geometry of curves, surfaces, and solids; and particular formulations for facilitating calculating geometric properties. Fundamentals of solid model construction and analysis are discussed extensively. Some applications in computer graphics, CAD, and CAM are also mentioned.

CIS 683 - Object-Oriented Software Development (3 credits)
Prerequisites: CIS 635, experience in software design and development or explicit approval of the instructor. Advanced course in software development. Presents the object-oriented methodology for software development and examines various areas to which this methodology can be applied. Analysis, design, and implementation of object-oriented software and the effect of this methodology on code reusability, extensibility, and robustness. Examines object-oriented languages, object-oriented databases, and object-oriented user-interfaces.

CIS 684 - Business Process Innovation (3 credits)
Prerequisites: CIS 631, CIS 673, knowledge of information systemsdevelopment. Discusses a balanced approach to business process innovation (BPI) that includes both incremental improvement and re-engineering. Introduces strategy and process alignment, various types of busines processes, and process mapping software. Details a BPI implementation methodology, interwoven with many case studies. Students will work on real process re-design projects using a process mapping software product.

CIS 688 - Programming for Interactive Environments (3 credits)
Prerequisite: knowledge of C++. A thorough study of the fundamental concepts and techniques of programming for modern interactive support environments, better known as graphical user interfaces (GUIs). A balanced blend of principle and practice, incorporating a general paradigm of interactive program development and numerous examples from, and projects in, the major GUI environments.

CIS 696 - Network Management and Security (3 credits)
Prerequisites: CIS 652 or ECE 683, and CIS 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 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.

CIS 697 - Principles of Broadband ISDN and ATM (3 credits)
Prerequisite: CIS 652 or ECE 683 or equivalent. Study of the Broadband Integrated Services Digital Network (B-ISDN) architecture and services. In-depth study of the Asynchronous Transfer Mode (ATM), ATM Adaptation Layer (AAL), ATM switching architectures, SONET/SDH, ATM traffic control, broadband integrated traffic models, Operation Administration and Management (OAM) functions, TCP/IP over ATM, and ATM market. Same as ECE 639.

CIS 700 - Master's Project (3 credits)
Prerequisite: matriculation for the master's degree. An approved project involving design, implementation, and analysis, or theoretical investigation is required of all students in the Master of Science degree program who do not take CIS 701 Master's Thesis. A project proposal must be submitted in a prior semester by an announced date and receive faculty approval. Project work is normally initiated in a computer science course with the knowledge and approval of the instructor who will become the student's project advisor.

CIS 701 - Master's Thesis (6 credits)
Prerequisite: matriculation for the master's degree. An approved project involving design, implementation, and analysis or theoretical investigation may be the basis for the thesis. The work will be carried out under the supervision of a designated member of the faculty. The thesis should be of such 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 indicated for the thesis.

CIS 725, 726 - Independent Study in Computer Science I, II (3 credits)
Prerequisites: graduate standing and department consent.

CIS 730 - Seminar in Database Management Topics (3 credits)
Prerequisite: CIS 631. A seminar in which students pursue intensive study of specialized topics in the current literature of database management. Each topic is supported by an initial reading list covering current problems in theory and practice. Students present the results of their studies in class with faculty and invited specialists participating. Topics include, but are not limited to, advanced data modeling, object oriented databases, query languages, semantic optimization, database mapping and integration, physical database architecture, database/knowledge-base integration, distributed databases, database machines, database version control, logical and deductive databases.

CIS 731 - Applications of Database Systems (3 credits)
Prerequisites: CIS 675 and CIS 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.

CIS 732 - Design of Interactive Systems (3 credits)
Prerequisite: CIS 675. Design of interactive systems and human computer interfaces. Covers the current professional literature in this field and the knowns about design. Emphasizes application areas that have a great deal of cognitive variability and diverse user populations. Design interfaces for various applications. The impact of costs and operational practices upon user behavior and current research topics in interface design are covered.

CIS 734 - Data Mining (3 credits)
Prerequisites: Permission from instructor. Covers the concepts and principles of advanced data mining systems design. Presents methods for association and dependency analysis, classification and predication, and clustering analysis. Optional topics may include Web and scientific data mining, knowledge discovery applications, and current trends in data mining.

CIS 735 - Computer Mediated Communication Systems (3 credits)
Prerequisite: CIS 675. Seminar for students contemplating research in the following areas: designs and the impact of, computer-based systems for human communication, including electronic mail, computer conferencing, Computer-Supported Cooperative Work (CSCW), Group Decision Support Systems (GDSS), the Internet and the World Wide Web. Topics include alternative design structures, impacts of primarily text-based asynchronous group communication, and recent empirical studies. Completion of a publishable state-of-the-art written review or design of a tailored CMC system is required.

CIS 741 - Communication Network Design (3 credits)
Prerequisites: CIS 651 and CIS 652. Basic problems of communication network design: analyzes their complexity and provides algorithms, heuristics and other techniques for their solution.

CIS 744 - Data Mining and Management in Bioinformatics (3 credits)
Prerequisites: CIS 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.

CIS 750 - High Performance Computing (3 credits)
Prerequisite: CIS 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.

CIS 752 - Communication Protocol Synthesis and Analysis (3 credits)
Prerequisite: CIS 652 or basic familiarity with communication protocols. An in-depth study of the state of the art of protocol engineering. Enables students to apply the techniques of protocol design to real problems in communication protocols.

CIS 754 - Measurement and Evaluation of Software Quality and Performance (3 credits)
Prerequisites: Ph.D. core courses, CIS 630, CIS 661. A study of the tools for the measurement of software products and the use of these tools in the evaluation of software quality and performance. Structural and functional models of algorithms, programs, and systems are presented to define the quantitative and subjective characteristics of computer products. Course includes the use of hardware and software tools, the study of simulation and analytic techniques, description of workloads and benchmarks for system evaluation, problems of scale, proof of program correctness, feature value analysis, and the design and interpretation of experiments.

CIS 759 - Advanced Image Processing and Analysis (3 credits)
Prerequisite: CIS 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.

CIS 762 - Computerized Information Systems for Planning and Forecasting (3 credits)
Prerequisite: CIS 675. Capturing and processing of subjective and empirical data for use in planning and forecasting information systems and the incorporation of these facilities into information systems designs. Emphasis on conveying understanding of the limitations of various methods and techniques to meet various planning and forecasting objectives. Use of various techniques such as the Delphi method, structural modeling, cluster analysis and regression approaches.

CIS 767 - Decision Support Systems (3 credits)
Prerequisite: CIS 675. The design, implementation, and utilization of models and their software support systems for application in managerial decision making at the strategic, tactical, and operational levels. Topics include the perspective of decision-support systems, the management of large simulation models and documentation standards, combined hybrid simulation languages and their applications, financial modeling and financial modeling languages. Systems dynamics and its managerial applications at the strategic level; specialized modeling and analysis software packages for managerial decision making; and recent research in computer-aided tools for capturing group judgment, modeling, and decision-making are also discussed.

CIS 775 - Seminar in Software Engineering (3 credits)
Prerequisite: CIS 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.

CIS 776 - Independent Study in Information Systems (3 credits)
Prerequisite: restricted to students in the doctoral program in computer science or in management who have a major or minor in computer and information systems in management. Students must have an approved advanced program of study and approval of a faculty advisor to register for this course. Independent study is in a student-selected specialization. Students must present to a field exam committee a state-of-the-art review of the specialization topic area.

CIS 776 - Independent Study in Information Systems (3 credits)
Prerequisite: restricted to students in the doctoral program in Information Systems (or students in the joint Rutgers-NJIT PhD in management who major in CIS). Students must have an approved program of study and approval of a

faculty advisor to register for this course. Normally used for work on the "state of the art literature review," preceding the thesis, which is then presented to a committee for approval.

CIS 777 - Seminar in Software Management and Production (3 credits)
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.

CIS 780 - Computer Vision (3 credits)
Prerequisite: CIS 505. Intensive study of the construction of explicit and meaningful descriptions of physical objects from computer images. Covers ideas from artificial intelligence, psychology, computer graphics, and image processing.

CIS 780 - Computer Vision (3 credits)
Prerequisite: CIS 505. 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 contemporary development in all mainstream areas of computer vision e.g., Image Formation, Feature Representation, Classification and Recognition , Motion Analysis, Camera Calibration, 3D Vision, Shape From X, and typical applications such as Biometrics.

CIS 782 - Pattern Recognition and Applications (3 credits)
Prerequisite: CIS 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.

CIS 785 - Seminar in Computer and Information Science I (3 credits)
Prerequisites: 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.

CIS 786 - Special Topics in Computer and Information Science (3 credits)
Prerequisites: same as for CIS 785. A continuation of CIS 785.

CIS 787 - Information Systems PhD Seminar A (1 credit)
The seminar includes student presentations related to their research, faculty presentations, and occasional outside speakers. Its goal is to enable students to identify their research areas for the dissertation, and to obtain constructive feedback on their papers and research in progress. Two presentations are required of each student. Open to students in the PhD program in Information Systems.

CIS 788 - Information Systems PhD Seminar B (3 credits)
Prerequisite: at least one credit of CIS 787. The seminar includes student presentations related to their research, faculty presentations, and occasional outside speakers. Its goal is to enable students to identify their research area for the dissertation, and to obtain constructive feedback on their papers and research in progress. Students are required to do at least three presentations including one for a paper to be submitted to a professional meeting or journal. Three credits of CIS 788 may count as the equivalent of three credits of predoctoral research. Open to students in the PhD program in Information Systems.

CIS 788 - Information Systems PhD Seminar B (3 credits)
The seminar includes student presentations related to their research, faculty presentations, and occasional outside speakers. Its goal is to enable students to identify their research area for the dissertation, and to obtain constructive

feedback on their papers and research in progress. Students are required to engage in a research internship under the direction of a faculty member, and to make at least three presentations, including at least one for a paper to be submitted to a professional meeting or journal. Three credits of CIS 788 may count as the equivalent of three credits of predoctoral research. Open to students in the PhD program in Information Systems.

CIS 790 - Doctoral Dissertation (Credits as designated)
Corequisite: CIS 791. Required for all doctoral students in computer science and for doctoral students in the joint NJIT/Rutgers doctoral program in management who major in computer information systems. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation while engaged in doctoral research. After 30 credits (additive to a maximum of 6 credits of CIS 792) are completed, students must register for 3 credits each semester until the dissertation is completed.

CIS 791 - Graduate Seminar (Non-credit)
Corequisite (for doctoral students only): CIS 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.

CIS 792 - Pre-Doctoral Research (3 credits)
Prerequisite: 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 CIS 792 may be applied to the CIS 790 requirement.

CIS 794 - Computer Science Colloquium (Non-credit)
Prerequisite: graduate standing with major in computer science. Colloquium in which national and international experts in the various fields of computer science are invited to present and discuss the results of their recent research.

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* pending approval

Ecology and Evolution

Offered by the Department of Ecology and Evolution at Rutgers-New Brunswick

16:215:533 - The Behavior of Animal Populations (3 credits)

Prerequisite: animal behavior or ecology. Topics in ecological adaptations of behavior; emphasis on the population level. Student research topics.

16:215:565 - Community Dynamics (4 credits)

Patterns and processes involving sets of two or more coexisting species. Theoretical and empirical studies.

16:215:590 - Population Ecology (4 credits)

Prerequisite: one ecology course. Population dynamics and demography, natural selection and evolution, life history strategies, population regulatory mechanisms, species interactions and co-evolution, variability among populations and ecological differentiation and island biogeography.

Economics

Offered by the School of Management. See Management course list for faculty.

Econ 565 - Managerial Economics (3 credits)
Managerial decision-making for different markets: structure of industry, vertical integration, conglomerate firms, multinational firms, theory of contestable markets, entry deterrence, estimating demand and cost functions, price discrimination, agency trade, theory of regulation, market signaling and hiring, and theory of share economy.

Electrical and Computer Engineering

Offered by the Department of Electrical and Computer Engineering

ECE 501 - Linear Systems and Random Signals (3 credits)

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 550 - Circuit Analysis (3 credits)

Introduction to analysis of linear circuits and systems. Techniques used include mesh and nodal analysis, network theorems, steady-state and transient methods, analogs, Fourier series and transforms, and LaPlace transforms. Pole-zero diagrams are developed as an aid in the study of low-order systems. Credits for this course may not be used to fulfill any electrical engineering degree requirement.

ECE 590 - Graduate Co-op Work Experience I (3 credits)

Prerequisites: 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 additive credits)

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 additive credits)

Prerequisites: 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 599 - Electrical Engineering Laboratory (3 credits)

Prerequisites: B.S. in engineering or science, and permission from ECE department. Workshop on fundamental measurements involving instrumentation commonly used in testing electronic and power circuits. Credits for this course may not be used to fulfill any electrical engineering degree requirement.

ECE 601 - Linear Systems (3 credits)

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)

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)

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)

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)
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)
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)
Protection of Power Systems

ECE 614 - Dynamics of Electromechanical Energy Conversion (3 credits)
Prerequisites: ECE 620 and undergraduate electric machines. Dynamic behavior of lumped parameter systems; study of a continuum electromechanics, such as magnetic diffusion and the stress tensor; and dynamics of electromechanical continua in two- and three-dimensional systems.

ECE 615 - Advanced Electromechanical Energy Conversion I (3 credits)
Prerequisite: undergraduate electric machines. Steady-state performance of synchronous machines; time constants, sudden reactive loading; sudden short-circuit conditions; dynamic behavior of synchronous machines; speed torque-current control of induction machines; magnetic noise and voltage ripples; and Kron generalized machine theory.

ECE 616 - Power Electronics (3 credits)
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 618 - Power System Design of Alternative Energy Sources (3 credits)
Prerequisite: EE 451 or equivalent (see undergraduate catalog for description). System design modeling, economic feasibility, and applications of alternative and renewable energy sources including: fuel cells, storage batteries, bio-electrochemical cells, redox flow cells, ocean thermal energy converters, and magnetohydrodynamic converters. The modes of system interconnections, including linkage to conventional power systems, are also studied.

ECE 620 - Electromagnetic Field Theory (3 credits)
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)
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)
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)
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)
Prerequisites: 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)
Prerequisites: 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)
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)
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)
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)
Prerequisites: ECE 682 or ECE683 or equivalent, and ECE 637 or equivalent. 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 - Introduction to Internet Engineering (3 credits)
Prerequisites: ECE683 or CIS 652 or equivalent. Provides a comprehensive introduction to the architecture of the Internet, the TCP/IP technology and the associated design and performance issues. The main topics of focus are: current LAN technologies, TCP/IP protocol suite, Internet configuration and troubleshooting, "unplugged'' (Mobile) Internet, internetworking solutions (routers, bridges, routing protocols), real-time traffic support and flows in Internet, performance issues and other design considerations.&#0;scovery (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.&#0; correctness semantics of programs.&#0; mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

ECE 638 - Network Management and Security (3 credits)
Prerequisites: CIS 652 or ECE 683, and CIS 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 ISDN and ATM (3 credits)
Prerequisite: CIS 652 or ECE 683 or equivalent. Study of the Broadband Integrated Services Digital Network (B-ISDN) architecture and services. In-depth study of the Asynchronous Transfer Mode (ATM), ATM Adaptation Layer (AAL), ATM switching architectures, SONET/SDH, ATM traffic control, broadband integrated traffic models, Operation Administration and Management (OAM) functions, TCP/IP over ATM, and ATM market. Same as CIS 697.

ECE 640 - Digital Signal Processing (3 credits)
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 642 - Communication Systems I (3 credits)
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)
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 - Introduction to Wireless and Personal Communications Systems (3 credits)
Prerequisite: ECE 642 or equivalent. Introduces emerging personal communications networks (PCN) and envisioned personal communication services (PCS). Discussion of recent history of underlying technologies that are being used to synthesize PCN and delineation of the alternative approaches being considered. Focuses primarily on U.S. technologies, with coverage of wireless technologies in Europe and Japan.

ECE 645 - Wireless Networks (3 credits)
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)
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)
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)
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)
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 657 - Semiconductor Devices (3 credits)
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)
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)
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)
Prerequisites: 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)
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 662 - Large Power Control Systems (3 credits)
Prerequisites: ECE 660, ECE 614, or equivalents. Emphasis on the design and test analysis of servomechanisms and regulation systems involving large power components such as dc machines, induction motors, and alternators. Positioning and velocity servos using rotating amplifiers are covered. A velocity servo for controlling a large induction motor is designed and a typical alternator voltage regulator studied, with regard to its servo characteristics. Methods of determining motor size and gear ratio in large positioning servos are covered.

ECE 664 - Real-time Computer Control Systems (3 credits)
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)
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 - Systems Studies in Bioengineering (3 credits)
Prerequisite: Undergraduate or graduate course in linear systems. Basic techniques of simulation including digital simulation languages. Physiologic systems of current interest using systems analysis techniques leading to formulation of mathematical, computer, or electric circuit models. Systems examined include the circulatory, respiratory, or hormonal control systems. Basic techniques of signal processing are explored which are necessary to analyze data from physiologic systems. Same as BME 667.

ECE 673 - Random Signal Analysis I (3 credits)
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)
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 - Broadband Packet Switches (3 credits)
Discussion and comparison of performance and implementation complexity. Topics include introduction of B-ISDN and asynchronous transfer mode (ATM) technology, ATM switch design criteria and performance requirement, survey of existing ATM switch architecture, shared-, medium- and shared-memory switches, knockout switch, terabit ATM switches, multicast ATM switch, optical ATM switch, IP switches and routers.

ECE 682 - Introduction to Computer Network Design: Internet Perspective (3 credits)
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)
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)
Prerequisites: 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)
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)
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)
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)
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 - Digital System Design for Machine Arithmetic (3 credits)
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)
Prerequisites: ECE 684 and CoE 353 (see undergraduate catalog for description) or CIS 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 698 - Selected Topics in Electrical and Computer Engineering (3 credits)
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)
See description for ECE 698 above.

ECE 700 - Master's Project (3 credits)
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 701 - Master's Thesis (3 credits)
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 710 - Economic Control of Interconnected Power Systems (3 credits)
Prerequisite: ECE 610. Theoretical developments and computer methods in determining economic operation within the boundaries of a given steam-electric operating area. Energy accounting control and economic theories for interconnected steam and hydroelectric power systems.

ECE 711 - Power System Dynamics and Stability (3 credits)
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 719 - Advanced Electromechanical Energy Conversion II (3 credits)
Prerequisites: ECE 615, ECE 622. Derivation of circuit models of rotating systems, based on the cross-sectional space wave method and the study of generalized Maxwell-Lorentz equations, applied to coupled rotational bodies.

ECE 725 - Independent Study I (3 credits)
Prerequisite: 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)
See description for ECE 725 above. This course is not available to master's students.

ECE 730 - Theory of Guided Waves (3 credits)
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)
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)
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)
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 745 - Advanced Wireless Networks (3 credits)
Prerequisite: ECE 645. This course explores next generation wireless networks. Students are expected to conduct research on the up to the minute advances in research, development, and standards activities in wireless networks. Resource allocation and Quality of Service provisioning which include advanced queueing tools in the case of long range dependent and self-similar traffic are discussed. State of the art topics such as mobility management, routing, Mobile IP, Cellular IP, and relevant open issues are studied. New network architectures are studied in detail. These include advanced wireless data communications via ad hoc networking, wireless Internet, and multimedia service provisioning over broadband air interfaces.

ECE 746 - Adaptive Array Processing and Interference Cancellation (3 credits)
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)
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)
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)
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 - Wireless Communications (3 credits)
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)
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)
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)
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)
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)
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)
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 773 - Random Signal Analysis II (3 credits)
Prerequisite: ECE 673. Continuation of ECE 673. Non-stationary stochastic processes, harmonic analysis, the zero crossing problem, Markov processes, the Poisson process, orthogonal expansions, non-Gaussian processes, non-linear operations.

ECE 776 - Information Theory (3 credits)
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)
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)
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 783 - Computer Communication Networks (3 credits)
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)
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)
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)
See description for ECE 788.

ECE 790 - Doctoral Dissertation (Credits as designated)
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 791 - Graduate Seminar (0 credit)
Required every semester of all master's students in computer engineering or electrical 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.

ECE 792 - Pre-Doctoral Research (3 credits)
Prerequisite: 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 ECE 790 after the student fulfills requirements of doctoral candidacy.

Engineering Management

Offered by the Department of Industrial and Manufacturing Engineering

EM 501 - Industrial Management (3 credits)

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)

Prerequisite: 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)

Prerequisites: 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)

Prerequisites: 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 607 - Seminar in Contemporary Management Problems (3 credits)

Prerequisites: undergraduate courses in economics and management. Readings, discussions, field studies, and reports in areas of contemporary management, behavioral science, management science, economics, and systems planning and control. Course is designed to encourage and give direction to student research for thesis.

EM 617 - Environmental Risk Assessment (3 credits)

Prerequisites: 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)

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)

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)

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)

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)
Prerequisites: 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)
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)
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 638 - Advanced Topics in Project Management and Cost Engineering (3 credits)
Prerequisites: EM 636, EM 637 or equivalent. Considers project management from its initial development to its successful execution from the owner and vendor's perspective. Topics emphasized include pre-proposal activities, project finance, risk control claim management, contract administration and human resource utilization and termination. Assignments include working in a team setting and, when appropriate, using relevant software.

EM 640 - Distribution Logistics (3 credits)
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)
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)
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)
Prerequisites: 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)
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)
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)
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)
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)
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)
Prerequisites: 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 701 – Master's Thesis (6 credits)
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)
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)
Prerequisites: 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)
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)
Prerequisite: 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 740 - Management of Transportation Carriers (3 credits)
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)
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)
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.

English

Offered by the Department of Humanities and Social Sciences. See Humanities and Social Sciences course list for faculty.

Eng 601 - Advanced Professional and Technical Communication (3 credits)

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 bibliographic research; usability analysis; working in teams; report writing; visual thinking; communicating with new technologies; and technical writing style.

Eng 603 - Cultural and Technological Change (3 credits)

Prerequisite or corequisite: ENG 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.

Eng 604 - Communication Theory and Research (3 credits)

Prerequisite or corequisite: ENG 601 . Reviews 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.

Eng 605 - Information Design and Publishing (3 credits)

Prerequisite or corequisite: ENG 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.

Eng 610 - Creating Hypertext: User and Task Analysis (3 credits)

Prerequisite: ENG 605 or equivalent . Covers the complex tasks needed to create nonlinear material: audience assessment, task analysis, scenario development, and evaluation. Students complete the life cycle of planning, implementing, testing and revising a nonlinear writing project. This is a writing intensive course that focuses on creating effective goal-oriented online products.

Eng 612 - Theory and Practice of Text Encoding (3 credits)

Prerequisite: ENG 605 or equivalent . In the beginning, IBM created "Script," a series of low-level commands that formatted text on a page. Then came Generalized Markup Language (GML) a series of macros for Script. Today we have Standard Generalized Markup Language (SGML) Hypertext Markup Language (HTML) and Extensible Markup Language (XML), all of which rely on the same basic concepts. Students will learn XHTML in order to gain a solid understanding of the theory of text encoding, while looking into the past (when technical writers wrote the code behind the text) and into the future (when VoiceXML enables unified messaging in a single interface). Each student will also create a website.

Eng 613 - Multimedia Presentations (3 credits)

Prerequisite: ENG 605 or equivalent . There are many ways to create presentations with short films, voice recordings, animations, photos, graphics, narrative, etc. The presentations can 'live' in a variety of ways - on the web, on CD, doing the email rounds, or appearing at a formal board meeting. We will experiment with as many multimedia programs as possible and during our experimentation we will uncover the bugs that go along with making multimedia presentations. We will also consider the balance between content and style - how much is TOO much Each student will create several presentations.

Eng 620 - Proposal Writing (3 credits)

Prerequisite or corequisite: ENG 601 . 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.

Eng 622 - Working in Teams (3 credits)

Prerequisite or corequisite: ENG 601 . Uses case studies and simulations to provide both the theoretical foundations and the hands-on practice needed to work effectively in and among heterogeneous corporate groups. Includes collaborative writing, interviewing, and conflict resolution, and computer-mediated group work.

Eng 624 - Professional and Technical Editing (3 credits)

Prerequisite or corequisite: ENG 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.

Eng 626 - Hypertext Design Studio (3 credits)

Prerequisite: ENG 605 or equivalent. Integrates language, image, linking and thinking in a studio approach to advanced HTML projects. Students work in computer laboratory with instructor on designing individual projects using current audio and video design applications.

Eng 631 - Communication and Environmental Problem Solving (3 credits)

Prerequisite or corequisite: ENG 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.

Eng 632 - Knowledge Management:Tools for the Workplace (3 credits)

Prerequisite or Corequisite: ENG 601. The three skills that technical writers most often need are an ability to elicit information from recalcitrant SMEs (Subject Matter Experts), the ability to put this information on paper(user manuals) and the ability to put it online in a Help system. This class will focus on the development of skills and abilities that will enable Help system developers to gather, translate and manage information for end users. Students will use theory and practical applications such as RoboHelp and Forehelp to develop an on-line Help module in this course.

Eng 642 - Corporate Communication (3 credits)

Prerequisite or corequisite: ENG 601 . Develops communication skills for modern global corporate and business markets. Business documents may include mission/vision statements, business plans, financial statements/plans, marketing plans, and corporate policies and procedures.

Eng 650 - Web Based Training Design (3 credits)

Prerequisite or corequisite: ENG 601 and ENG 605 . Web-based Training (WBT) is at the forefront of the recent 'e-learning' boom. However, while WBT use is on the rise, specific skills and tools are required to ensure a successful WBT implementation. Based on proven instructional design concepts, this course provides the student with the skills necessary to create effective web-based training programs.

Eng 698 - Selected Topics in Professional and Technical Communication (3 credits)

Prerequisite or corequisite: ENG 601

Eng 700 - Project in Professional and Technical Communication (3 credits)

Prerequisites: approval of graduate advisor, and 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. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, CD-ROM) and completes a paper describing the theory and methodology supporting the project application. With graduate advisor, student selects a faculty advisor, faculty reviewer, and external reviewer.

Eng 701 - Thesis in Professional and Technical Communication (6 credits)

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.

Eng 725 - Independent Study in Professional and Technical Communication (3 credits)
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.

English as a Second Language

Eng 500 - English for International Graduate Students I (3 credits)
Practice in listening and conversational English for students whose native language is not English. Level: Low Intermediate

Eng 502 - English for International Graduate Students II (3 credits)
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)
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)
Designed to improve English pronunciation; accent reduction. Level: Advanced.

Eng 507 - Advanced Conversation and American Culture (3 credits)
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)
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.

Eng 598 - Special Topics in ESL: Understanding Research Articles in Information Systems (3 credits)
Develops skills in reading journal articles in Information Systems efficiently and with understanding. Includes practice in writing about journal articles. Helpful for CIS 675 and CIS 677.

Eng 599 - University Teaching Methods/Communication Skills (3 credits)
Provides ideas, strategies, and techniques to help teaching assistants with their teaching assignments and to enhance their professional communication and interpersonal skills. Includes practical information on classroom management, the culture of the American classroom, diversity issues, and leadership skills.

Environmental Engineering

Offered by the Department of Civil and Environmental Engineering. See Civil Engineering course list for faculty.

EnE 610 - Hazardous Site Operations (3 credits)
Course consists of overview of OSHA regulations and NIOSH standards concerning toxicological hazards and medical surveillance requirements, and recognition and monitoring of site hazards. Site layout, design of engineering control to minimize exposure, risk assessment, and modeling will also be presented. Students will receive a certification for the 40-hour OSHA Hazardous Waste Operation training.

EnE 620 - Environmental Chemodynamics (3 credits)
The overall objective of this course is to introduce students to concepts, mechanisms, and models used to describe the transport of chemicals in the environment. Concepts and models presented in the first six weeks are applied to the air-water, sediment-water, and soil-air interfaces during the rest of the term.

EnE 660 - Introduction to Solid and Hazardous Waste Problems (3 credits)
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 - Microbiology for Environmental Engineers (3 credits)
Prerequisite: EnE 663. (May be taken concurrently.) Biological and microbiological principles applied to environmental and sanitary engineering. Bacteriological examinations in the laboratory of water and wastewater.

EnE 662 - Site Remediation (3 credits)
Prerequisite: EnE 663 or EvSc 610 (May be taken concurrently.) 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)
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)
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)
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)
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)
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 668 - Air Pollution Control (3 credits)
Prerequisite: EnE 663 or physical chemistry. The nature of air pollution, its effect on the public, and legal and engineering remedies.

EnE 669 - Water and Wastewater Analysis (3 credits)
Prerequisite: EnE 663. (May be taken concurrently.) Measurement of parameters of interest in water and wastewater quality studies is performed in the laboratory. Specific project requiring analysis, interpretation, and recommendations will be a major part of the work.

EnE 670 - Advanced Processes in Water Pollution Control (3 credits)
Prerequisite: EnE 669. Detailed laboratory experiments using unit operations of sedimentation, coagulation and flocculation; chlorination, filtration, aeration, sludge treatment and digestion. Aspects of pilot plant design and layout are considered. Design parameters discussed in prerequisite courses are developed by advanced bench-scale laboratory procedures. Advanced design and synthesis are considered.

EnE 671 - Environmental Impact Analysis (3 credits)
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 700 - Environmental Engineering Project (3 credits)
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 (6 credits)
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)
Prerequisite: advisor's approval. Topics of special current interest in environmental engineering.

EnE 725 - Independent Study I (3 credits)
Prerequisite: 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)
Prerequisite: 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 727 - Independent Study III (3 credits)
Prerequisite: 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 760 - Applied Environmental Soil Chemistry (3 credits)
Prerequisites: EnE 663, Math 651 or equivalent. Understanding of physical and chemical processes occurring in soils as well as the chemical and physical properties of subsurface soil environments. Emphasizes current research on the subsurface environment.

EnE 790 - Doctoral Dissertation (Credits as designated)
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 (3 credits)

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 EnE 790 unless requirement is waived, in writing, by the dean of graduate studies.

Environmental Policy Studies

Offered by the Department of Humanities and Social Sciences

EPS 601 - Behavioral Research Methods and Analysis (3 credits)
Introduces beginning graduate students to the research tools necessary for specialized study in other environmental policy studies courses. Problem identification, research design and problem solving; methods of data analysis; gathering of original field data.

EPS 602 - Research Analysis for the Social and Policy Sciences (3 credits)
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 606 - Technology Forecasting and Management Planning (3 credits)
Prerequisite: quantitative background in science, social science, or engineering. Basic forecasting techniques such as regression analysis, scenario generating, Delphi conferencing, and morphological analysis with particular case studies and problems pertaining to the forecasting of technological development. The relation of technological forecasting to the management process and the understanding of the technological development process. Demonstration of techniques and application to the contemporary fields of technological importance such as energy, communications, transportation, housing, and computers.

EPS 609 - Environmental Risk Assessment (3 credits)
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)
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)
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 (3 credits)
Detailed overview of the relationship between political economy and the environment drawing on diverse case studies including global warming, ocean resources, energy policies, and contamination of the nation’s water, air and soils. Economic and social policies for the fast-changing relationship between society and nature.

EPS 615 - The Politics of Science (3 credits)
Geopolitical context in which scientific discovery and governmental science policy have been formulated since World War II: social construction and the constituencies that have a stake in its outcome; military influence on science policy priorities; and legislative obstacles to various science policy objectives.

EPS 616 - Global Problem Solving in Science, Technology, and the Environment (3 credits)
Developing policy for the global era. Analyses and theories on political concept of sovereign nation states; the earth as one integrated economy, technology, science, politics and ecology; multinational corporations; worldwide patterns of capital and labor migration; energy flows; technology transfer; and impact of modernization and development on ecology.

EPS 622 - Sustainable Development (3 credits)
Prerequisite: EPS 612 Challenges of sustainable development in the United States and in other countries, influence of sustainable development concepts on environmental decision-making, sustainable development as a paradigm for environmental policy-making.

EPS 630 - Technology, Engineering and Civilization (3 credits)
Technological development and technical innovation dating from the ancient world, medieval Europe, to the modern era, with emphasis on Western civilization. Comparisons of the United States, Europe, China and Japan. Major themes include the role of the military and war, proto-industrialization and industrial revolution, technology transfer, emergence of engineering as an occupational class, and the place of the United States as the world's premier technological nation.

EPS 634 - Professional Ethics (3 credits)
Professional ethics: its source, range, and limits. Ethical thought and behavior in Western tradition and culture as they apply to business, engineering, and government. By studying both theoretical arguments and practical, real-life case studies, students learn to recognize, analyze and evaluate the ethics of personal professional decisions about work, careers, and policies.

EPS 642 - Urban Environmental Policy Studies (3 credits)
Critical evaluation and formulation of environmental policy as it affects urban setting. History and theory of environmental policy. How the U.S. legal structure shapes environmental regulation and its administration. Shifting environmental policy paradigms. Case study analyses focusing on urban settings.

EPS 644 - The Rhetoric of Environmental Policy (3 credits)
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)
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)
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/EPS 699 - Special Topics in Environmental Policy (3 credits each)
Prerequisite: advisor's approval. Topics of special or current interest.

EPS 701 - Master's Thesis (6 credits)
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 711 - Environmental Policy: Corporate Approach and Organization (3 credits)
Explores corporate and business advocacy approaches to influencing and responding to environmental policy and regulation from organizational, historic and strategic perspectives.

EPS 712 - Advanced Studies in Environmental Policy (3 credits)
Analysis of environmental policy development and implementation by studying current issues such as the shift from command and control to pollution prevention, brownfields, clean air from local, regional and national perspectives, and environmental policy priority setting.

EPS 714 - Environmental and Natural Resources Economics (3 credits)
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)
Prerequisite: 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)
Prerequisite: 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 761 - Ethics and Environmental Policy II (3 credits)
Presents a detailed investigation of the ethical bases of environmental policy decisions. Examines both theoretical philosophical arguments and practical case studies.

Environmental Science

Offered by the Department of Chemical Engineering, Chemistry and Environmental Science

EvSc 592 - Graduate Work Experience (3 additive credits)
Prerequisite: 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 600 - Environmental Science Seminar (Non-credit)
Prerequisite: 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)
Prerequisite: 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)
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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: graduate standing. Applications ofquantitative risk assessment concepts to the management of environmental problems.

EvSc 615 - Global Environmental Problems (3 credits)
Prerequisite: 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)
Prerequisite: 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)
Prerequisite: CHEM125 and CHEM126 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 700 - Master's Project (3 credits)
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 701 - Master's Thesis (3 credits)
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 702 - Special Topics in Environmental Science II (3 credits)
Prerequisite: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

EvSc 711 - Advanced Environmental Analysis (3 credits)
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 717 - Mass Spectrometry and Mass Spectral Interpretation (3 credits)
Prerequisite: CHEM125 and CHEM126 or equivalent. Chem 717 and Evsc 617 are comprised of Chem/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)
Prerequisite: 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)
See description for EvSc 725.

EvSc 790 - Doctoral Dissertation (Credits as designated)
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 (Non-credit)
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.

Epidemiology

Offered by the UMDNJ-New Jersey Medical School

EPI 615 - Introduction to Epidemiology and Control of Chronic and Infectious Diseases (3 credits)
Prerequisites: epidemiology core courses. Terminology; major causes; occurrence, distribution and dynamic behavior; epidemiologic concepts; epidemiology of selected diseases; investigation of outbreaks and epidemics; application to medicine (individual basis) and public health (community and population basis); implement levels of prevention and control.

EPI 616 - Advanced Topics in Infectious and Chronic Diseases Epidemiology (3 credits)
Prerequisites: epidemiology core courses, EPI 615. Utilizing practical and detailed examples, explores topically important issues in epide-miology to provide a framework for future self-learning and field research experiences. Applies principles to critically analyze relevant literature. Presents advanced, selected topics in depth with an emphasis on infectious disease epidemiology.

EPI 621 - Survey Research Methods/Questionnaire Design (3 credits)
Prerequisites: biostatistics, epidemiology, health information systems core courses. Introduces basics of survey research; provides skills necessary to conduct research. Conduct a one-page survey and present the results to the class as a final project.

EPI 625 - Community-Based Epidemiological Research (3 credits)
Prerequisites: epidemiology and biostatistic core courses. Investigate the epidemiology of a disease or an outbreak or risk factor(s) or any of the current public health issues. The investigation must warrant publication upon successful completion of the study; include detailed study in primary and secondary prevention of the selected topic; and requires review of relevant literature.

EPI 626 - Emerging and Re-emerging Infections (3 credits)
Covers the problem organisms and the various approaches to the problems from immunization and surveillance to attacking the societal variables that provide the setting in which these epidemics arise and flourish. Includes deliberately initiated infections (bioterrorism) and controversial partial solutions such as food irradiation.

EPI 627 - Innovations in Public Health (3 credits)
Includes some of the major historical approaches, current concepts (including control of illicit drug use, unusual community-based projects, use of large national cohorts) and potential future approaches; marketing of public health; appropriate, fiscally responsible screening; nutrition; and changes that will be created in public health innovations related to deciphering the genome.

EPI 628 - Pharmacoepidemiology (3 credits)
Prerequisites: epidemiology core courses, required track courses. Familiarization with methodological issues in pharmacoepidemiology; commonly used designs (e.g. cohort, case-referent); identification of main sources of bias in these designs; familiarization with tactics to deal with these biases. Students present for discussion proposals for pharmacoepidemiologic research.

EPI 629 - Oral Epidemiology of Chronic and Infectious Diseases (3 credits)
Provides an epidemiological overview of oral diseases. Topics include: clinical-decision analyses for the diagnosis, treatment, prevention and prognosis; research protocol; epidemiological data sources and clinical measurements; scientific papers; sampling techniques and research designs; descriptive and inferential statistics.

Financial Management

Offered by the School of Management

Fin 516 - Principles of Financial Management (3 credits)
Fundamentals of financial management divided into two segments: investment and corporation finance.

Fin 600 - Financial and Economic Environment (3 credits)
Intended for public and private organizations. Issues related to interest rates, extraordinary rates of inflation, fiscal and monetary policy, and regulatory policy are integrated with market structure, cost and production technology, pricing policy, cash flow, risk-return opportunities, capital budgeting techiques, and decision making in companies.

Fin 618 - Public and Private Financing of Urban Areas (3 credits)
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 - Financial Management (3 credits)
Prerequisite: Fin 516. The management of assets, liabilities and equity in a domestic framework. Includes: goals of the firm, time value of money, financial statement analysis, financial ratio analysis, financial planning and forecasting, capital budgeting, cost of capital, capital structure, dividend policy, working capital management, mergers and acquisitions, and pricing of options.

Fin 626 - Financial Investment Institutions (3 credits)
Prerequisite: Fin 516. 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)
Prerequisite: Fin 516. 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 630 - Applied Business Econometrics (3 credits)
Introduces methodological development of quantitative tools essential to modern managers. Includes sampling distribution, hypothesis testing, nonparametric statistics, and simultaneous regression models. Centers on application setting with statistical results providing insights into management decisions.

Fin 631 - Working Capital Management and Credit Analysis (3 credits)
Prerequisite: Fin 516. Optimal management of a firm's working capital, such as cash, marketable securities, receivables, and inventories with an emphasis on the institutional background and environmental modeling. Deals with cash flow analysis, the assessment of financial needs, and selecting the appropriate domestic and international sources for meeting a firm's credit needs.

Fin 632 - Financial Valuation of Technology-Based Companies (3 credits)
Prerequisite: Fin 516. Concentrates on techniques and procedures of assessing, managing, and forecasting value of alternative corporate and business level strategies of companies with emphasis on technology-based companies. These strategies include new product introduction, joint venture agreements, new market entries, and capital expenditures.

Fin 634 - Mergers, Acquisitions, and Restructuring (3 credits)
Prerequisite: Fin 516. 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 660 - Financial Planning and Decision Making (3 credits)
Prerequisite: Fin 624. This course introduces the in-depth qualitative and quantitative analysis of the short-term and long-term investment and financing decisions in an uncertain environment. The course emphasizes a quantitative analysis (simulation model) and case studies that deal with actual business decisions and challenges. Students are assigned to competing financial management teams in order to develop financial planning and decision making expertise.

Fin 700 - Seminar in Theory and Research in Financial Management (3 credits)
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 (6 credits)
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.

Geology

Offered by the Department of Geological Sciences at Rutgers-Newark

26:460:577 - Seminar in Environmental Geology (3 credits)
Human interaction with the geological environment. Case histories involving geological hazards to engineering works, transportation, land use, water, mineral and energy resources, disposal of wastes, and public health.

History

Offered by the Federated History Department of NJIT and Rutgers-Newark

Hist 620 - City and Disease in History (3 credits)

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)

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)

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)

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)

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)

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)

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)

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)
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 638 - Social History of Communication (3 credits)
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)
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)
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)
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 701 – Master’s Thesis (6 credits)
Prerequisite: permission of graduate history advisor. For students writing a master’s thesis in the history of technology, environment and medicine.

Hist 725, Hist 726, Hist 727 - Independent Study in History (3 credits)
Prerequisites: permission of graduate history advisor and course instructor.

Hist 791 - Seminar in History of Technology, Environment and Medicine (Non-credit)
Faculty, students and invited speakers present and discuss current topics of research in history, technology and medicine.

26:510:520 - Topics in the History of Technology (3 credits)
Selected topics in the history of technology.

26:510:525 - Colloquium in the History of Women (3 credits)
Readings and discussion on the history of women in the United States and Western Europe.

26:510:526 - Problems and Readings in Afro-American History (3 credits)
An introduction to the major historiographical problems and recent literature in the history of Afro-Americans in the U.S.

26:510:527,528 - Selected Topics in European Political and Diplomatic History (3 credits each)
An examination of issues and methods in European political and diplomatic history, with a consideration of some leading problems in the field.

26:510:529,530 - Selected Topics in European Intellectual and Cultural History (3 credits each)
An examination of issues and methods in European intellectual and cultural history, with a consideration of some leading problems in the field.

26:510:531,532 - Problems and Directed Readings in the History of U.S. Foreign Policy and Diplomacy (3 credits each)
An examination of issues and methods in American diplomatic history, with a consideration of some leading problems in the field.

26:510:533,534 - Selected Topics in American Social and Economic History (3 credits each)
An examination of issues and methods in American social and economic history, with a consideration of some leading problems in the field.

26:510:537,538 - Problems and Readings in the Ancient World (3 credits each)
An introduction to the major historiographical problems and recent literature of the ancient world.

26:510:539,540 - Problems and Readings in Medieval History (3 credits each)
An introduction to the major historiographical problems and recent literature in medieval European history.

26:510:541,542 - Problems and Readings in European History, 1350-1650 (3 credits each)
An introduction to the major historiographical problems and recent literature in European history from 1350 to 1650.

26:510:543,544 - Problems and Readings in European History, 1650-1850 (3 credits each)
An introduction to the major historiographical problems and recent literature in European history from 1650 to 1850.

26:510:545,546 - Problems and Readings in European History Since 1850 (3 credits each)
An introduction to the major historiographical problems and recent literature in European history since 1850.

26:510:547 - Comparative World Colonialism (3 credits)
Examines interactions of Europeans and non-Europeans after 1500. Emphasis is on comparative analysis of the colonial experience in Asia, Africa, and Latin America.

26:510:548 - Topics in the History of the American Environment (3 credits)
Selected topics in the history of the interaction between humans and the environment in North America.

26:510:551,552 - Selected Topics in American Intellectual and Cultural History (3 credits each)
An examination of issues and methods in American intellectual and cultural history, with a consideration of some leading problems in the field.

26:510:553,554 - Selected Topics in American Political and Legal History (3 credits each)
An examination of issues and methods in American political and legal history, with a consideration of some leading problems in the field.

26:510:555,556 - Selected Topics in American Urban and Ethnic History (3 credits each)
An examination of issues and methods in American urban and ethnic history, with a consideration of some leading problems in the field.

26:510:557,558 - Selected Topics in European Social and Economic History (3 credits each)
An examination of issues and methods in European social and economic history, with a consideration of some leading problems in the field.

26:510:559 - Cities in Change I (3 credits)
The process of urbanization as seen in the growth of historic European and North American cities and in the underdeveloped world: the revival of towns in the Middle Ages, the royal capital as center of power, rise of an urban way of life, nineteenth-century industrial cities, changing city forms and functions of the twentieth century, urban values in politics, business, and material culture.

26:510:560 - Cities in Change II (3 credits)
The process of urbanization as seen in the growth, decline, and revival efforts of Newark, N.J. Examination of the economic, political, geographical, and social factors that helped develop Newark as New Jersey's most important city and as one of the most troubled urban communities in the U.S. Attention to the origins of Newark's decline; its relationship with suburban communities in northern New Jersey; the settlement of European immigrants and rural Afro-Americans in the late nineteenth and twentieth centuries; and recent efforts to revive the city's political, economic, and cultural life.

26:510:566 - American Historiography (3 credits)
Examines the major historiographical disputes among American historians, including such topics as Jacksonian Democracy, the Civil War, foreign policy, the Progressive Era, and the New Deal.

26:510:567,568 - Modern Russia (3 credits each)
Major themes of post-Petrine Imperial Russia and the Soviet Union

26:510:569 - American Legal History to 1860 (3 credits)
Readings and discussion of 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.

26:510:570 - Topics in American Legal History (3 credits)
Readings and discussion of 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.

26:510:571 - Introduction to Historical Method (3 credits)
Examines major theoretical approaches that have been used by historians and some of the works that have employed those approaches.

26:510:572 - Philosophy of History (3 credits)
A general survey of major trends in historiography and of leading issues in the philosophy of history.

26:510:573,574 - Problems in Central European History (3 credits each)
Topics in the nineteenth- and twentieth-century political, social, and intellectual history of Germany. The Hapsburg monarchy and its successor states.

26:510:576 - Problems and Readings in American History, 1492-1789 (3 credits)
An introduction to the major historiographical problems and recent literature in American history from 1492 to 1789.

26:510:577 - Problems and Readings in American History, 1789-1865 (3 credits)
An introduction to the major historiographical problems and recent literature in American history from 1789 to 1865.

26:510:581 - Problems and Readings in American History, 1865-1912 (3 credits)
An introduction to the major historiographical problems and recent literature in American history from 1865 to 1912.

26:510:583 - Problems and Readings in American History, 1912-1945 (3 credits)
An introduction to the major historiographical problems and recent literature in American history from 1912 to 1945.

26:510:585 - Problems and Readings in American History, 1945 to Present (3 credits)
An introduction to the major historiographical problems and recent literature in American history since 1945.

26:510:589,590 - Problems and Readings in African History (3 credits each)
Various problems in African history, from the ancient African civilizations to the present day. Topics vary from year to year; contact the instructor for current topics.

26:510:618 - Seminar: Teaching of History (3 credits)
Experience in the planning of a course, leading discussions, and lecturing under the supervision of the student's major professor. Critiques are made by both the professor and the seminar participants.

26:510:669 - Business and Government in the Twentieth Century I (3 credits)
An exploration through selected readings of industrial and financial concentration in the U.S. and attempts at resolution of the dilemma through overhead management (the New Deal), associationalism (the trade association), and decentralism (antitrust).

26:510:670 - Business and Government in the Twentieth Century II (3 credits)
Examines the history of the relationship of federal government policies, presumptions, and practices to American business activity financial, industrial, and commercial outside the United States.

26:510:695 - Individual Studies in History (3 credits)
Prerequisite: permission of the director of graduate programs. Offered both terms.

26:510:696 - Advanced Individual Studies in History (3 credits)
Prerequisite: permission of the director of graduate programs. Offered both terms.

26:510:697,698 - Research in History (3 credits each)
Normally reserved for master of arts thesis credit.

Human Resources Management

Offered by the School of Management. See Management course list for faculty.

HRM 601 - Organizational Behavior (3 credits)
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)
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 607 - Personnel and Evaluation Research (3 credits)
Focuses on the assessment and improvement of personnel systems. Emphasis is on the use of diagnostic tools in problem identification, developing action plans, and assessing outcomes of HRM interventions. Special attention is given to survey methodology and to the use of assessment tools in conducting personnel research. Databases and statistical software packages are used in project work.

HRM 608 - Behavioral Issues in Transportation Studies (3 credits)
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 Tran 608.

HRM 609 - Employee Development and Training (3 credits)
Key concepts in training including needs analysis, curriculum design and delivery, managing external consultants, and the evaluation of off-site training programs are introduced to gain understanding of the training function in organizations. Emphasis is on the impact of technological changes on employee skills utilization and development; training as a means of sustained competitive advantage for technology-based organizations; and the effects of technological advances on the design and delivery of training programs.

HRM 610 - Seminar on Leadership Skills (3 credits)
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 616 - Job Analysis and Design (3 credits)
Analyzing and designing jobs in work organizations, particularly technology-based organizations. Principles of job analysis and job design are applied to the allocation of tasks in organizations. Draws upon theory and research from industrial and organizational psychology, organizational sociology, social psychology, industrial engineering and occupational medicine.

HRM 630 - Managing Technological and Organizational Change (3 credits)
Prerequisite: HRM 601. 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)
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 650 - Human Resource Information Systems (3 credits)
Information systems as a tool in improving human resource functions in organizations. Emphasis is on the design of information systems and their applications to HRM problems. The course is applications oriented. A technical MIS background is not required.

HRM 655 - Theory and Research in Organizational Behavior (3 credits)
Prerequisite: permission of the instructor. Survey of theory and empirical research on the behavior of individuals in organizations. Foundation in theories and concepts of organizational behavior, organizational psychology, and social and individual psychology. Read critically and evaluate classic works in these areas.

HRM 660 - HRM Issues in Technology-Based Organizations (3 credits)
Prerequisite: HRM 606. An interactive course that emphasizes the special problems faced by organizations that include a high percentage of technically trained professional employees. Linkages between HRM functions are examined and then built upon to develop a strategic plan for the firm's human resources. Special attention is directed toward the needs of technology-based organizations such as building technical skills aimed at maintaining competitive advantage; managing innovation; assessing employee skills bases company-wide; cross training; and fostering organizational learning. Case studies and comparative analyses are used extensively.

HRM 662 - Organizational Diagnosis and Development (3 credits)
A problem-oriented approach to organizational development with a focus on improving work group and organizational performance. Diagnostic tools are introduced as a means of problem definition. Attention then turns to structural and process issues in organizational development. Issues with respect to technology and structure are also examined. Emphasis is primarily on the internal organization. Representative topic areas include self-managed work teams, empowerment strategies, work group structures and technologies, and conflict resolution strategies. Development also covers quality of work life issues.

HRM 670 - Advanced Issues in Resource Management (3 credits)
Prerequisite: permission of the instructor. A research-based course that studies current issues in HRM. Course is designed for students in the Rutgers-Newark Ph.D. program.

HRM 685 - Cross Cultural Management Studies (3 credits)
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.

HRM 693 - Employment Relationships and the Law (3 credits)
Legal issues in government regulation of labor-management relations: selection and designation of bargaining agents; administration and enforcement of collective bargaining agreements; activities of unions and employers in labor disputes; and laws regulating wages, hours, and benefits.

HRM 700 - Project in Human Resource Management (3 credits)
Prerequisites: matriculation and advisor's approval. Comprehensive proposal for a program of human resource management; or a major component of a management program applied to an organization chosen by the student, including a design for recruitment, selection, OSHA, benefits services, and/or training program with an evaluation procedure. Another alternative is a comprehensive evaluation of existing human resource programs, including human resource plans and personnel operations requiring cost-benefit analysis. Students select an acceptable organization on which to base their proposal plans.

HRM 701 - Thesis in Human Resource Management (6 credits)
Prerequisites: matriculation for the master's degree, adequate graduate courses in the field of proposed research, and research advisor's approval. Thesis may be developmental experience at an appropriate professional level, or a scholarly research paper providing useful data and/or conclusions for other professionals interested in further study. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits indicated.

Industrial Engineering

Offered by the Department of Industrial and Manufacturing Engineering

IE 501 - Fundamentals of Industrial Engineering (3 credits)
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 additive credits)
Prerequisites: 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 additive credits)
Prerequisite: 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 additive credits)
Prerequisites: 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 601 - Measurement Methods for Performance Analysis of Operations (3 credits)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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)
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 - 3 credits (Facility Maintenance)
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 661 - Man-Machine Systems (3 credits)
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 664 - Advanced Ergonomics (3 credits)
Prerequisites: IE 355 or equivalent, or one year of college physics and one semester of biology. Concepts of work physiology and biomechanics as the basis for ergonomic design of work and workplace. Study of the neuromuscular, circulatory and respiratory systems, and their responses to various types of job demand. Structural elements of the human body and the effects of internal and external forces on the body. Development of the biomechanical models and their application in work, industry and rehabilitation.

IE 665 - Applied Industrial Ergonomics (3 credits)
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)
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)
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)
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)
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)
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)
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)
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 685 - Systems Safety (3 credits)
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 699 - Special Topics in Industrial Engineering (3 credits)
Prerequisite: 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 701 – Master's Thesis (6 credits)
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)
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)
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)
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)
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 753 - Airport Design and Planning (3 credits)
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)
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)
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)
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)
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 791 - Graduate Seminar (Non-credit)
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.

Infrastructure Planning

Offered by the School of Architecture

MIP 601 - Interdisciplinary Infrastructure Studio I (6 credits)
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)
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)
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 615 - Introduction to Transportation Studies (3 credits)
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 the highway capacity software (HCS) and SiDRA. Same as CE 660 and Tran 615.

MIP 618 - Public and Private Financing of Urban Areas (3 credits)
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)
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)
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)

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)
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)
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)
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.

International Studies

Administered by the Office of International Students and Faculty

MR INTL - Study Abroad (12 maintenance-of-registration credits)
Prerequisite: permission from the Office of International Students and Faculty. NJIT, through direct exchange agreements and through membership in an engineering educational exchange consortium, offers students the opportunity to study abroad for a semester or an academic year. Students may select any of the courses that meet their degree requirements with written approval from the academic advisor. Transfer credits will be awarded for pre-approved courses successfully completed at the end of the exchange period. Open to all degree programs.

Management

Offered by the School of Management

Mgmt 580 - Managerial Science (3 credits)
Introduction to methods of operations research and systems analysis of managerial problems: objective functions and constraints, theories of values, optimization and simulation modeling with emphasis on models of production systems, decision analysis, inventory systems, project planning, and transportation systems. Deterministic and stochastic approaches to these topics are covered.

Mgmt 610 - Foundations of Management in Organizations (3 credits)
Presented during the residence week for the Executive Program. Includes management accounting, managerial economics, statistics, operations research, marketing, MIS, and finance.

Mgmt 620 - Management of Technology (3 credits)
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)
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)
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.

Mgmt 635 - Data Mining and Analysis for Managers (3 credits)
Prerequisite: Mgmt 630. Introduction to the application of research methodologies and quantitative methods to typical problems in business and organizations, including the areas of manufacturing, transportation/logistics, MIS, and organizational research. Covers framing research questions to selecting the appropriate method and analytical technique to be used, and interpreting the analysis output. Business software tools such as Excel, SPSS, SAS, Minitab and Statbox are used for data analysis. Topics include experimental, quasi-experimental, correlational, and survey research designs and descriptive and differential data analysis using a variety of procedures. All topics use management case studies and illustrations.

Mgmt 640 - New Venture Management (3 credits)
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.

Mgmt 645 - New Venture Finance (3 credits)
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 650 - Knowledge Management (3 credits)
Prerequisite: MIS 545. 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.

Mgmt 655 - Global Competitiveness (3 credits)
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.

Mgmt 657 - Import/Export Processes (3 credits)
Prerequisite: Mgmt 670 or Mgmt 655. Discusses key elements of import/export planning processes with an emphasis on the technology-based firm. International environment, market analysis, export strategy, and transactions are studied. Covers trade regulations and policies, financial advantage of foreign trade zones, and international standards for technology-based products. Factors underlying trade encouragement and restrictions between nations are also considered.

Mgmt 660 - Managing Supply and Value Chains (3 credits)
This course is focused on the flow of products, information and revenue across supply and value chains in organizations. Special emphasis is placed on emerging e-business models and their effects on supply and value chains, and customer relationship management. The course also includes a survey of relevant information technologies.

Mgmt 665 - International Product Development (3 credits)
Prerequisite: Mgmt 670 or Mgmt 655. Students will learn about product development processes as part of international business development operations. Examines differences in developing products for: national and international customers, production and service industries, and static and dynamic client needs. Examines methods of design management, means to integrate product design, production, and marketing functions, and measures for product life-cycle accounting. Term projects examine national differences in product development.

Mgmt 670 - International Business (3 credits)
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 675 - Legal Environment of International Business (3 credits)
Focuses on the legal aspects of international business activities. Topics include: international trade practices and government regulations; legal aspects of international joint ventures, mergers, and acquisitions; and the legal component of intellectual property rights and its relation to trade disputes.

Mgmt 676 - Managing the Digital Firm (3 credits)
Sweeping technological change coupled with globalization has led to the development of new organizational forms which fall into the general category of digital firms. This course is focused on the digital processes that are transforming organizations and on managing all aspects of the digital firm. Topics include managing a virtual workforce, managing digital technologies, and protecting and leveraging digital assets.

Mgmt 678 - Management Strategies for Electronic Commerce (3 credits)
Examines recent developments in information technology that have had a significant impact on the economy and various industries with a focus on management strategies. Topics include intellectual property rights, privacy, ownership of information, and security.

Mgmt 680 - Entrepreneurial Strategy (3 credits)
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.

Mgmt 685 - Operations Research and Decision Making (3 credits)
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 688 * - Information Technology, Business and the Law (3 credits)
Includes historical and constitutional foundations, crimes, and torts in cyberspace, virtual property (patents online, copyrights in digital information, trade secrets in cyberspace, and cybermarks), electronic commerce contracting,

electronic commerce, electronic money and the law, and information technology and online infringement of rights of intellectual property.

Mgmt 690 - Electronic Communities in Organizations (3 credits)
The rapid acceptance of the Internet and the growth of corporate intranets have spawned the development of electronic communities within and outside of organizations that share ideas, information and knowledge. This course explores the development, use and dynamics of electronic communities with an emphasis on their role in work organizations. Students will learn how to analyze and evaluate learning communities and to examine their relationship to important processes in organizations such as change, knowledge management, and customer relationship management.

Mgmt 691 - Legal and Ethical Issues (3 credits)
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.

Mgmt 692 - Strategic Management (3 credits)
Prerequisites: Mgmt 691, HRM 601. Integration of the functional areas in management providing a top management perspective to the role of chief executive in an organization; strategy formulation and implementation; and ethical issues related to corporate strategies.

Mgmt 695 - Business Strategy for Environmental Management (3 credits)
This is a capstone course integrating the functional areas in management to provide a top management perspective to potential managers. The course deals with the role of the chief executive in environmental management and how strategies are formulated and implemented.

Mgmt 701 - Master's Thesis (6 credits)
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)
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 791 - Graduate Seminar (Non-credit)
Faculty, students and invited speakers present and discuss current topics of research in management.

26:620:555 - Seminar in Organizational Behavior (3 Credits)
Survey of theory and empirical research about the behavior of individuals and groups in organizations. Typical topics include motivation, socialization, job design, satisfaction, performance, leadership, group norms, and decision-making processes.

26:620:556 - Seminar in Organizational Theory (3 credits)
Survey of theory and empirical research about the behavior of individuals and groups in organizations. Typical topics include models or organizations such as theories of bureaucracy and closed, open, and natural systems; effects of technology including environment, power and decision-making, and organizational culture.

26:620:671 - Management of Innovation and Technology (3 credits by arrangement)
Examines individual, structural, and contextual factors that facilitate and inhibit the gener-ation and implementation of new technology. Emphasizes the management of innovation in organizations.

26:620:677 - Culture and Organizations (3 credits by arrangement)
Draws on the cross-cultural psychology literature on national and ethnic cultures and on the management literature on culture in organizations. Major topics include the content and manifestations of culture, cultural similarities and

differences, the transmission of culture, culture and subculture, culture change, leadership and culture, and managing organizational culture.

* Same as EM 640 and Tran 640 course designations pending
* pending approval

Management Information Systems

Offered by the School of Management

MIS 545 - Management Information Systems (3 credits)
Tools and techniques of management information systems and how they can be used to improve the quality of management decisions. Includes computer-based solutions to management problems in office automation, budgeting, communications, and decision support, major features of hardware and software computer system components and how to design a system, and technical tools ranging from flowcharts and decision tables to automated design.

MIS 620 - E-Commerce Technologies (3 credits)
The manipulation of relational databases. Normally the main language will be SQL, which facilitates the use of personal computer-based database management software.

MIS 625 - Management Strategies for E-Commerce (3 credits)
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 635 - Management of Telecommunications (3 credits)
A comprehensive review of current trends in telecommunications with an emphasis on the techniques required by non-technically trained managers to deal with hardware, software, and human interfaces. Specific areas to be covered include the types of telecommunication networks, common network operating systems, and network design strategies.

MIS 636 * - Telecommunications: Policies and Regulations ( )
Familiarization with government regulations for all forms of telecommunications, including video and audio. Covers such aspects as the ways in which corporations manage and provide security for telecommunications. Covers briefly: major telecommunications policies and regulations that have made a major impact on the current environment; telecommunications regulations in a global environment.

MIS 645 - Managing IT for Competitive Advantage (3 credits)
Prerequisite: MIS 545. 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)
Prerequisites: MIS 545, Mgmt 580. 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 654 - Design of Accounting Information Systems (3 credits)
Management's need for information and design of systems to provide this information. Emphasis on designing controls to ensure that the system meets management's objectives. Comparison of management and technical aspects of information systems. Accounting information systems will be used as models, but the course will incorporate all functions within the organization and provide the student with tools needed to manage the system and safeguard the assets of the organization.

MIS 655 - Information Systems Audit, Control and Security (3 credits)
Emphasizes controls and how an auditor or a manager verifies that controls are in existence and are effective. Security and controls are complementary and should be included in an MIS system environment. Covers the internal controls that should be present in an information system given its environment.

MIS 665 - Introduction to Electronic Commerce (3 credits)
Examines the changes in business processes and organizations enabled by electronic commerce technologies and application. Develops an understanding of the new electronic marketplace based on fundamental economics of the digital economy. Investigates electronic economies, new organizational structures, information systems architectures, and decision analysis.

MIS 680 - PC Tools for Managers (3 credits)
Presents a cross section of the personal computer tools available to most managers. Builds on traditional spread sheets, word processors, and databases and may include presentation graphics, project management, and others.

MIS 690 - Executive Information Systems (3 credits)
Provides decision makers a framework for designing and building systems to gain competitive advantage. Covers executive support systems, executive information systems, and group support systems.

MIS 701 - Thesis in Information Systems Management (6 credits)
Prerequisites: MIS 645, MIS 648, CIS 675, CIS 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.

* pending approval

Manufacturing Systems Engineering

Offered by the Department of Industrial and Manufacturing Engineering

MnE 601 - Manufacturing Systems (3 credits)
Modeling and control of large-scale systems with application to complex manufacturing systems including mathematically based modeling and control, and artificial intelligence-based methods.

MnE 602 - Flexible and Computer Integrated Manufacturing (3 credits)
Prerequisites: EM 602 and MnE 601, or instructor's approval. Integrated manufacturing as a decision and information network, with appropriate automation; manufacturing LANs, MAP, PDES, programmable controllers, and MRP-II are discussed in technical detail; group technology, cellular manufacturing and relevant process planning approaches; mathematical techniques for CIM and FMS scheduling and control.

MnE 603 - Management of Manufacturing Systems (3 credits)
Methods of planning and control of manufacturing organization, processes and facilities including demand forecasting, product development, capacity planning, inventory control, site selection, finance development, decision processes, personnel development and training, and manufacturing policy formulation.

MnE 612 - Robotic Manufacturing Systems (3 credits)
Industrial robotic programming and control. Robotic end effectors and sensors, tactile and vision. Cell design and control. Artificial intelligence. Robotic project using one of twenty industrial robots. Economic analysis and productivity. Material transfer, machine loading, assembly, inspection, welding, painting, and safety aspects. Hardware/software interfacing.

MnE 638 - Multi-lifecycle Engineering (3 credits)
Prerequisites: basic knowledge of applied probability and statistics. Considers the fundamental elements of multi-lifecycle engineering from a systems perspective forming a framework for industrial ecology and a pathway towards sustainable development. `Topics emphasized include lifecycle assessment, demanufacturing systems, design for environment, reengineered materials, and environmental risk management and product stewardship. Assignments include working in a team setting and, when appropriate, using relevant software.

MnE 654 - Design for Manufacturability (3 credits)
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)
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 (3 credits)
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 (6 credits)
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 715 - Selected Topics (3 credits)
Prerequisite: approval of the program director. Topics in various areas of specialization.

MnE 725 - Independent Study in Manufacturing (3 credits)

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 - Manufacturing Engineering Seminar (1 credit)

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.

Marketing

Offered by the School of Management. See Management course list for faculty.

26:630:576 - Quantitative Methods in Marketing Credits by arrangement (3 credits)
Emphasis on quantitative approach to marketing decision making and model building inparticular.

26:630:625 - Clustering Analysis (3 Credits by arrangement)
Prerequisites: calculus, intermediate statistics, optimization theory, and graph theory. Emphasizes such methods of data analysis as: clustering, including formal underpinnings, measures of association or dissimilarity coefficients, overlapping clustering, partitioning, constrained clustering, consensus clustering, cluster validity, computational advances, and substantive developments, with emphasis on market segmentation and product positioning.

26:630:660 - Qualitative Research Methods (3 credits)
Emphasizes issues of eliciting, analyzing, and representing verbal data in qualitative research. The topics considered are definition and evaluation of qualitative research; methods of eliciting data from individuals and groups; methods of analyzing verbal data; issues of representing narratives; and new research directions using feminist, historical, and aesthetic methods.

26:630:668 - Causal Modeling (3 credits)
Prerequisite: 26:960:577. In-depth analysis of recent advances in the statistical analysis of causal models. Topics include structural equation methods, log-linear modeling, and Bayesian methods.

Marketing Management

Offered by the School of Management

Mrkt 530 - Principles of Marketing 3 credits (3 credits)
Examination of the factors relating to marketing process. The nature and significance of consumer and organization buying behaviors, competition, government regulations, consumerism, and social responsibility are analyzed. Covers decision making in market research, product development, pricing, distribution, advertising, promotion, selling, and marketing strategy.

Mrkt 620 - Competing in Global Markets (3 credits)
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)
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 - Market Planning and Analysis (3 credits)
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 632 - Marketing Strategy for Technology-Based Organizations (3 credits)
Students combine the knowledge and skills learned in other marketing courses and develop strategic marketing plans that focus on quality management, productivity improvement, and international competitiveness. Buyer decision making, market segmentation and targeting, product positioning, market response, and competitive actions are analyzed. Case studies and student projects add realism and practical experience to the course.

Mrkt 636 - Design and Development of High Technology Products (3 credits)
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)
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)
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 640 - Industrial Marketing Management (3 credits)
Stresses the role of the manager in all aspects of marketing. Managerial decision-making techniques and strategies for product development, product pricing, distribution channels, personal selling, advertising and promotion. Strategic and operational marketing plans are developed based on student field research.

Mrkt 642 - International Marketing Management (3 credits)
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)
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 701 - Thesis in Marketing Management (3 credits)
Prerequisites: Mrkt 630, Mrkt 631, Mrkt 632 or waived with approval of the Dean. For students who do a thesis in marketing. State-of-the-art marketing research methods: importance in marketing decision making, research objectives, research design, measurement concepts, reliability and validity, primary and secondary data collection, sampling design, qualitative and quantitative research and analytical methods, field studies and survey research, multivariate analytical models. Also covers planning, preparation and submission of the thesis.

Mrkt 731 - Advanced Market Planning and Analysis (3 credits)
Prerequisite: Mrkt 631. Covers advanced topics in the design and analysis of market research studies. Focus on the development of statistical sampling methods and techniques to develop estimates for complex marketing problems. Also focuses on advanced multivariate analysis and estimation techniques needed in the interpretation of complex marketing problems.

Mrkt 753 - Marketing Science (3 credits)
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.

Materials Science and Engineering

Offered by the Materials Science and Engineering Committee

MtSE 605 - Fundamentals of Engineering Materials (3 credits)
Prerequisite: graduate standing. The effect of structure on the properties and behavior of engineering materials. Topics include atomic structure, bonding, crystallography, and defects in solids; properties of metals, semiconductors, ceramics, and polymers and their behavioral response to mechanical, chemical, optical, electrical, and magnetic stimuli.

MtSE 610 - Mechanical Properties of Materials (3 credits)
Prerequisite: graduate standing. Elements of elasticity and plasticity theory, deformation and fracture behavior of materials, the concept of dislocations and their interaction with other lattice defects, strengthening mechanisms in solids, and principles of failure analysis. Materials to be studied include metals, polymers, ceramics, glasses, and composites.

MtSE 615 - Composite Materials (3 credits)
Prerequisites: MtSE 605 and MtSE 610. Introduction to fundamental principles of design and technology of composite materials. Materials based on polymer, ceramic, and metal matrices are discussed. Properties of the constitutive materials, their structure, methods of structural arrangements, as well as properties and characterization of the final products are described. The different perspectives, examples, and problems in composite applications are outlined.

MtSE 619 - Nano-scale Characterization of Materials (3 credits)
Prerequisites Graduate standing or consent of instructor. The course presents the basics of nanotechnology and the principles and applicaation 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.

MtSE 625 - Introduction to Ceramics (3 credits)
Prerequisite: MtSE 605. Mechanical, thermal, electrical, magnetic, and optical properties of crystalline and glassy ceramics are discussed from a structural viewpoint. Important processing methods, design and evaluation of properties, and modern applications of ceramic materials are emphasized.

MtSE 627 - Glass Science and Engineering (3 credits)
Prerequisites: MtSE 605 and MtSE 630. Formation and structure of inorganic, polymeric, and metallic glasses. Transport phenomena, kinetics of crystallization, glass transition, and phase separation; chemical, mechanical and optical properties of glasses.

MtSE 630 - Thermodynamics of Materials (3 credits)
Prerequisite: undergraduate thermodyamics. Review of first, second, and third laws of thermodynamics and their applications to materials. Stability criteria, simultaneous chemical reactions, binary and multicomponent solutions, phase diagrams, surfaces, adsorption phenomena, thermochemistry of homogeneous and heterogeneous reactions are covered.

MtSE 648 - NanoMaterials (3 credits)
Prerequisite: Junior or Senior courses of modern materials science, chemistry and physics. Introduction to functional nanomaterials and nanotechnology. Types of nanomaterials-fullerenes, nanotubes, quantum dots, supramolecules, dendrimers. Fundamental, materials science, chemistry and physics of nanomaterials. Nanoscale properties and computational modeling. Synthesis, assembly and fabrication techniques. Characterization of nanomaterials. Emerging applications in nanoelectronics, nano-sensors, biology and fuel cells.

MtSE 650 - Physical Metallurgy (3 credits)
Prerequisite: MtSE 605. Processing-structure-property relationships in metallic alloys. Alloy systems covered include carbon steels, stainless steels, aluminum and titanium alloys, and super alloys. Topics to be presented include elementary theory of metals, defects and related phenomena, solidification, phase phenomena, solid state diffusion, nucleation and growth kinetics, as well as transformation and deformation processes.

MtSE 655 - Diffusion and Solid State Kinetics (3 credits)
Prerequisite: MtSE 630. The atomic theory of diffusion and mathematical derivation of the diffusion equations. Diffusion phenomena in dilute alloys as well as in ionic and covalent solids are considered. High atom mobility effects at defect sites and surfaces are examined. Chemical kinetics and kinetics of phase transformations including nucleation, growth, and spinodal decomposition are discussed.

MtSE 690 - Directed Study in Materials Science and Engineering (3 credits)
Prerequisites: As specified by the instructor. Directed study at the Master's level under the guidance of a faculty member on a topic in materials science and engineering.

MtSE 700 – Master’s Project (3 credits)
Prerequisites: sufficient experience and/or graduate courses to work on the project and approval of project advisor. 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. Students may extend the master’s project into a master’s thesis.

MtSE 701 – Master’s Thesis (6 credits)
Prerequisites: sufficient experience and/or graduate courses to work on the thesis and approval of thesis advisor. Research involving experimental or theoretical investigations or collaborative projects with industry or governmental agencies may be accepted. Completed work in the form of a written thesis should merit publication in a technical journal and must be approved by a committee consisting of three faculty members. A student must register for 3 credits per semester. Only the 6 credits indicated for the thesis will be applied to the degree.

MtSE 702 - Characterization of Solids (3 credits)
Current methods for characterizing the chemical composition, crystallographic structure, electrical mapping, and morphology of solid materials. Principles and application of Auger Electron Spectroscopy (AES), Secondary Ion Mass Spectroscopy (SIMS), X-ray Photoelectron Spectroscopy (XPS), X-ray Emission Spectroscopy (XES), and Rutherford Backscattering Spectroscopy (RBS) for chemical analysis, X-ray Diffraction (XRD) and electron diffraction for crystallographic analysis, Electron Beam Induced Current (EBIC) microscopy, voltage contrast microscopy, Cathodoluminescence for electrical mapping, and Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM) and Nomarski interference contrast microscopy (DIC) for morphology.

MtSE 719 - Physical Principles of Characterization of Solids (3 credits)
Prerequisite: MtSE 619/ME 619, Nano-scale characterization of materials. Basic science behind solid state characterization. Elements of modern physics. Optical microscope. Neutron scattering. Infrared and Raman spectroscopy. Rutherford backscattering spectroscopy. NMR. X-ray diffraction. X-ray photoelectron spectroscopy and Auger Electron Spectroscopy. SEM, TEM, STEM and STM.

MtSE 725 - Crystallography and Diffraction (3 credits)
Prerequisite: graduate standing. The atomic arrangement of crystalline materials including treatment of crystalline defects and diffraction phenomena. Lattices, crystal systems, symmetry operations are covered as well as the fundamentals of electron and X-ray diffraction.

MtSE 737 - Transport of Electrons and Phonons in Solids (3 credits)
Prerequisite: Phys 687/26:755:687. Basic transport processes involving electrons and phonons in solids. Topics inlcude transport-related phenomena such as Hall effect, quantum Hall effect, magneto-resistance, size effects, thermal conductivity, thermoelectric effects, phonon drag, ballistic phonons, and ballistic electrons. Applications of transport to the characterization of new electronic materials including thin films are stressed.

MtSE 757 - Defects in Solids (3 credits)
Prerequisites: MtSE 605 and MtSE 725. Crystallographic defects in solids, namely point defects such as vacancies and interstitial, line defects such as dislocations, and planar defects such as grain boundaries. Correlation of these defects to the mechanical, electrical and optical behavior of materials is examined in particular. Experimental methods for observation and characterization of defects including TEM, EBIC, DLTS are described.

MtSE 765 - Science and Technology of Thin Films (3 credits)
Prerequisite: graduate standing. Methods of preparing thin films by physical and chemical means are examined. Topics pertinent to nucleation and growth mechanism of single and polycrystalline films, structure determination,

film thickness and compositional evaluation properties are discussed. The electrical, magnetic, optical, and mechanical properties of metallic, semiconductor, and insulating thin films are studied with particular relevance to integrated circuit applications.

MtSE 780 - Current Topics in Materials Science and Engineering (3 credits)

Prerequisites: As specified by the program for the semester's offering. Topics of current interest in materials science and engineering.

MtSE 790 - Doctoral Dissertation (Credits as designated)

Required of all candidates for the degree of Doctor of Philosophy. A minimum of 36 credits is required. Students must register for 6 credits each semester until 36 credits are reached. If the dissertation is not yet complete, registration for an additional 3 credits is required each semester thereafter.

MtSE 791 - Graduate Seminar (Non-credit)

Required of all students enrolled in the M.S. or Ph.D. Program in Materials Science and Engineering. Faculty, students, and invited speakers will present and discuss current topics of research in materials science and engineering.

MtSE 792 - Pre-Doctoral Research (3 credits)

Prerequisite: permission of the program director. For students enrolled in the Ph.D. program before passing the Ph.D. qualifying examinations. Research is carried out under the supervision of a faculty member of the student’s choice. A maximum of 6 credits may be applied to MtSE 790

Mathematics

Offered by the Department of Mathematical Sciences

Math 545 - Introductory Mathematical Analysis (3 credits)
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)
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)
Prerequisites: Math 222, Math 337, and departmental approval. Methods and applications for systems of ordinary differential equations: existence and uniqueness for solutions of ODEs, linear systems, and stability analysis, phase plane and geometrical methods, Sturm-Liouville eigenvalue problems.

Math 590 - Graduate Co-op Work Experience I (3 additive credits)
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 additive credits)
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

Math 592 - Graduate Co-op Work Experience III (3 additive credits)
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

Math 599 - Teaching in Mathematics (3 credits)
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 611 - Numerical Methods for Computation (3 credits)
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 222, Math 337, and proficiency in a computer language (FORTRAN, C, or C++), or departmental approval. A practical introduction to the numerical methods of science and engineering. Numerical solution of linear systems. Interpolation and quadrature. Iterative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial- and boundary-value problems for ODEs. Introduction to numerical solution of PDEs. Includes examples requiring student use of a computer with some use of software packages.

Math 613 - Advanced Applied Mathematics I: Modeling (3 credits)
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)
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 630 - Linear Algebra and Applications (3 credits)
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)
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)
Prerequisites: Math 211 or 213, Math 337, and CIS 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)
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)
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 644 - Regression Analysis Methods (3 credits)
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)
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)
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)
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 - Applied Mathematics I (3 credits)
Prerequisite: (This course is not intended for students in a graduate program in Mathematical Sciences.) 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, Fourier series, Fourier and Laplace transforms, and eigenfunction expansions.

Math 652 - Applied Mathematics II (3 credits)
Prerequisite: (This course is not intended for students in a graduate program in Mathematical Sciences.) Math 651. Continuation of Math 651. Topics include: partial differential equations, functions of a complex variable, and the calculus of variations.

Math 656 - Complex Variables I (3 credits)
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 661 - Applied Statistics (3 credits)
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 662 - Probability Distributions (3 credits)
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 664 - Methods for Statistical Consulting (3 credits)
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 668 - Probability Theory (3 credits)
Prerequisite: Math 645 and Math 662, or departmental approval. Introduction to measure theory and integration, axiomatic probability, random variables, distribution function, expectation, independence, modes of convergence, characteristic functions, Laplace-Stieltjes transforms, sums of identically distributed random variables, conditional expectation, martingales.

Math 671 - Asymptotic Methods I (3 credits)
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)
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)
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)
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)
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)
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 685 - Combinatorics (3 credits)
Prerequisite: Math 545 or Math 645. Generating functions, principle of inclusion-exclusion, pigeonhole principle, partitions. Polya's theory of counting, graph theory, and applications.

Math 687 - Quantitative Analysis for Environmental Design Research (3 credits)
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 689 - Advanced Applied Mathematics II: Ordinary Differential Equations (3 credits)
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)
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)
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 698 - Sampling Theory (3 credits)
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)
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 (3 credits)
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 (6 credits)
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)
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, numerical analysis and scientific computation, theoretical and numerical aspects of combustion, mathematical biology, and various topics in statistics.

Math 710 - Graduate Research Methods (3 credits)
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 gives 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 712 - Numerical Methods II (3 credits)
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 (3-0-3)
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 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 720 - Tensor Analysis (3 credits)
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 745 - Analysis II (3 credits)
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)
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)

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 762 - Statistical Inference (3 credits)

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 771 - Asymptotic Methods II (3 credits)

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)

Prerequisites: Math 762 and Math 668. 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)

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 - Doctoral Dissertation (Credits as designated)

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 (1 credit)

All master's and doctoral students receiving departmental or research-based awards must register for this course each semester.

Math 792 - Pre-Doctoral Research (3 credits)

Prerequisite: Departmental approval. For students admitted to the Ph.D. program in the Mathematical Sciences. Research is performed under the supervision of a designated faculty member. If the work culminates in doctoral research in the same area, up to 6 credits may be counted toward Math 790. See Math 790.

Mechanical Engineering

Offered by the Department of Mechanical Engineering

ME 590 - Graduate Co-op Work Experience I (3 additive credits)
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 additive credits)
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 additive credits)
Prerequisites: permission from Department of Mechanical Engineering and Division of Career Development Services. Course cannot be used for mechanical engineering degree credit.

ME 607 - Advanced Thermodynamics (3 credits)
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)
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)
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)
Prerequisites: undegraduate fluid mechanics, heat transfer, and ME 616. (May be taken concurrently.) 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)
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)
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)
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)
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)
Prerequisites: differential equations and ME 616. (May be taken concurrently.) 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)
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)
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)
Prerequisites Graduate standing or consent of instructor. The course presents the basics of nanotechnology and the principles and applicaation 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)
Prerequisites: undergraduate differential equations, strength of materials and ME 616. (May be taken concurrently.) 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)
Prerequisites: undergraduate differential equations, strength of materials and ME 616. (May be taken concurrently.) 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)
Prerequisites: undergraduate differential equations, strength of materials and ME 616. (May be taken concurrently.) 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)
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)
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)
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)
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)
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 633 - Dynamics of Machinery (3 credits)
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)
Prerequisites: demonstrated competence in computer programming, ME 616 or equivalent and ME 622. (ME 622 may be taken concurrently.) 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)
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)
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)
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)
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)
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)
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)
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)
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)
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 664 - Experiments and Simulations in Particle Technology (3 credits)
Prerequisites: gradute standing and consent of the instructor. Covers a particle size analysis using sieves as well as laser diffraction technique, size reduction with ball mill, measurement of powder flow properties and internal angle of friction, measurement of angle of repose, design of mass flow hoppers using Jenike direct shear tester, measurement of minimum sintering temperature of powders, particle sedimentation, powder mixing, dry particle coating, and fluidized beds. Simulations involve various dry and fluid based particle systems, focusing on particle-particle and fluid-particle interactions. Same as ChE 664.

ME 670 - Introduction to Biomechanical Engineering (3 credits)
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)
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 672 - Biomaterials-Characterization (3 credits)

Prerequisites: mechanics of materials, principles of materials science and engineering. Engineering physiology, stress analysis and mechanical laboratory. Fundamental concepts on the methods and rationales used in characterization of metal, ceramic, polymeric, and biologic materials used in biomedical implant fabrication including survey of various techniques and engineering design aspects on biomaterials.

ME 675 - Mechanics of Fiber Composites (3 credits)

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)

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)

Prerequisite: ME 316 (see undergraduate catalog for description) or equivalent. 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)

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)

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 (3 credits)

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 (6 credits)

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)

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)

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)

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)
Prerequisite: ME611, 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)
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)
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 721 - Thermal Stresses (3 credits)
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, ME 726, ME 727 - Independent Study I, II, III (3 credits)
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 734 - Analysis and Synthesis for Design (3 credits)
Prerequisites: ME 616 and ME 620 or ME 610. Fundamental concepts of advanced mathematics and their application to analysis and synthesis of mechanics, electricity, thermodynamics, fluid mechanics, and heat transfer systems and their components.

ME 735 - Advanced Topics in Robotics (3 credits)
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)
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 752 - Design of Plates and Shells (3 credits)
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)
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)
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 776 - Dynamics of Polymeric Liquids (3 credits)
Prerequisites: ME 610 and ME 611. An advanced course in fluid dynamics which concentrates on the behavior of polymeric liquids. Topics include constitutive equations of polymeric liquids, fluid dynamics of rheometry and kinetic theory of polymeric fluid dynamics.

ME 785 - Theory of Deformable Solids in Mechanical Engineering I (3 credits)
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)
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 - Doctoral Dissertation (Credits as designated)
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 792 - Pre-Doctoral Research (3 credits)
Prerequisite: permission of department chairperson. For students admitted to the doctor of philosophy program in mechanical engineering who have not yet passed the qualifying examination. Research is carried out under the supervision of designated mechanical 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 toward the 36 credits required under ME 790.

ME 794 - Mechanical Engineering Colloquium (Non-credit)
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.

Mechanics

Offered by the Department of Civil and Environmental Engineering. See Civil Engineering course list for faculty.

Mech 540 - Advanced Strength of Materials (3 credits)
Prerequisite: mechanics of deformable bodies. Topics beyond the scope of elementary mechanics of deformable bodies are studied with particular emphasis on the assumptions, limitations, and applications to actual problems.

Mech 630 - Theory of Elasticity (3 credits)
Prerequisite: differential equations. Theory of elasticity as basis for both advanced stress analysis and for a critical examination of elementary stress analysis.

Nursing

Offered by the College of Nursing at Rutgers-Newark

26:705:504 - Human Diversity and Social Issues in the Community (3 credits)
Advanced nursing practice examined from epidemiological perspective in the context of cultural and social pluralism. Emphasis on multiple dimensions of human diversity with identification and assessment of vulnerable and undeserved populations and ethical issues.

26:705:534 - Community Health Nursing Theory II (3 credits)
Prerequisites: 26:705:524, 525. Advanced specialized knowledge relevant to the design, implementation, and evaluation of programs that address health promotion and prevention in populations, groups, and the individual/family in the community examined. Focus on planning, implementation, evaluation of programs, and services.

Occupational Safety and Industrial Hygiene

Offered by the Department of Chemical Engineering, Chemistry and Environmental Science

OSIH 601 - Environmental, Safety and Health Program Management (3 credits)
Prerequisite: graduate standing or permission of the instructor. For students in the occupational safety and industrial hygiene master's program and other students enrolled in environmental and safety programs. Considers various management techniques, roles, history, program elements and current trends in environmental, safety and health, in industrial and governmental settings.

OSIH 602 - Worker Compensation and Risk Management (3 credits)
Prerequisite: graduate standing or permission of the instructor. For students majoring in the OSIH master's program, and other students enrolled in environmental and safety programs. Considers worker compensation and risk management in industrial and government settings.

OSIH 603 - Transportation of Hazardous Materials (3 credits)
Prerequisite: graduate standing or permission of the instructor. Considers regulatory compliance, basic knowledge of hazard identification, controls, safety management principles, and regulations for the transportation industry.

OSIH 604 - Construction Safety (3 credits)
Prerequisite: graduate standing or permission of the instructor. Considers regulatory compliance, basic knowledge of hazard identification, controls, safety management principles, and regulations for the construction industry. Satisfies OSHA 30-Hour Construction Safety and Health Certification.

OSIH 605 - Principles of Radiation Safety (3 credits)
Prerequisite: graduate standing or permission of the instructor. Considers the principles of radiation safety, recognition, evaluation, and control of routine radiation sources in the workplace. Topics include, radioactivity, interactions with matter, radiation dosimetry, biological effects, instrumentation, non-ionizing radiation safety, laser safety, X-ray machine safety, and regulatory requirements.

OSIH 606 - Health Care/Hospital Health and Safety (3 credits)
Prerequisite: graduate standing or permission of the instructor. Provides understanding of the health care environment and its potential hazards. Covers standards of the Joint Commission for Accreditation of Healthcare Organizations (JCAHO), College of American Pathologies (CAP) requirements, and applicable OSHA standards.

OSIH 607 - Industrial Issues in Occupational Safety and Industrial Hygiene (3 credits)
Prerequisite: graduate standing or permission of the instructor. A series of lectures by experts from the private sector, in areas such as worker compensation, electrical safety, occupational medical services, and risk management.

OSIH 608 - Safety Training Program Development (3 credits)
Prerequisite: graduate standing or permission of the instructor. Evaluating and identifying training program needs, and reviewing critical safety training elements using 29 CFR 1910. Experience in outlining, organizing and presenting safety programs.

OSIH 609 - Food Process Safety and Clean Design (3 credits)
Prerequisite: graduate standing or permission of the instructor. Introduction to FDA requirements for food safety and process system control.

OSIH 610 - Sampling and Testing Methods for Industrial Hygiene I (3 credits)
Prerequisites: graduate standing or permission of the instructor. Introduction and familiarization with methods to test and sample the workplace environment. Industrial hygiene equipment is used.

OSIH 611 - Sampling and Testing Methods for Industrial Hygiene II (3 credits)
Prerequisite: graduate standing or permission of the instructor. Continuation of OSIH 610.

OSIH 612 - Fundamentals of Controls (3 credits)

Prerequisite: graduate standing in OSIH program or equivalent. Introduction for non-engineering students to the fundamentals of control technologies for mitigation of air and workplace exposures (focusing on ventilation), noise and vibration, electrical hazards, and fire protection.

OSIH 698 - Special Topics in Occupational Safety and Industrial Hygiene (3 credits)
Prerequisite: graduate standing or permission of the instructor. Topics of current interest in occupational safety and industrial hygiene.

OSIH 700 - Master's Project (3 credits)
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 every semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

OSIH 725 - Independent Study (3 credits)
Prerequisites: written permission from the associate chairperson for environmental science and courses prescribed by the supervising faculty member. 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.

Operations Management

Offered by the Department of Management at Rutgers-Newark

26:711:585 - Control Models (3 credits)
Project control scheduling theory as it relates to the control function, manpower scheduling. Discusses model formulation, solution techniques, and system dynamics. Applies model formulation and computer simulation to dynamic systems.

Optical Science and Engineering

Offered by the Physics Departments of NJIT and Rutgers-Newark

OPSE 601 - Advanced Topics in Optical Science and Engineering (3 credits)

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.

Pharmaceutical Engineering

Offered by the Department of Chemical Engineering jointly with the department of Industrial Engineering

PhEn 500 - Pharmaceutical Engineering Fundamentals I (3 credits)
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)
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)
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 additive credits)
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 additive credits)
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 additive credits)
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 601 - Principles of Pharmaceutical Engineering (3 credits)
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)
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 Processing and Manufacturing (3 credits)
This course covers state-of-the-art pharmaceutical processing, identifying underlying chemical process engineering principles and providing quantitative approaches to drug product manufacturing process design and optimization. It also provides interdisciplinary training in pharmaceutical engineering focusing on issues relating to issues in quality testing, drug absorption and bioavailability.

PhEn 604 - Validation and Regulatory Issues in the Pharmaceutical Industry (3 credits)
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)
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 612 - Pharmaceutical Reaction Engineering (3 credits)
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)
Prerequisite: PhEn 601, PhEn 603; undergraduate courses in differential equations, fluid mechanics, heat transfer, and mass transfer, or completion of bridge program for students who are required to take it. This course examines pharmaceutical separation processes in a variety of systems under a variety of conditions. Physicochemical basis of separations, flux-force relations and phase equilibrium phenomena will be considered to provide a fundamental background to equilibrium separation processes, external field-based processes and membrane-based separations in closed systems. A variety of separation processes will be studied in detail, including distillation, extraction, crystallization, absorption, ion exchange, chromatography, moving bed processes, electrophoresis, freeze drying, microfiltration/ultrafiltration, reverse osmosis, pervaporation, and others. Integrated pharmaceutical product manufacturing flow sheets will also be studied.

PhEn 618 - Principles of Pharmacokinetics and Drug Delivery (3 credits)
Prerequisites: PhEn 601, undergraduate courses in fluid mechanics, and mass transfer, or completion of bridge program for students who are required to take it. This course is focused on the study of the absorption, transport distribution, metabolism, and excretion of drugs and metabolites in the human body. The course covers the basic principles of pharmacokinetics, including drug transport, parenteral and enteral routes of drug administration, and factors affecting drug absorption, distribution, and metabolism. Mathematical pharmacokinetic models and drug delivery processes are also presented and quantitatively studied.

PhEn 698 - Special Topics in Pharmaceutical Engineering I (3 credits)
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)
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

PhEn 701B - Master's Thesis (3 credits)
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)
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)
Prerequisite: graduate standing and permission of the instructor. Topics of current interest in pharmaceutical engineering.

PhEn 725 - Independent Study (3 credits)
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 (non-credit)
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.

Physics

Offered by the Physics Departments of NJIT and Rutgers-Newark

Phys 601 - Mechanics I (3 credits)
Concepts and basic methods for the treatment of equilibrium and accelerated motion; Newton's Laws and the Free Body Diagram applied to problems in statics and dynamics; vectors, vector quantities, and their application in mechanics.

Phys 602 - Mechanics II (3 credits)
Prerequisite: Phys 601 or equivalent. Laws of conservation of energy and conservation of momentum in work and energy, power, impulse and momentum, collisions, recoil, and rocket propulsion. Angular motion, torque, moment of inertia, work and energy in rotational motion, and the application of Newton's laws and the law of conservation of angular momentum to problems in rotational dynamics are studied.

Phys 603 - Electricity and Magnetism I (3 credits)
Prerequisite: Phys 602 or equivalent. Electric charge, electric field, Gauss's law, electric potential, potential energy difference, current, resistance, and emf are studied. Also considers the law of conservation of charge and Kirchoff's laws, direct current circuits and instrumentation. Class includes demonstration lectures, related supervised computation problems, and recitations.

Phys 604 - Electricity and Magnetism II (3 credits)
Prerequisite: Phys 603 or equivalent. Magnetic field, force on moving charges, force on current-carrying conductor, and torque on a current-carrying coil; the Hall effect, magnetic field due to moving changes, induced emf, Faraday's and Lenz's laws, mutual and self-inductance, R-L, L-C, and R-L-C circuits, ferromagnetism and permanent magnets. Also considers alternating currents, circuits with resistance, inductance, and capacitance, average and RMS values, phasors, power, resonance, and transformers. Class includes demonstration lectures, supervised computation problems, and recitation.

Phys 607 - Topics in Astronomy and Cosmology (3 credits)
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 725 - Radio Astronomy (3 credits)
Prerequisites: Phys 621and 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 611/26:755:611 - Advanced Classical Mechanics (3 credits)
Prerequisite: undergraduate advanced mechanics or equivalent. Newton's laws of motion; mechanics of a system of particles; D'Alembert's principle and Lagrange's equations; derivation of Lagrange's equations from variational principle; conservation theorems and symmetry properties; the Hamilton equations of motion; canonical transformation, Poisson brackets; Hamilton-Jacobi theory; the rigid body equations of motion; small oscillations.

Phys 621/26:755:621 - Classical Electrodynamics (3 credits)
Prerequisites: undergraduate electromagnetism and working knowledge of ordinary and partial differential equations, special functions, complex variable functions, and vector analysis. Electrostatics; magnetostatics; and boundary value problems; time-varying fields, Maxwell equations, conservation laws; plane and spherical electromagnetic waves; wave propogation in dielectric and conducting media; waveguides and resonant cavities.

Phys 631/26:755:631 - Quantum Mechanics (3 credits)
Prerequisite: Phys 611/26:755:611. Limits to classical physics; wave mechanics and the Schrodinger equation; uncertainty principle; eigenvalues and eigenfunctions of simple systems including quantum well, potential barrier,

harmonic oscillator, and hydrogen atom; matrix mechanics, Hilbert space and operator method; approximation methods; scattering theory; time-dependent perturbation theory; quantization of electromagnetic radiation; quantum theory of angular momentum, spin.

Phys 641/26:755:641 - Statistical Mechanics (3 credits)
Prerequisite: Phys 631/26:755:631. Review of thermodynamic laws; ensemble theory; thermodynamic functions; classical ideal gas and imperfect gas; chemical reactions; Boltzmann, Bose-Einstein, and Fermi-Dirac statistics; quantum statistical theory of solids, magnetism and phase transitions.

Phys 651/26:755:651 - Atomic and Molecular Physics (3 credits)
Prerequisite: Phys 441 (see undergraduate catalog for description). Fundamentals of quantum mechanics; one-electron atoms; orbital angular momentum, spin, and total angular momentum; transition rates and selection rules; multi-electron atoms, LS coupling and JJ coupling; optical properties of atoms, the lasers; H2 molecules; molecular bonding; molecular spectra; the Raman effect.

Phys 654/26:755:654 - Nuclear and Particle Physics (3 credits)
Prerequisite: Phys 441 (see undergraduate catalog for description). Nuclear stability; saturation of nuclear forces; two nucleon potentials for finite nuclei, the deutron; nucleon-nucleon scattering; effective interactions; nuclear matter; models of nuclear structure; nuclear excitations; description of elementary particle phenomena; applications of scattering theory; conservation laws and symmetrical properties of interactions; structure of nucleons.

Phys 661/26:755:661 - Solid-State Physics (3 credits)
A brief review of basic concepts of quantum mechanics; free electron theories of metals; lattices in real and momentum space; electron levels in a periodic potential; the tight-binding method for calculating band structures; classification of solids; electrical and optical properties of semiconductors; cohesive energy; phonons; dielectric properties of insulators; magnetism; superconductivity.

Phys 667/26:755:667 - Modern Experimental Techniques for Materials Processing and Characterization (3 credits)
Prerequisite: Phys 441 (see undergraduate catalog for description) or equivalent. Bonding and material classification, phase transitions and phase diagrams, basic material structures and properties. Materials processing: various techniques for crystal growth and thin film fabrication. Materials modification: diffusion, ion implantation, and wet and dry etching. Materials and characterization: chemical and structural, electrical, optical and mechanical techniques.

Phys 671/26:755:671 - Applied Optics (3 credits)
Maxwell’s theory, linear and elliptical polarized light, Fresnel’s equations, electromagnetic waves in crystals, dielectric functions, optical constants. Ellipsometry, interference, amplitude and wavefront dividing interferometry, Fabry-Perot interferometer, modes in layered structures. Fraunhofer and Fresnel diffraction, spatial coherence, Zernike’s theorem. Symmetric and asymmetric Fourier transform spectroscopy. Fourier optics, imaging with quasimonochromatic and monochromatic light, holography. Scattering of light. Geometrical optics of thin and thick lenses, aberration. Radiometry, blackbody, synchrotron, and laser radiation. Radiometric quantities.

Phys 675/26:755:675 - Cellular Biophysics (3 credits)
Prerequisites: differential and integral calculus and introductory physics. Lecture and lab covers the basis for cell membrane voltages, both static and dynamic. Basic biochemistry pertinent to biological systems, bioelectricity of the cell membrane, electrophysiology, and relevant microscopy. Laboratory sessions include electronics, bioelectric measurements both in artificial and biological cells, and microscopy.

Phys 687/26:755:687 - Physics of Materials (3 credits)
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 689/26:755:689 - Simulations of Electronic Device Structures (3 credits)
Prerequisite: EE 657 or equivalent. Extensive introduction to the modeling programs used to stimulate devices and the processes used to build them. Standard software such as SIMION (for electron optics and vacuum microelectronic device physics), SUPREM (for process modeling), PISCES (for device modeling), and ANSYSM

and ANSYST (for finite element mechanical and thermal modeling) will be used. Each student will be assigned a final modeling project.

Phys 690/26:755:690 - Directed Study of Applied Physics (3 credits)

Directed study under the guidance of a physics faculty member on a topic of applied physics.

Phys 700/26:755:700 – Master's Project (3 credits)

Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take Phys 701/26:755:701 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 701/26:755:701 – Master's Thesis (6 credits)

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. The thesis is written under the supervision of a designated physics graduate faculty member. A paper based on 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 721/26:755:721 - Classical Electrodynamics II (3 credits)

Prerequisites: Phys 621 or equivalent, and 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 an accelerated charge, synchrotron radiation, and bremsstrahlung.

Phys 731/26:755:731 - Quantum Mechanics II (3 credits)

Prerequisite: Phys 631/26:755:631 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 732/26:755:732 - General Relativity and Gravitation (3 credits)

Prerequisites: Phys 611/26:755:611, Phys 621/26:755:621, and Phys 631/26:755:631, or equivalents. Review of special relativity; principles of equivalence and the metric tensor; tensor analysis; effects of gravitation; Einstein's field equations; the Schwarzschild singularity; gravitational radiation and cosmology.

Phys 761/26:755:761 - Solid-State Theory (3 credits)

Prerequisite: Phys 661/26:755:661 or equivalent. Fundamentals of group theory; symmetry of solids; application of group theory in solid-state physics; density functional theory; the one-electron approximation and energy bands; thermodynamic and transport properties; pseudopotentials and other methods of band structure calculation; Fermi liquid theory, collective excitation and mean field theory of superconductivity and magnetism; lattice vibrations, the electron-phonon interaction, and the BCS theory of superconductivity.

Phys 762/26:755:762 - Electronic Structure of Solids (3 credits)

Prerequisite: Phys 631/26:755:631 or equivalent. Tight binding theory; bond orbitals and the electronic structure of covalent solids; universal tight-binding parameters and the prediction of the bonding and dielectric properties of semiconductors; ionic solids and the bonding and dielectric properties of insulators. Theory of silicon dioxide and related compounds and their properties; transition metals and their compounds.

Phys 763/26:755:763 - Surface and Interface Physics (3 credits)

Prerequisite: Phys 661/26:755:661 or equivalent. Introduction to UHV (Ultra High Vacuum) technique; clean surface preparation; surface symmetry and LEED (Low Energy Electron Diffraction); surface and interface electronic structure and electron spectroscopy; XPS, UPS, AES and ESCA; surface compositional and geometric structure and EXAFS; STM (Scanning Tunneling Microscopy) and STS (Scanning Tunneling Spectroscopy).

Phys 771/26:755:771 - Quantum Electronics (3 credits)
Prerequisites: Phys 631/26:755:631 and Phys 651/26:755:651, or equivalents. Physics of lasers and the interaction of radiation with matter. Semiclassical and quantum theory of the interaction of the laser with single and multiple electromagnetic fields, and with homogeneously and Doppler-broadened media.

Phys 772/26:755:772 - Applied Plasma Physics (3 credits)
Prerequisites: Phys 621/26:755:621 and Phys 631/26:755:631, or equivalents. Properties of ionized systems, electromagnetic interactions, experimental techniques and selected topics on discharges and thermonuclear plasmas.

Phys 773/26:755:773 - Particle-Solid Interactions (3 credits)
Prerequisites: Phys 631/26:755:631 and Phys 661/26:755:661, or equivalent. The particle-solid interactions that form the basis for ion implantation, sputter deposition, reactive ion etching, and other microelectronic processing technology. Ion beam interactions with solids and solid state materials and structures. Rutherford backscattering experiments, and ion channeling. Methods for observing defect distributions in materials, surfaces, and surface layer interfaces using ion scattering techniques.

Phys 774/26:755:774 - Principles of Spectroscopy (3 credits)
Prerequisites: Phys 651/26:755:651 and Phys 761/26:755:761, or equivalents. Theoretical and experimental principles of spectroscopy. Atomic absorption, emission, IR (infrared), Raman, fluorescence, NMR, X-ray spectroscopies. Fourier transformation techniques. Coherent and incoherent sources.

Phys 775/26:755:775 - Electrical Properties of Polymers (3 credits)
Prerequisite: Phys 631 or equivalent. The course is intended for graduate students in applied physics, chemical engineering, materials science, and electrical engineering. Topics include introduction to polymers, electronic properties of polymers, theory of dielectric conduction, dielectric properties of polymers, dielectric values, and experimental techniques.

Phys 780/26:755:780 - Current Topics of Applied Physics (3 credits)
Current research interests in applied physics. Emphasis is on research work related to microelectronics, optoelectronics, optical physics, materials science, surface science, free electron laser and solar physics

Phys 781/26:755:781 - Physics of Advanced Semiconductor Devices (3 credits)
Prerequisites: Phys 687/26:755:687 and EE 657, or equivalents. Physical principles and operational characteristics of the most important semiconductor devices for advanced electronics systems that process data at rates higher than 1 Gb/s, or handle analog signals at frequencies above 1 GHz. Devices addressed include: submicron MOSFET, MESFET, heterostructure MESFET, heterostructure bipolar transistors, quantum-effect devices, microwave devices, and photonic devices.

Phys 787/26:755:787 - Physics of Sensors and Actuators (3 credits)
Prerequisites: EE 657 and Phys 687/26:755:687, or equivalents. Fundamentals of sensors: optical, thermal, chemical, mechanical and electrical. Study of noise, phase-sensitive detection and other low-level measurement techniques. Semiconductor surface microstructures, including temperature, pressure, strain, acceleration, humidity, mass flow, and gas sensors. Actuators, including micro-motors, micro-robots, and other micro-mechanisms. Semiconductor vacuum microelectronic devices.

Phys 789/26:755:789 - Physics of Advanced Semiconductor Device Processing (3 credits)
Prerequisites: EE 657 and Phys 687/26:755:687, or equivalents. Intended for doctoral students in applied physics, electrical engineering, and materials science. 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 790/26:755:790 - Doctoral Dissertation (Credits as designated)
Prerequisites: passing grade on departmental qualifying examination. Corequisite: Phys 791. 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; 3 credits per semester are required thereafter. Registration for additional credits, a total of 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. 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 totally publication in a leading scientific or technical journal.

Phys 791/26:755:791 - Applied Physics Seminar (Non-credit)

Departments of physics at NJIT and Rutgers-Newark joint seminar on research and current topics in microelectronics, materials science, laser physics and other applied physics areas.

Phys 792/26:755:792 - Pre-Doctoral Research (3 credits)

Prerequisites: permission of the department. For students enrolled in the Ph.D. program to perform research in one of the designated applied physics areas under the supervision of an applied physics graduate faculty. If the student’s research activity culminates in doctoral research in the same area, a maximum of 6 credits may be applied toward the 36 credits required under Phys 790.

Political Science

Offered by the Department of Political Science at Rutgers-Newark

26:790:501 - Policy Making in the American Political System (3 credits)
Survey of political and governmental institutions and policy-making processes.

26:790:504 - Comparative Public Policy (3 credits)
Approaches to the study of policy making in different political systems. Includes case studies.

26:790:510 - Public Policy Analysis (3 credits)
Focuses on approaches to the analysis of the policy-making process and the evaluation of its outputs. Emphasis on the policy agenda-setting processes, the politics of problem definition, policy decision-making strategies, cost-benefit analysis, the problem of legitimation and political feasibility, policy implementation, experimental evaluation research, and the role of values in policy analysis. Special attention given to the integration of empirical and normative research in the analytical process.

26:790:512 - Ethical Issues in Public Policy and Administration (3 credits)
Consideration of selected ethical problems and dilemmas facing policymakers and public administrators. These include issues of conflict of interest, confidentiality, deception, official disobedience, whistle-blowing, record-keeping, and questions of distributive justice in health care and employment opportunities. Special attention given to conflicts between expedience and principle in policy-making and policy implementation. Readings in political theory and political ethics as well as cases and commentary.

26:790:516 - Urban Public Policy (3 credits)
Analysis of selected policy problems affecting urban areas.

26:790:537 - Recent International Relations: Global Governance (3 credits)
The organization of world politics and international cooperation beyond formal international organizations; emphasis on international regimes, institutions and norms; examination of nongovernmental organizations (NGOs); epistemic communities and multilateral cooperation.

26:790:538 - Recent International Relations: Global Environmental Issues (3 credits)
Examines global environmental institutions and issues.

26:790:571 - American Politics and Public Policy (3 credits)
Impact of American politics upon public policy issues of contemporary relevance.

Public Administration

Offered by the Department of Public Administration at Rutgers-Newark

26:834:521 - Technology and Public Administration (3 credits)

Implications of computer hardware and software issues for public sector management, with particular emphasis on applications of microprocessors. Includes a survey of database management problems, control, resource allocation, communications, and networking issues. Laboratory exercises required.

26:834:523 - Human Resources Administration (3 credits)

Human resource administration in public and non-profit settings, including human resource planning, staffing, development, and compensation. Behavioral and environmental determinants are examined, including production technology, market factors, service delivery, and government regulations.

26:834:524 - Strategic Planning and Management (3 credits)

Strategic planning and management in the public and nonprofit sectors, including methods that facilitate the achievement of organizational goals in a changing environment. Attention is paid to forecasting, goal and objective setting, strategy building, and resource mobilization.

26:834:541 - Political Economy and Public Administration (3 credits)

Explores basic economic concepts and applies them to issues relevant to public administration, including microeconomic and macroeconomic problems as they impact the public and nonprofit sectors.

26:834:542 - Government Budgeting Systems (3 credits)

Budget concepts and processes used by the American governments and their administrative units. Provides essential skills and experience in budgetary analysis and management applicable to nonprofit as well as public sector agencies.

26:834:562 - Policy and Program Assessment (3 credits)

Examines research methodologies and techniques employed in policy and program assessment. Includes social indicators, quantitative and qualitative methods, and experimental and quasi-experimental designs as used in applied policy and program research.

26:834:582 - Health Care Management (3 credits)

Focuses on the major social and political issues involved in the organization, delivery, and management of health care systems.

26:834:584 - Health Care Finance (3 credits)

Processes and methods of financial management in the health care industry. Patterns of health-care expenditures, methods of financing health care, financial planning and development, third party reimbursement, and controls in health institutions management.

26:834:585 - Health Care Policy (3 credits)

Analysis, development, implementation, and evaluation of policies and programs affecting health. Focuses on health care institutions, with some attention to managing health problems with non-medical interventions at the community level. Uses the case method applied to realistic situations in which specific decisions must be made by health managers or officials.

26:834:586 - Violence in the United States (3 credits)

Life-cycle approach to violence, including violence against children; juvenile, domestic, male-male, and cultural violence. With each type of violence, examination of historical and empirical dimensions of the problem, current theories about dynamics and causality, and the likely efficacy of current and proposed interventions. Emphasis placed on class, racial, and gender inequalities.

26:834:602 - Decision Making and Policy Analysis (3 credits)

Logic, form, use, and critical assessment of decision making and policy analysis in public administration. Development of a practical yet critical perspective on policy analysis and its role in public administrative decision making and behavior.

Public Health

Offered by the Department of Humanities and Social Sciences

MPH 601 - Introduction to Epidemiology (3 credits)

Epidemiology and its uses. Occurrence, distribution and dynamic behavior of disease and public health problem in human population. Descriptive epidemiology, observation cross-sectional study, longitudinal study and analytic epidemiologic study. Principles and methods of epidemiologic investigation. Evaluate the efficacy of preventive and therapeutic modalities and of new pattern of health care delivery. Measurement and interpretion of the morbidity and mortality indices. Application of findings to public policy. Evaluating public policy.

MPH 602 * - Introduction to Biostatistics (3 credits)

Introduction to biostatistical concepts and methods utilizing a lecture format followed by computer laboratory sessions to apply statistical methods to problems commonly encountered by public health professionals.

MPH 603 - Principles of Environmental Health (3 credits)

Examines the environmental, occupational, residential factors and agents that have an impact on the health of people and the community. Structural and non-structural intervention to prevent, mitigate and minimize the impact as well as intervention benefits and limitations such as the role of biodiversity; ecological influences and impact; community perceptions; behavior impact; the role of culture, tradition and education; legal and regulatory remedies; government agencies; monitoring and technological interventions.

MPH 604 - Introduction to Health Care Systems and Policy (3 credits)

History, organization, financing and regulation of U.S. medical and public health services, particularly among under-served and urban populations. Social and behavioral factors that shape health and health services.

MPH 605 * - Health Education and Public Health Issues (3 credits)

Consists of five sessions on health education; one each on public health, history, ethics, nutrition and Newark health problems; and ten half sessions devoted to emerging infections, health promotion, aging, tuberculosis, malaria, sexually transmitted diseases, HIV/AIDS, alcohol and drugs, the genetic revolution, and violence.

MPH 644 - Social Foundations of Urban Health (3 credits)

Theory used to explain and predict individual and aggregate behavior from the operationalization standpoint. Theories from economics, psychology, sociology, social psychology and geography. Theories of rational and habitual behavior under certain and uncertain outcomes. Statistical models in the estimation of structural models. Simulations using Resampling Stats.

MPH 645 - Society, Chronic Illness, and Disability: An Urban Perspective (3 credits)

Extend and intensity of chronic illness and disability with emphasis on urban populations. Conduct functional status assessments. Prepare sickness impact profiles. Perform physical performance tests. Depression and costs of several forms of long term care.

MPH 646 - Urban Child in a Global Perspective (3 credits)

Protective, rehabilitative and preventive strategies addressing the failure to meet the survival, nurturing and participatory rights of children as specified in the U.N. Convention on the Rights of the Child, the UNICEF programs for children in especially difficult circumstances, and the human capability approach of Amartya Sen. Covers the social and economic conditions that affect the care taking arrangements for infants, young children and adolescents at one or more epochs of their physical and psychosocial development.

MPH 647 - Perinatal Health and Family Planning (3 credits)

Extent of perinatal health problems in the United States particularly inner city populations. Etiology including chemical and behavioral factors. Clinical specialists discuss current issues. Covers clinical solutions and public policy initiatives. Team project includes preparation and presentation of a major project.

MPH 648 - Community and Environmental Approaches to Health Behavior Change in Urban Disadvantaged Populations (3 credits)
Socio-environmental factors influencing health-related behavior, role of groups, institutions and social structures in encouraging healthy or unhealthy behavior. Intervention designed to improve health behavior through changes in the social environment; economic, social and political structures and practices creating barriers to effective interventions. Examples include environmental characteristics affecting alcohol and tobacco use, diet, and injury control.

MPH 650 - Medical Geography (3 credits)
Organization of society and the elaboration of disease; spatial vocabulary; geographic concepts related to disease distribution and adaptability; disease as an initiator of social and economic change in geographic constructs, economic development and population; contemporary health policy in the United States and its geographic influences and determinants.

MPH 660 - Health Economics (3 credits)
Explores questions of policy with regard to quality, cost and distribution of personal health care services and the proper role of government. Involves microeconomic and macroeconomic issues, theories and analysis tools.

MPH 698/699 - Special Topics in Public Health I, II (3 credits each)
Special area course given when suitable interest develops. Topics are announced in advance.

MPH 725 - Independent Study (3 credits)
Prerequisite: approval of track coordinator. Covers a topic that is either not offered in the master of public health degree program curriculum or is offered but the student wishes to study the topic in greater depth and or breadth. Work is supervised by a public health faculty member.

* pending approval

Quantitative Methods

Offered by the UMDNJ-New Jersey Medical School

QM 611 - Design of Epidemiological Studies and Clinical Trials (3 credits)
Prerequisites: biostatistics and epidemiology core courses, or equivalent. Principles of exper-imental design; recognize a well-designed study in the literature; identify and explain inadequacies in study designs and suggest improvements; prepare and submit a protocol for a well-designed study.

QM 612 - Linear Models: Regression and Analysis of Variance (3 credits)
Prerequisites: biostatistics core course or equivalent. Practical introduction to the linear statistical methods that are so commonly used in public health research. A statistical computer package such as SAS, STATA or SPSS is used for exercises. Apply regression, correlation and analysis of variance to data. Apply principles of study design and sample size planning. Provide statistically valid interpretation of output from data analysis.

Statistics

Offered by the Department of Management at Rutgers-Newark

26:960:577 - Introduction to Statistical Linear Models (3 credits)

Prerequisite: undergraduate or master's-level course in statistics. Linear models and their application to empirical data. The general linear model; ordinary-least-squares estimation; diagnostics, including departures from underlying assumptions, detection of outliners, effects of influential observations, and leverage; analysis of variance, including one-way layouts, two-way, and higher dimensional layouts, partitioning sums of squares, and incomplete layouts (Latin squares, incomplete blocks, and nested or repeated measures). Emphasizes computational aspects and use of standard computer packages such as SAS.

Transportation

Offered by the Interdisciplinary Program in Transportation

Tran 552 - Geometric Design of Transportation Facilities (3 credits)

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)

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 additive credits)

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)

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)

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 604 - Public and Private Financing of Urban Areas (3 credits)

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 MIP 618.

Tran 608 - Behavioral Issues in Transportation Studies (3 credits)

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)

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)

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)
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)
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)
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)
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)
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)
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)
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 (3 credits)
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 701 - Master's Thesis (6 credits)
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)
Prerequisite: advisor's approval. Topics of special or current interest.

Tran 705 - Mass Transportation Systems (3 credits)
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)
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 740 - Management of Transportation Carriers (3 credits)

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 modes. Same as EM 740.

Tran 751 - Transportation Design (3 credits)

Prerequisite: Tran 603. Design problems for airports, terminals, and highway intersections and interchanges are undertaken. Same as CE 751.

Tran 752 - Traffic Control (3 credits)

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)

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)

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)

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 Transportation Networks (3 credits)

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)

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 and Research (Credits as designated)

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 791 - Doctoral Seminar (Non-credit)

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 - Seminar (Non-credit)

Students periodically present the results of their research activities to faculty, research staff and other students. Outside speakers may be invited. Required each semester for those students who receive departmental or research-based awards.

NJIT NEW JERSEY INSTITUTE OF TECHNOLOGY

2003-2004 Graduate Catalog

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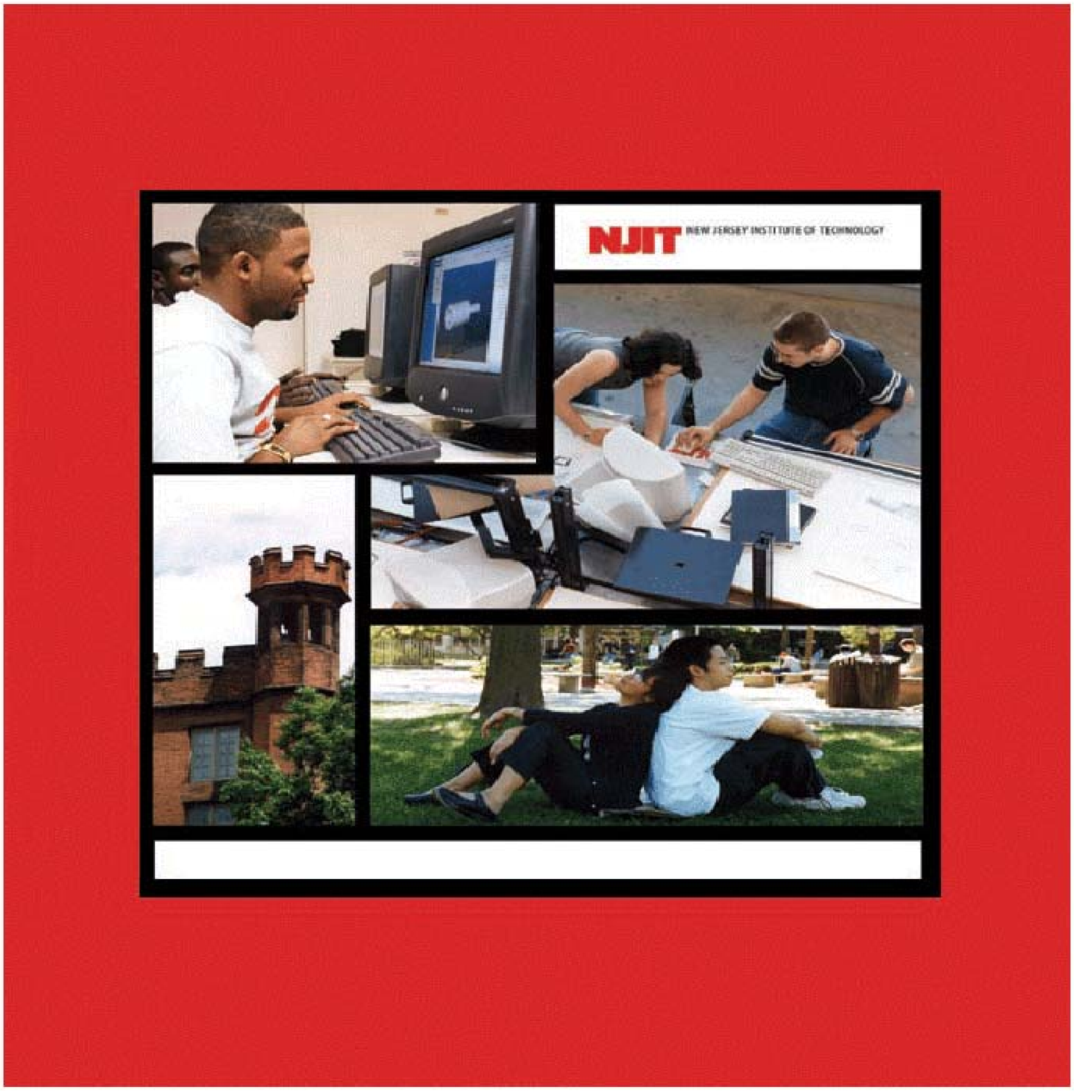

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Ph.D., 1963.

P.E., PROFESSOR OF MATHEMATICS, AND ASSOCIATE CHAIR OF THE DEPARTMENT (1935), POMPEY
Newark College of Engineering, B.S., 1933;
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PADALINO, JOSEPH J
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Newark College of Engineering, B.S., 1944;
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PATTINSON, JOHN P
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Cambridge University, B.A., 1947;
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PAWEL, HANS
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Massachussetts Institute of Technology, S.B., 1941;
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Executive Director, Information and Decision Engineering Center.
Polytechnic Institute of Brooklyn, B.C.E., 1951;
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Technical University of Graz, Dr. of Tech. Sc., 1961.

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REFF, ISRAEL
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Electrical Engineering (1958)
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P.E., Professor of Mechanical Engineering and Chairperson of the Department (1949)
Lehigh University, M.E., 1920;
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THOMAS, STAN S
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University of Akron, B.S.M.E., 1950;
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New York University, A.B., 1948;
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Rutgers, The State University of New Jersey, B.S., 1928;
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ZATZKIS, HENRY
Distinguished Professor of Mathematics (1953)
Ohio State University, B.S., 1942;
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Chemistry (1993)
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Architecture (1991)
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Chemical Engineering, Chemistry And Environmental Science (1998)
Slippery Rock University, B.S., 1992;
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Rose Polytechnic Institute, B.S.E.E., 1966;
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United States Military Academy at West Point, B.S., 1968;
University of Hawaii, M.A., 1976;
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New Jersey Medical School, M.D., 1971.

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Computer And Information Science (1999)
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Temple University, B.S, 1979;
University of Dundee, M.S, 1994.

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Environmental Science (1997)
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New Jersey Institute of Technology, M.S., 1997.

CASTRONOVA, LOUISE
Humanities And Social Sciences (1983)
Upsala College, B.A., 1973;
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Mathematics (1991) And Biomedical Engineering (2000)
Punjab University (India), B.A., 1952;
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Indian Institute of Technology, Kharagpur, Ph.D., 1967.

CHEN, WAN-LING
Electrical Engineering (1993)
National Tsing-Hua University, B.S.E.E., 1984;
Michigan Technological University, M.S.E.E., 1986;
Case Western Reserve University, M.S., 1988;
New Jersey Institute of Technology, Ph.D., 1993.

CHU, JOSEPH C
P.e., Engineering Technology (1990)
Kansas State University, M.S.C.E., 1970;
Taipei Institute of Technology, Diploma C.E., 1965.

COHEN, HARVEY
Electrical Engineering (1959)
Newark College of Engineering, B.S.E.E., 1956;
Yale University, M.S., 1958.

CORRIN, LINDA
Humanities And Social Sciences (1998)
University of Michigan, B.A., 1977;
Indiana University, M.B.A., 1982;
William Paterson University, M.A., 1994.

DAKEN, RICHARD
P.e., Electrical And Computer Engineering Technology (1993)
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William Paterson College, M.B.A., 1992.

DAME, ENID
Humanities And Social Sciences (1998)
Towson State College, B.S., 1963;
City College of New York, M.A., 1973;
Rutgers, The State University of New Jersey, Ph.D., 1983.

DART, JAMES
A.i.a., R.a., Architecture (1985)
Rhodes College, B.A., 1976;
University of Pennsylvania, M.Arch., 1981.

DAULARD, MARIE-THERESE A
Assistant Professor and Program Coordinator, Computer Technology (1995) .
Ecole Superieure d'Electricite (France), Engrg. Diploma, 1969;
Fairleigh Dickinson University, M.S.E.E., 1975;
Monmouth College, M.S., 1986;
Rutgers University, Ph.D., 1991.

DAVIE, GEORGE W
Industrial And Manufacturing Engineering (1994)
Polytechnic Institute of Brooklyn, B.S., 1967;
Fairleigh Dickinson University, M.B.A., 1976.

DEAUX, THOMAS
Computer And Information Science (1998)
Christopher Newport College, B.S., 1974;
New Jersey Institute of Technology, M.S., 1998.

DEEK, MAURA ANN

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Cook College, B.S., 1982;
New Jersey Institute of Technology, M.S.C.S., 1986.

Industrial And Manufacturing Engineering (1985)
New Jersey Institute of Technology, B.S.I.E., 1981;
Rutgers, The State University of New
Jersey, M.S.I.E., 1984.

DINE, PAUL J
Management (1997)
Campion House (U.K.), B.A., 1951;
St. John's Seminary (U.K.), M.A., 1957;
Pontificia Universita Gregoriana (Italy), S.T.L.
(M.A.), 1959;
Pontificium Institutum Bliblicum (Italy), L.S.S.
Ph.D., 1961.

DOBI, JOHN
Environmental Science (1995)
Rutgers, The State University of New
Jersey, B.S., 1970;
M.S., 1972;
University of Massachusetts, Ph.D., 1979.

DREYZIN, EDWARD
Research Professor Of Mechanical Engineering (1999)
Odessa College of Measurements, B.S., 1980;
Odessa University (Ukraine), M.S., 1985;
Ph.D., 1992.

DUPRÉ, ARTHUR
Computer And Information Science (1998)
Wofford College, A.B., 1959;
George Washington University, M.S., 1962;
University of Maryland-College Park, Ph.D., 1965.

DURAN, SERGIO
R.a., Architecture (1996)
Southern California Institute of
Architecture, B.Arch., 1985;
University of Tokyo, M.Arch., 1989.

DURAN, WALTER
Biomedical Engineering (1985)
Catholic University of Chile, Ph.D., 1965;
Duke University, Ph.D., 1974.

EGAN, JOHN
Humanities And Social Sciences
St. Peter's College, B.A., 1971;
University of Hawaii, M.A., 1979.

EISHER, LUDWING
Electrical And Computer Engineering Technology
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New Jersey Institute of Technology, B.S., 1989.

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ENGLISH, JERRY FITZGERALD
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Stanford University, B.A., 1956;
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ESCHE, JOHN
Humanities And Social Sciences

FARRAUTO, ROBERT
Chemical Engineering (1989)
Manhattan College, B.S., 1964;
Rensselaer Polytechnic Institute, Ph.D., 1968.

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Physics (1999)
State University of Samar Island (USSR), B.S., 1969;
M.S., 1971;
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Physics (USSR), Ph.D., 1977.

FISHER, ELLIOT A
Mathematics (1991)
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California Institute of Technology, Ph.D., 1977.

FLEISCHER, DORIS
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Brooklyn College, B.A., 1958;
New York University, M.A., 1961;
Ph.D., 1979.

FRANKENFELD, JOHN
Chemistry (1993)
University of Chicago, B.A., 1952;
M.S., 1957;
Massachusetts Institute of Technology, Ph.D., 1961.

FRIEDMAN, JEFFREY
Mechanical Engineering Technology (1992)
New Jersey Institute of Technology, B.S.M.E., 1985;
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Coordinator for Distance Learning and Extension
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Computer And Information Science (1993)
Brooklyn College, B.A., 1984;
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Humanities And Social Sciences (1983)
Pace University, B.A., 1967;
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Johns Hopkins University, M.D., 1963;
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Chemical Engineering (1996)
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