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Abbreviations

The following abbreviations are used in this catalog:

GMAT	- Graduate Management Admission Test
GPA	- Grade Point Average
GRE	- Graduate Record Examinations
GUR	- General University Requirements
LSAT	- Law School Admission Test
MCAT	- Medical College Admission Test
TOEFL	- Test of English as a Foreign Language
Rutgers-New Brunswick	- Rutgers University, New Brunswick campus
UMDNJ	- University of Medicine and Dentistry of New Jersey

Degree Programs

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- Finance
- Geology
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- Human Resource Management
- Humanities
- Industrial Engineering
- Infrastructure Planning
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- International Studies
- Management
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- Manufacturing Systems Engineering
- Marketing
- Marketing Management
- Materials Science and Engineering
- Mathematics
- Mechanical Engineering
- Mechanics
- Nursing
- Operations Management

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 well over 8,000 students, NJIT is the largest technological university in the New York metropolitan region. The university has state-of-the-art facilities with more than 2 million square feet located on a 45-acre campus in Newark, and a solar observatory in Big Bear, California. With robust distance education programs, NJIT's degree and non-degree programs are available throughout the world.

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.
- 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.
- Contributing to the state's **economic development** through partnerships and joint ventures with the business community and through the development of intellectual property.

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

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

NJIT's Six Colleges

NJIT's roots are in engineering education. For more than eight decades, **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 -- nationally recognized for integrating computer technology into its design curriculum. The college's design curriculum was so successful that in 2008 it changed its name to the **College of Architecture and Design**, now comprised of the **NJ School of Architecture** and the **School of Art and Design**.

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 approximately 2,000 students in 13 degree programs.

A Public Research University

NJIT is designated as a "Research Intensive" University by the Carnegie Foundation and ranks among the "best national universities" by U.S. News and World Report. The university expends more than $75 million in a panoply of research and development partnerships with industry, government and other universities. NJIT researchers are making important advances in a wide range of areas, including the biosciences, manufacturing, microelectronics, multimedia, transportation, computer science, solar astrophysics, environmental engineering and science, and architecture and building science.

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.

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 complex algorithms to reducing simulation times on large-scale parallel computers, to advancing the frontiers of visualization technology in computer-aided design, to patenting optics-based sensors, to developing computer-based infrastructure management systems, to developing advanced computer-mediated communications systems.

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

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

NJIT's multi-gigabit network connects more than 6,500 nodes in classrooms, laboratories, residence halls, faculty and staff offices, the library, student organization offices and others. The campus wireless network blankets the university's public, classroom and outdoor areas. Both networks provide access to a wealth of shared information services. Included among these are high-performance, multi-processor servers used for simulation and computational research; disk arrays for storage of large data sets; communication servers for computer conferencing and e-learning, and a digital library with access to over 19,000 online journals. A virtual private network combined with Internet access extends access to network services to faculty, staff and students at home, work, any of the university's extension sites or throughout the world.

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

The Van Houten Library's Information Commons provides a convenient and relaxed atmosphere to check e-mail, search the Web, view digital archives of lectures, or retrieve scholarly publications from the university's digital library collections. Over 19,000 of the library's databases and subscriptions are available on-line allowing remote access from anywhere in the world with an Internet connection. Reference librarians are available on-line and in-person to help students and researchers 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 recorded broadcast of e-courses as well as satellite downlinks for a wide variety of video conferences and other educational and public service satellite broadcasts. Several interactive television studio classrooms provide distance learning facilities. Multi-media capability is now being deployed to all areas on campus via network based video technologies.

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

NJIT is one of the founding members and administrative home to NJEDge.Net, New Jersey's higher education network. NJEDge.Net provides collaborative resources and networked information services to its members and affiliates in support of education; research and development; outreach and public service; as well as economic development throughout the state of New Jersey. With 53 connected institutions including all of New Jersey's research universities, NJEDge.Net leverages economies of scale and supports new and emerging technology-enabled forms of inter-institutional collaboration among members and affiliates.

Library Services

The University Library is composed of two modern library facilities in Newark and extensive online resources which may be accessed on campus or remotely at www.library.njit.edu. The main library, the Van Houten Library, is located in the Central Avenue Building. Erected in 1992, it provides a modern facility for individual and group study, research and browsing. The Barbara and Leonard Littman Architecture Library, redesigned and relocated in 1998, is found on the fourth floor of Weston Hall, part of the Architecture and Building Sciences Complex.

The collections include more than 150,000 volumes of print and electronic books plus maps, slides, models, images, theses and dissertations, product catalogs, CDs, DVDs and an historical archive. The Libraries have over 19,000 subscriptions to journals, databases, and other serials, almost all available online remotely. These focus on NJIT's curriculum and research areas of architecture, engineering science, computer science and technology, management, and liberal arts.

Library staff acquire and organize books and other materials in print and electronic format and make them accessible to the NJIT community. Though the library and online collections form the backbone of research support at the university, NJIT librarians consider the world their resource and help faculty and students obtain materials from other libraries or online sources whenever necessary through the Library's Inter-Library Loan and Document Delivery services.

Through collaborative agreements, NJIT students and faculty have access and borrowing privileges, with some limitations, at several other nearby academic libraries. These include 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. Arrangements can be made for special privileges at other institutions in the New York area, when appropriate, through an NJIT Reference Librarian.

The libraries are truly academic centers. They are popular places to study, with comfortable chairs, tables, study carrels, rooms for group study, quiet work areas, and a computer lab called the Information Commons.

The Information Commons at the Van Houten Library consists of 120 computer workstations designed to satisfy student computing and online research needs. Both libraries are wireless to facilitate the collaboration so characteristic of the NJIT community. The Van Houten Library's Information Commons provides a convenient and relaxed atmosphere to check e-mail, search the Web, view digital archives of lectures, or retrieve scholarly publications from the university's digital library collections. Reference librarians are available on-line and in-person to help students and researchers sort through the vast amounts of information resources available and access what they need.

A team of highly trained information and research assistants, reference and instructional librarians bridge the gaps between research resources and users. They provide ad hoc assistance in person via the Research Helpdesk at the Van Houten Library and the service desk at the Littman Architecture Library, or by phone (973-596-3210 for Van Houten and 973-596-3083 for Littman), email, and instant messaging. The online library is available 24/7 as is the chat help line at www.QandANJ.org, a New Jersey librarians' collaborative providing research assistance round the clock.

Reference Librarians are subject specialists and work closely with departmental faculty in all of NJIT's curriculum and research areas to ensure that the right information resources are accessible to the right people at the right time. They teach research techniques and resources in the classroom in conjunction with course content and in small groups. They are also available for individual in-depth consultation sessions. Contact information for departmental liaisons can be found on the library website.

More information about the library can be found at www.library.njit.edu or by calling (973) 596-3210.

Consortium with Rutgers-Newark and UMDNJ

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

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

NJIT Campus

Located in the University Heights section of Newark, NJIT's 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 College of Computing Sciences and industrial and manufacturing engineering instruction and research facilities.

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

Academic Policy and Procedures

The academic calendar lists the dates classes begin and end, dates on which the university is closed for holidays, deadline dates for registration and withdrawal and other dates of interest to the academic community. It may also be accessed at http://www.njit.edu/Calendar/Academic.html.

Registration for Courses at NJIT

Registration is required each semester. The Registrar's office is located in the Student Mall, on the ground floor of the parking deck. The office is open when classes are in session, Monday 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.

Currently Enrolled Students Currently enrolled students are informed of registration procedures for the fall and spring semesters by the Office of the Registrar during April and October respectively, and must then register during the advance registration period. Students who fail to comply with these instructions are charged a late fee. Instructions for the summer session are provided separately and mailed to students. Currently enrolled 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.

International Students
New international students are only permitted to register after attending the required international student orientation program and must register in person. International students who register appropriately for full-time study will be reported in the Student and Exchange Visitor Information System (SEVIS) administered by the U.S. Immigration and Customs Enforcement Agency.

Non-Matriculated Students Non-matriculated students should contact the Office of University Admissions for details of admission and registration procedures at least one month before the date of intended enrollment. 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 available for international students during the international student orientation program.

Auditing a Course
Students who wish to audit a course must state their intention to do so at the time of registration. Change in auditing status is not permitted once a semester has begun. Students who audit are required to pay full tuition and fees for the course. Financial awards are not applicable to audited courses. Audited courses are not counted in determining full-time status. Students on probation are not permitted to audit. Students who wish to attend a course must have an authorized reason for attendance and a registration in that course (regular or audit) and cannot merely "sit in" at their own discretion.

Undergraduate Registration in Graduate Courses
Undergraduate students who wish to take 500- or 600-level courses must obtain the written approval of the graduate advisor for the program that offers the course, their undergraduate advisor and submit an "**Approval for Undergraduates Taking Graduate Courses" form**. If undergraduates wish to take 600-level courses, they must also obtain written approval from the chairperson of

the department offering the course. Undergraduates are not permitted to take 700-level courses.

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 an "**Approval for Undergraduates Taking Graduate Courses" form** that requires appropriate signatures and reports the student's cumulative undergraduate GPA. Students shall have a cumulative undergraduate GPA of 2.5 to be approved for registration in 500-level courses (500G for Architecture) and 2.8 for registration in 600-level courses.

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

Undergraduate students 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 associate provost 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.

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 associate provost 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.

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, the flat rate (12--19 credits) may still apply. Students who add a course to their program will be charged the full tuition and fee for the course added. All schedule changes are completed via ***Highlander Pipeline*** and a schedule change fee will be assessed during late registration as determined by the Registrar.

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

Withdrawal from 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. International students must consult with the Office of International Students and Faculty because of the possible impact of federal reporting of status in SEVIS. 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.

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 within the overall time limits for completion 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.

Master's project, master's thesis, or doctoral dissertation registration must be at least 3 credits during a semester. Summer session registration, if needed to allow completion for the August 31st degree date, must be at least 3 credits.

All students must have the program advisor's approval and appropriate section identification each time they register for project, thesis, dissertation, pre-doctoral research, co-op, or independent study. Students must register within the deadlines established by the registrar.

Maximum credit registration each semester is 12 credits for the doctoral dissertation, 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 associate provost of graduate studies. It is highly recommended that the masters thesis registration be only 3 credits in a semester unless a single semester completion is anticipated.

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 the final grade of P when the Office of Graduate Studies confirms it has received all documents in final and approved form and all related bills have been paid.

Approval by the graduate program advisor and the Office of Graduate Studies must be obtained if 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 U, 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 U, 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.

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.

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.

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.

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

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

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 note 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.

Responsibility for Registration
NJIT emails notices in advance, but cannot guarantee delivery. Regardless, students are expected to obtain all necessary information and comply with all registration procedures on time. Students who receive financial support must be in attendance at NJIT and will not be permitted to have other persons register for them.

Scheduling of Classes
Graduate courses at NJIT and at Extension Sites are, in general, scheduled for late afternoon and evening hours and Saturdays for the convenience of those employed full-time. Evening courses normally begin at 6 p.m. and end at 9 p.m. Some laboratory sessions begin at 6 p.m. and end at 9:50 p.m.

Courses in heavy demand may be scheduled for additional sections if adequate enrollment can be assured. Day and evening classes during the summer months are possible under the same conditions. Special programs such as the Executive Management program and those offered by Distance Learning have their own schedules.

Course Cancellations
The university does not guarantee offering all or any of the courses listed in this catalog. When there is inadequate registration, a course may be 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 via ***Highlander Pipeline***.

Courses Taken at Other Colleges

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, cross-registration cannot occur for summer sessions.

Registration at Another College
To take graduate courses at colleges other than those in the cross-registration program, students must obtain prior approval from their advisor and the associate provost 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.

Transfer Credits
Transfer credits are calculated by NJIT according to the total number of instructional minutes earned at the other institution. The equivalent instructional minutes of a maximum of 9 credits of graduate work, taken within seven years, from accredited US educational institutions may be transferred and applied to degree requirements at NJIT. Credits from educational institutions outside the United States (except Canada) cannot be transferred as individual courses. On a case by case basis, up to 9 transfer credits may be considered for non-collegiate-based instruction after evaluation by the associate provost of graduate studies. The university does not grant transfer credit for work experience or other non-instructional activities.

Groups of courses may sometimes be accepted as a block of credits toward some types of programs. An appropriate prior Master's degree is often accepted as a block equivalent to 30 credits toward a PhD program at NJIT. Subject to specific MBA program conditions, an equivalent block of 12 credits can be accepted from a graduate degree previously awarded by a US AACSB accredited management program or internationally from a program accredited by AACSB or an AACSB-affiliated accrediting agency. For the MBA program, the proposed block must be based on courses with grades of B or better and on courses with equivalent credit values of 3 or more credits

Credits are transferred only if the courses were taken for full academic credit, were never applied to any other degree, and a final grade of at least B (3.0 GPA equivalent) was attained. In addition, the student's graduate advisor and the Office of Graduate Studies must agree that such courses directly relate to the student's program of study before they can be transferred.

Requests for transfer credit must be submitted on a form available from the Office of Graduate Studies, accompanied by course descriptions from the other educational institution. Students must also arrange for the other institution to send an official transcript to the Office of Graduate Studies at NJIT. Requests may be submitted and approved at any time but are not added to a student's record until matriculation is granted and one semester completed. Grades that are transferred will not be calculated in cumulative GPAs.

Transfer of Credits Within NJIT
A student may transfer credits from one program to another program within NJIT under certain circumstances. This type of transfer requires consultation with The Office of Graduate Studies but does not require completion of a transfer credit form or submittal of NJIT transcripts. All graduate credits taken at NJIT, regardless of the major, appear on a general transcript.

Academic Standing

Enrollment Status
Students registered for 9 credits or more throughout an entire semester are considered full-time. International students must be in

full-time status every semester. The Office of International Students and Faculty will report, in SEVIS, international students who meet the full-time definition under F-1 regulation 8CFR 214(f)(6). Any international students unsure of their status should contact the office at 973-596-2451 or e-mail to international.students@njit.edu Students who are not registered for 9 credits and do not meet the conditions for full-time certification are considered part-time.

Full-time Certification
The Office of Graduate Studies may certify students as full-time even if they are not registered for 9 credits, under any of the following circumstances:

- If a master's thesis registration is included in a prior semester, an additional semester for a maximum of two with only a master's thesis registration is acceptable
- Students have fewer than 9 credits remaining for completion of all degree requirements and are registered for all credits needed to complete the degree. This certification can only be given for one semester.
- Doctoral candidates who completed all required course work, and 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 1 credit each semester.
- Students originally registered for 9 credits but have substantial extenuating circumstances that require a reduction in course load. Normally this certification applies only in cases of medical or similar emergencies that incapacitate a student for a significant part of a semester. Improper course registration, failure to seek proper advisement, inadequate academic progress, or risk of earning a weak or failing grade are not extenuating circumstances. Inability of an international student who had earlier filed a financial attestation to pay tuition and fees, is also not an extenuating circumstance.
- Students on a full-time cooperative education assignment are registered in a graduate co-op work experience or equivalent course. The Office of Graduate Studies should be consulted for limits on cooperative education because cooperative education has an influence on full-time certification and allowable time to complete the degree.
- Audited courses and withdrawn courses do not count toward full-time status; ESL (English as a Second Language) courses do count as one course each.

Half-time Students
For federal, financial aid, and other reporting purposes, half-time graduate student status may be defined for students registered for 6 credits or fewer during a semester. Contact the Office of Graduate Studies for more information.

Grades
The following grades are used for graduate courses:

GRADE	GPA	SIGNIFICANCE
A	4.0	Excellent
B+	3.5	Good
B	3.0	Acceptable
C+	2.5	Marginal Performance
C	2.0	Minimum Performance
F	0.0	Failure
I		Incomplete
W		Approved Withdrawal
AUD		Audited (no academic credit)
S or U		Satisfactory or Unsatisfactory
P		Passing for Master's Thesis or Doctoral Dissertation

(Unlike undergraduate courses, there is no D grade for graduate courses. Assigned grades must be consistent with the level of the course and not the matriculation level of the student in the course. Grades used in GPA calculations (A, B+, B, C+, C, and F) are not to be used as grades for dissertation research (790), pre-doctoral research (792), master's thesis, 0, 1/2, and 1 credit seminars, co-op, teaching methods, and ESL courses. Incompletes are not assignable for these courses with the exception of co-op as described later.)

Project, Thesis and Dissertation Grades
Grades for these are S or U until completion. Students who do not complete a thesis or project in a semester, regardless of

accumulated credits, must register again for at least 3 credits of thesis or project dissertation in the following semester. Students who do not complete a dissertation in their final proposed semester must register for at least 1 credit in the following semester.

Final Grades in Project, Thesis and Dissertation
Letter grades bearing on the GPA are given for satisfactory completion of a project. The final grade for a completed and approved thesis or dissertation is P. Theses and dissertations require a successful defense before the thesis or dissertation committee after which the P is assigned. Theses and dissertations are submitted to the Office of Graduate Studies. Projects are submitted to the project graduate advisor.

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 dismissal from the program.

Special Topics
Regular letter grades are assigned for special topics courses.

Independent Study
Regular letter grades are assigned for independent study courses.

Incomplete
A grade of I (Incomplete) is given when courses cannot be completed because of special circumstances. Students on academic probation are not permitted a grade of incomplete without permission from the Office of Graduate Studies. Required course work may be finished at the discretion of the instructor, no later than the end of the subsequent semester. Receipt of an I does not require or suggest attendance in the 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. The new grade cannot be changed.

A grade of I cannot be given for thesis, project, dissertation, seminar, pre-doctoral research, or English as a Second Language (ESL) courses. Students in joint programs or cross-registered from 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. Students continuing for a second consecutive registration period in co-op with the same employer will have an I assigned as a grade for the first registration. This will be changed to S or U, based on co-op performance and evaluation by the co-advisor at the end of the second registration period.

Satisfactory and Unsatisfactory
The grades S or U report progress in project, thesis, dissertation, and pre-doctoral research courses. These also can be final grades in seminar, co-op, teaching methods and ESL courses. The grade of S is given for satisfactory progress and U is given for unsatisfactory progress. Students who fail to meet with their advisors or do not satisfy relevant attendance requirements will receive a U grade. Credits for courses in which U is received cannot count toward a degree.

Grade Reports
The registrar no longer issues grade reports. Grades may be viewed using a confidential password and identification number at http://www.njit.edu/Registrar, the registrar's home page.

Grade Changes
Grade change requests will not be accepted after the end of the subsequent semester. Students should carefully monitor their records and contact the Registrar or the Office of Graduate Studies about any missing or incorrect grades no later than the end of the following semester.

Grade Disputes
Students are expected to resolve disputes about grades with their instructors. If they cannot reach a satisfactory settlement with their instructor, students are permitted to request the intervention of the chairperson of the department and the dean of the school or college. Most schools and colleges have defined procedures for grade disputes coordinated by the dean of the school or college. The associate provost 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 associate provost of graduate studies any special circumstances that may adversely affect academic standing. This action must be taken as soon as such circumstances develop.

Course Repetition
Graduate students may request approval to repeat a course using a form available from the Office of Graduate Studies. The grade received in a repeated course is calculated in the cumulative GPA, but the first grade still appears on the transcript. A maximum of two courses may be repeated in matriculated graduate study. Students may not repeat a course without prior approval from the department and the Office of Graduate Studies. Non-matriculated students, including certificate students, may repeat a maximum of one course. Students who receive an F in a course will be required to repeat that course.

When a student repeats the same course in a future semester, the Banner system will be programmed to automatically calculate the grade from the second enrollment in the cumulative GPA. The associate provost 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.

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 be making satisfactory progress toward a degree. Students who do not have satisfactory academic standing are subject to academic warning, academic probation or academic dismissal.

Academic Warning
Students who have completed at least one full-time semester (or its equivalent of 9 credits) and do not have satisfactory academic standing may be asked to meet with their graduate advisor and also by the Office of Graduate Studies to visit in-person to review their academic record.

Academic Probation
Students who have completed two or more semesters, or more than 9 credits, and do not achieve satisfactory academic standing may be placed on academic probation or be subject to dismissal. Conditions for continuing graduate study at NJIT are sent, in writing, to students on academic probation. The Office of Graduate Studies will work with advisors and students to determine approaches toward successful program completion. 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 9 credits.
- Failing to make satisfactory progress toward a degree.
- Failing to meet the requirements for graduation.
- Failing a required or repeated course more than once.
- Failing to satisfy requirements for project, thesis, or dissertation within the required time limits.
- Failing doctoral qualifying and similar examinations required for continuing studies in the program, or failing to take examinations within prescribed time limits.
- Professional conduct offenses as defined in the NJIT Code of Professional Conduct.
- Making a false representation relating to admission, registration, or the awarding of financial support.
- Failure to pay all tuition, fees and other charges within the required time limits.

Dismissal is noted on the permanent academic record.

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 associate provost 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 on Graduate Appeals is chaired by the Provost. 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 associate provost of graduate studies. A copy of the request together with information that defines the student's record are distributed to the committee members for their consideration.

Readmission if Dismissed
Students dismissed from NJIT for academic reasons may apply for readmission to another degree program after at least one calendar year.

Dismissed students who seek readmission should apply to the Office of University Admissions at least two months before the date of intended readmission. These students must complete, in full, the application for admission and provide all requested documentation, regardless of previous applications. Readmission is treated as a new application. Readmits compete against all other applicants for admission that semester. The circumstances and conditions of the dismissal will be considered in the readmission process.

Students dismissed for professional conduct offenses or for making false representation will not be readmitted to NJIT.

Students who reapply should also include supportive material to justify readmission. Such material may include, but not be limited to, scores obtained in the GRE or GMAT, grades obtained in graduate level work at other institutions, letters of recommendation, and a statement by the applicant. A non-refundable fee of $60 must accompany applications.

General Graduate Degree Requirements

Graduate degree candidates must achieve a cumulative GPA of at least 3.0 in all graduate-level courses (500 level and above) and satisfy other academic and non-academic requirements. These include financial obligations to the university. Until the Office of Graduate Studies verifies that all tuition bills and fees have been paid, and that any required master's thesis or doctoral dissertation has 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 (500G for Architecture) or higher graduate courses are included in the cumulative graduate GPA. Only the initial grades for graduate courses that have been repeated (with a maximum of two allowed) are excluded from GPA calculations. Undergraduate credits taken by graduate students are not counted. Some programs also may require a 3.0 GPA in designated core course requirements.

In addition, the cumulative GPA for all courses counted for the degree, exclusive of master's project, master's thesis or doctoral dissertation, must be 3.0 or better. Grades for master's project must be a B or better. Successful completion of the master's thesis and the defense or the doctoral dissertation and the defense will be assigned a grade of P for passing. The P grade is for the thesis or dissertation credits taken in the student's final semester.

Theses and Dissertations
Theses and dissertations submitted for graduate degrees must follow a prescribed university format. The approved format is based on the Estrin/Roche manual: Guidelines for Scientific and Professional Theses. The Office of Graduate Studies provides

seminars, guidance documents and continuing assistance for students. The office or its web site should be consulted for more information.

Degrees cannot be certified until the Graduate Studies Office receives and approves the final thesis or dissertation documents with all related requirements completed. The Graduate Studies Office will notify the advisor and the registrar that these documents have been approved before a final grade of P can be assigned. The NJIT Library handles the scanning of completed theses and dissertations into the NJIT website and works with the external bindery. Students are notified by the Library about availability of completed and bound theses and dissertations, typically several months after degree completion. The Graduate Studies Office can make arrangements, for a specified period, for sequestering a completed thesis or dissertation for proprietary or patent reasons, if requested by the student or the advisor.

Special Topics
Special Topics courses are occasionally offered by departments to present new areas of study or of high demand where rapid developments in the field have not allowed time for formal approval of specifically named courses in advance of the offering. These are announced by the departments in time for registration and are typically well-enrolled. They may be at the master's or doctoral level. There is no university limitation on the number of special topics courses that may be taken.

Independent Study
Some programs permit up to three independent study courses (a total of 9 credits) to be taken by graduate students. Independent study is for students who want highly specialized study with a specific faculty member in areas in which specifically titled courses are not normally available. Most departments offer independent study at both the master's and doctoral level. Students should see their advisors regarding independent study options. For students in doctoral programs, a maximum of two independent study courses may be used to partially satisfy the 700-level course requirements. Enrollment in independent study may be as low as one student under a faculty section number.

Expiration of Credit
For all degrees, credits expire seven years after completion of the semester in which they are earned. Expired courses cannot be used to fulfill degree requirements and must be replaced by current credits.

Degree requirements must be 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 associate provost 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.

Awarding of Degrees
Degrees are awarded three times each academic year: August, January and May. The university conducts its commencement ceremony once per year, normally in May. Candidates for graduation must file an Application for Candidacy with the registrar. The application must be consistent with the student's program of admission and current record. Forms are available at www.njit.edu/registrar. 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.

MS students who have not completed all requirements for the degree can only participate (walk) in the May commencement if the course needed for completion is not a core course. No PhD candidates will be allowed to walk without having completed all requirements for the degree

Deadline Waiver
Applicants for the August, January or May degree dates whose master's thesis or doctoral dissertation is substantially complete, but who are unable to submit it in final form by the specified date, may request a deadline waiver from the 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 allow formal completion.

Master's Degree Requirements

NJIT offers Master's degrees in a variety of disciplines through the five degree granting colleges and schools: Newark College of

Engineering, College of Science and Liberal Arts, College of Computing Sciences, School of Management, and New Jersey School of Architecture. NJIT also offers master's degrees in interdisciplinary areas that may include coursework from a number of colleges or schools. The programs are flexibly arranged to allow new specializations and to allow new programs to be developed in response to changing needs. All current programs are listed in another section of the catalog. Students seeking more than one Master's degree should consult the Office of Graduate Admission and the Office of Graduate Studies. There are options available that can reduce the time and number of credits for completion of the second degree.

Most Master's degrees require a minimum of 30 credits to complete. Some master's degree programs, particularly those in professional areas require additional credits beyond 30 credits. Specific program sections of the catalog describe these requirements. The university requirements within the 30 credit minimum are 18 credits minimum in a specialization; the other 12 credits may be elective or include other required courses as determined by the program. In general, courses for Master's programs must be numbered at the 600 level or above; some programs will allow up to two courses numbered 500-599. Some programs may also require a Master's Thesis or a Project.

Up to 9 credits from outside NJIT, subject to approval by the advisor and the Graduate Studies Office and based on NJIT transfer credit policies described elsewhere, may be applied to Master's degrees. Generally, NJIT does not allow transfer of credits already used as part of the credit requirements for a prior degree outside of NJIT. However, students who have completed a Master's degree elsewhere that includes much more than the typical 30 credits for a master's degree and are considering an NJIT Master's degree that also includes much more than the typical 30 credits such as an MBA or an MArch degree, will be considered for a block transfer of up to 12 credits from the prior degree toward the NJIT degree. These types of transfer will require approval of the advisor and the associate provost of graduate studies.

Bridge Program
Students who seek a master's degree in an academic discipline different from that of the bachelor's degree may be admitted to a master's degree program but may be required to complete appropriate undergraduate and/or graduate prerequisites in addition to the normal graduate degree requirements of the program. The program of courses will be individually designed in consultation with their graduate advisor. Bridge courses must be completed before 9 credits of graduate degree courses are earned. Bridge courses are not counted as degree credits but do count in graduate GPA calculations if the course is numbered 500 (500G for Architecture) or higher.

Master's Thesis Advisor, Committee, and Defense
A master's thesis committee should be formed at the start of the second semester of thesis registration (or at the start of the first semester if a single semester completion seems certain). The committee must have at least three members. All members of the committee must hold faculty rank.

The chair of the committee must be a tenured or tenure track faculty member in the department or program offering the degree. At least one other member of the committee must be a tenure or tenure track faculty member or a research professor in the department or program offering the degree. Approval of the committee is made by the program director and reported to the Graduate Studies Office on a standardized thesis committee appointment form.

The thesis must be defended in a publicly announced oral defense. Each program has its own policies on scheduling and submitting thesis drafts to members of the committee. Students are responsible for following their program's policies. Successful defense of the thesis is determined by vote of the thesis committee. The chair of the thesis committee, one other person who is a tenured or tenure-track faculty or a research professor, and third member of the committee must be present to hear the defense. Every member of the thesis committee must sign and date the approval page of the final thesis document. A report on passage, conditional passage, or failure of the defense is completed by the thesis committee chair, signed by the thesis committee members, and sent to the Graduate Studies Office on a standardized form.

Specific Requirements
Detailed descriptions of the degree requirements for specific degrees or degree/discipline combinations may be found in the Degree Programs section of this catalog.

Doctor of Philosophy Degree Requirements

The number of credits required for completion of doctor of philosophy degrees varies with the program and the level of entry into the program. Students holding a prior master's degree generally require a minimum of 60 graduate credits beyond the master's degree (which is assumed to have included at least 30 graduate credits beyond the bachelor's degree). Students entering the doctoral program with a bachelor's degree and who do not wish to complete a master's degree while pursuing the doctoral degree will be required to complete a minimum of 84 graduate credits beyond the bachelor's degree for programs offered by the Newark College of Engineering and 78 graduate credits beyond the bachelor's degree for programs offered by the College of Science and

Liberal Arts.

Students who enter an NJIT doctoral program with two or more master's degrees already completed or a large number of appropriate prior graduate credits may be considered for a reduction in the credits required at NJIT. The evaluation of the requirements will be made by the program advisor in consultation with the Associate Provost of Graduate Studies. The minimum credit requirement at NJIT for the doctoral degree at NJIT is 36 dissertation research credits, regardless of any other requirement waiver.

Doctoral program credit requirements for joint programs for which the names of multiple universities appear on the diploma, are to follow the requirements of the program as approved by the universities, generally a minimum of 72 credits beyond the bachelor's degree.

In addition to overall credit requirements, each program includes the following minimal requirements:

- For those entering the program with master's degrees, 24 credits of course work beyond the master's degree of which at least 12 credits must be at the 700 level and none at the 500 level or lower.
- For both entry levels; baccalaureate or master's start-point, at least 12 credits of course work at the 700 level; no more than two independent study courses may be used to satisfy this requirement. Master's project or thesis cannot be used to satisfy this requirement.
- 36 credits minimum of doctoral dissertation research for programs offered offered jointly with other universities.
- 30 credits minimum of doctoral dissertation research for the programs offered by the College of Computing Sciences.
- Dissertation research credits in accordance with the program approval documents for programs offered jointly with other universities
- Seminar attendance each semester or as required by the program. Nominal credit values, if any, for registration in seminar do not count toward fulfillment of overall credit requirements.

Students who wish to complete a master's degree while pursuing a doctorate in the same field must be approved for this by the doctoral department, the Associate Provost 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. The committee consists of a minimum of five members, one of whom is external to the program or to NJIT. The majority of the committee members are tenured or tenure-track faculty from the student's program or department having research experience or developing research interests related to the dissertation research. The dissertation committee chairperson typically is the doctoral candidate's dissertation advisor, but other faculty may be selected, provided they are from the student's program or department. The dissertation committee chair must be a tenured or tenure-track faculty member in the program. Two committee members, including an external member, may serve as co-advisors. The advisor or at least one of the co-advisors must be a tenured or tenure-track faculty member from the program.

The other members of the dissertation committee, except for an external member from outside the university, must have faculty rank at the level of Assistant Professor, Associate Professor, Professor, Distinguished Professor, or Research Professor. Former students of any committee member, who are less than four years beyond doctoral completion, are specifically excluded from membership. Post-doctoral Associates, Instructors, Special Lecturers, Research and Teaching Assistants, or any other student category, are specifically excluded from membership. The external members should either have appropriate faculty rank elsewhere or have sufficient research expertise to warrant inclusion on the dissertation committee.

Part-time doctoral students pursuing the doctorate with industry collaboration should have at least one dissertation committee member from the participating industrial partner whose research credentials would otherwise be appropriate for a member of the university faculty. Committees for joint doctoral programs with other universities shall either follow these policies or the specific policies for the joint program consistent with the program approval and related documents.

Each doctoral program has specific requirements for preparing, presenting and accepting proposals. Research is expected to investigate or develop a unique contribution to science and technology. Research may be experimental, analytical, applied, or theoretical, provided it satisfies this 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 associate provost 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 graduation date.

Dissertation and Defense
The dissertation should be a scholarly publication of the quality to warrant conference presentation or paper submission to reputable journals. The dissertation must be defended in a publicly announced oral defense. Successful defense of the dissertation is determined by vote of the dissertation committee. All members of the committee must be present to hear the defense.

Each program has its own policies on scheduling and submitting dissertation drafts to members of the dissertation committee. Students are responsible for following their program's dissertation policies. In regard to format, the standard reference is the latest edition of the Estrin/Roche manual: Guidelines for Scientific and Professional Theses. Office of Graduate Studies policies on number of copies, deadlines, fee payments, information documents, and grade submission for acceptance of the final dissertation and for doctoral degree certification are to be followed. The Office of Graduate Studies provides guidance and assistance to students working on the final details of the dissertation. Students should contact the office for appointments early in the final semester. The review of format should proceed well in advance of final document approval and dissertation defense.

Every member of the dissertation committee must sign and date the approval page of the final dissertation document.

Graduate Certificate Requirements

Certificates require completion of 12 specified credits with a GPA of 3.0 or better. Only one course repetition is permitted for certificate students to improve the GPA. The cumulative GPA of the entire graduate record at NJIT also must be 3.0. Graduate certificate credits may be applied to a following master's degree. Dual use of credits from a completed first master's degree to a second and following certificate is not permitted.

Students in certificates programs are usually considered to be non-matriculated students for the duration of the certificate program. Graduate certificate programs are generally completed before students are admitted to a following matriculated graduate program. Students who did not apply for admission to a certificate program initially and instead complete the certificate requirements as part of a completed graduate degree program may be permitted to receive a certificate also with approval of the graduate program director.

Rights and Responsibilities

Code of Professional Conduct

New Jersey Institute of Technology requires students to conduct themselves with decorum and to adhere to standards of ethical and professional behavior. NJIT has adopted, and requires all students to comply with, a Code of Professional Conduct. The policies and procedures governing this code are contained in a separate publication, the Student Handbook, and are deemed incorporated into this catalog. The student handbook, maintained by the Dean of Students Office, is available online at: www.njit.edu/handbook/

Identification Card

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

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

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

NJIT cards are not transferable. Cards are not to be loaned to anyone for any reason. ID cards are the property of NJIT and must be returned upon request.

Family Educational Rights and Privacy Act

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

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

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

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

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

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

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

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

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

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

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

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

Students with drug and alcohol abuse problems should be aware that they can receive information, counseling and referral assistance from the Office of the Dean of Student Services, the Counseling Center, the Health Services Office, or the Stop-In Center. The professional staff of the Counseling Center can provide substance abuse counseling and assessment in some situations and will refer more serious problems to off-campus facilities and services.

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

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

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

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

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

Registrar

Academic Calendars

2012-2013 Academic Year

2012 Summer Semester

2012 Fall Semester

2013 Winter Session

2013 Spring Semester

2013-2014 Academic Year

2013 Summer Semester

2013 Fall Semester

2014 Winter Session

2014 Spring Semester

Rutgers-Newark Academic Calendar

Registrar @ Your Service

Online:Highlander Pipeline

24-Hour Email

Student Mall Staff

Spring/Fall Office Hours:
M-Th-F, 8:30 a.m.-4:30 p.m.
T-W, 8:30 a.m.-6:00 p.m.

Summer Hours
M-Th, 8:30 a.m.-5:00 p.m

MORE »

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

Contact Us

Maps & Directions

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

ABET
(CAC of ABET) Computing Accreditation Commission of the Accreditation Board for Engineering and Technology
(EAC of ABET) Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology
(TAC of ABET) Technology Accreditation Commission of the Accreditation Board for Engineering and

111 Market Place, Suite 1050
Baltimore, MD 21202
Tel. (410) 347-7700

AACSB International
777 South Harbour Island Boulevard
Suite 750
Tampa, FL 33602-5730
Tel. (813) 769-6500

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

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

Admissions

Every application for admission is processed through the Office of University Admissions and is reviewed by the Graduate Admissions Committee. Candidates are notified of their admission status by mail. Admission decisions cannot be communicated by telephone, e-mail, fax, in-person, or to third parties. For admissions information contact:

Office of University Admissions
New Jersey Institute of Technology
University Heights
Newark, NJ 07102-1982
(973) 596-3300, fax (973) 596-3461, e-mail: admissions@njit.edu

For an online application for admission go to www.njit.edu/admissions/apply-online.php

Test Requirements

Graduate Record Examinations (GRE) The GRE (general test) is required of all applicants to doctoral programs, all applicants seeking financial support, and all applicants whose most recent degree was awarded from an institution outside of the United States.

Specific master's programs: applied physics, architecture, biology, infrastructure planning, and materials science 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 MBA in Management of Technology and the MS in Management programs. Students with significant business experience who are seeking admission into the MS in Management program may apply for a GMAT waiver. For additional information, contact the graduate admissions office at (973) 596-6378. The GMAT also can be used to fulfill test requirements for the master's programs in information systems and in public health.

For further information about taking the GMAT, contact: Educational Testing Service, P.O. Box 592, Princeton, NJ, 08541; phone (609) 771-7330, 8 a.m. to 8:45 p.m.; or www.gmat.org

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); 79 (internet-based).

For further information about taking the TOEFL, contact: TOEFL/TSE Services, P.O. Box 6151, Princeton, NJ 08541; phone (609) 771-7100 Monday--Friday, between 8 a.m. and 9:45 p.m. and Saturday, between 9 a.m. and 4:45 p.m. New York time, for recorded information or personal assistance; or see www.toefl.org.

International English Language System (IELTS)
International applicants may submit results from the IELTS exam in lieu of the TOEFL. The minimum score id 6.0 with no sub-score lower than 6.0.

For further information about taking the IELTS, contact IELTS; www.ielts.org.

Master's Degree Programs

Master's degree programs provide advanced education needed by professionals in an era of rapidly expanding technology and normally require more specialization in the academic discipline of the student's bachelor's degree.

Applicants for admission to graduate study must have completed an undergraduate program accredited in the United States or its equivalent and demonstrate superior academic achievement in an appropriate discipline. Students are expected to have placed in the top half of their graduating class and program and to have achieved a cumulative GPA no lower than 2.8 on a 4.0 scale. Individual departments may impose requirements that are more stringent. Applicants with undergraduate degrees in engineering technology must have ranked in the top quarter of their class and have a cumulative GPA of at least 3.0.

All applicants should submit supplementary evidence of their potential for successful graduate work. Letters of recommendation, GRE or GMAT scores, a publications record, prior research experience, a record of exceptional career development, a statement of the applicant's objectives, interests and professional experience are examples of appropriate supplementary evidence.

Bridge Program
Students who seek a master's degree in an academic discipline different from that of the bachelor's degree may be admitted to a master's degree program but may be required to complete appropriate undergraduate and/or graduate prerequisites in addition to the normal graduate degree requirements of the program. The program of courses will be individually designed in consultation with their graduate advisor. Bridge courses must be completed before 9 credits of graduate degree courses are earned. Bridge courses are not counted as degree credits but do count in graduate GPA calculations if the course is numbered 500 (500G for Architecture) or higher.

Admissions Procedures for Master's Study
An Application for Admission to Graduate Study form may be obtained from the Office of University Admissions or submitted via online at www.njit.edu/admissions/apply-online.php. 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 1; for spring (January) admission by November 1. 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.There is also a dual degree program in which a student may simultaneously earn a masters degree in Infrastructure Planning from NJIT and in City and Regional Planning from Rutgers-New Brunswick.

Doctoral Programs

New Jersey Institute of Technology offers doctoral programs to fill society's need for creative research scientists and engineers.

Admissions Requirements for Doctoral Study

Applicants are required to have an appropriate academic background as described by the individual degree programs, which are located in the Degree Programs section of this catalog, and a GPA of at least 3.5 on a 4.0 scale in prior study. GRE scores are required for admission to all doctoral programs. Individual programs may establish additional or more stringent requirements.

An applicant who wishes to pursue a doctoral degree in a field different from that of previous study, and who is otherwise qualified, may establish eligibility by satisfactorily completing a program of study recommended by the department in which they seek admission.

Applicants who wish to complete a master's degree while pursuing a doctorate must apply for admission to the master's program. This requires the approval of the doctoral program and dean of graduate studies, and where permitted, generally occurs only at or near the completion of the doctoral program.

Mid-career scientists and engineers interested in part-time study may wish to consider the collaborative doctorate option described in the Graduate Studies section of this catalog.

Admissions Procedures for Doctoral Study

Admissions procedures are the same as for a master's degree. In addition, three letters of recommendation are required from individuals who can best judge the applicant's ability to pursue independent research and complete a doctoral program.

Joint Doctoral Degrees with Other Universities
NJIT cooperates with other universities in Newark in operating and developing doctoral programs of mutual interest.

The university participates in unique offerings of joint doctoral programs with Rutgers-Newark and UMDNJ. Students may apply and be admitted through either university. Programs that lead to joint degrees are applied physics, biology, environmental science and mathematical sciences with Rutgers-Newark, biomedical engineering with UMDNJ and urban systems with both Rutgers-Newark and UMDNJ.

NJIT faculty participate in the doctoral program in management offered by Rutgers-Newark. NJIT faculty supervise Rutgers doctoral students in this program. Admissions to the doctoral program in management is handled by Rutgers-Newark.

Admission Classifications

DEGREE (MATRICULATED STUDENTS)

Regular Admission
Applicants who meet NJIT standards and have an appropriate undergraduate academic background for the degree program to which they are seeking admission will be offered regular admission as degree-seeking (matriculated) students.

Conditional Admission
NJIT expects applicants to have a superior academic record, but recognizes that interest, creativity, maturity, and motivation are also important. Conditional admission to the university may be granted to applicants who do not have the appropriate academic background required for a particular degree program, but who have an academic record that meets NJIT's scholastic standards.

Once granted conditional admission, students must complete conditional or bridge courses specified by the university within their first two semesters. Such courses may be at either the undergraduate or graduate level and are NOT counted as degree credits although all courses numbered 500 (500G for Architecture) or higher are calculated in the cumulative GPA. Students must attain grades specified by the university and are not permitted to take more than 9 credits that count as graduate degree credits at NJIT before meeting the terms of conditional admission. Failure to meet these conditions may result in dismissal from the university.

Contingent Admission
Students who apply for admission to graduate programs before completing their bachelor's degree, and whose records demonstrate superior academic achievement, may be offered admission to NJIT contingent on their showing proof of receiving a bachelor's degree appropriate for the degree program for which they are seeking admission. Such students must show proof of graduation before being permitted to enroll in a graduate program.

Change of Program
Students are admitted to one graduate degree program and not to the university as a whole. Students who wish to change major on arrival at NJIT must file an application for the new program and must generally remain in the original program for one full year before the application is approved. There is no guarantee or requirement that the new application will be successful. Those on support are liable to loss of support from the original department and cancellation of a current award.

Change of Level
Students who wish to change current degree level must file an application for admission to the new degree level. There is no

requirement or guarantee that the application will be successful. Students who wish to drop down to a master's program from a doctoral program should be aware of the impact of this action on current and future financial support. Students who wish to raise their level from a master's to a doctoral program should be aware of any impact on incomplete master's theses or projects.

NON-DEGREE (NON-MATRICULATED) STUDENTS

Students who wish to take graduate courses without seeking a degree (non-matriculated status) should contact the Office of University Admissions for a Non-Degree Application Form.

Non-matriculated students may be permitted to take a maximum of 9 graduate-level credits accumulated over three registration periods, except students seeking a graduate certificate. These students may take a maximum of 12 graduate-level credits accumulated over four registration periods. Students wishing to take credits beyond these limits must apply and be accepted to a degree program as a matriculated student.

Academically qualified students who do not desire to enter degree programs may enroll in certain individual graduate courses. Such students must present transcripts of previous academic work or other appropriate evidence at each registration in order to indicate adequate preparation for the course work involved. If approved by the Office of University Admissions, registration will be permitted if space is available. Permission to enroll as a non-matriculated student does not imply eventual admission to a degree program.

Graduate Certificate Programs
NJIT offers designated courses in concentrated areas for students wishing to obtain a graduate certificate in specific areas. These require completion of 12 NJIT credits at the graduate level. Students in these programs are generally non-matriculated students for the duration of the certificate program. Graduate certificate programs may also be completed during a matriculated graduate program by making use of degree credits. Students in a matriculated degree program are not permitted to receive a certificate until completion of the degree program. Only one certificate can be earned within the credits applied toward a master's degree.

Students Matriculated at Other Universities
Graduate degree students at other colleges or universities may take courses for credit at NJIT for transfer back to their home institution. In addition to satisfying the course prerequisites, students must furnish a letter of approval from an appropriate administrative officer of their home institution.

NJIT Undergraduates
NJIT undergraduates may register for graduate courses, 500- or 600-level, with written approval from both their undergraduate advisor and from the graduate advisor in the department in which the course is taught. NJIT students in the BS/MS program are required to take 6 graduate-level credits while undergraduates to satisfy BS/MS program requirements.

Rejected Applicants
Students whose application for admission to a degree program is unsuccessful are not permitted to register as non-matriculated students.

International Students
International students on F-1 and J-1 visas are not permitted to register as non-matriculated students. Students on other visas should consult the Office of University Admissions regarding non-matriculated status.

Auditors
Students who wish to attend courses for which they are qualified, but who do not wish to be graded in the course, may be permitted to enroll as auditors. Registration will be approved only after a review of credentials by the Office of University Admissions and only if space is available. A notation signifying that the course was audited will be made on the student's record, but no credit will be granted for the course. Students who wish to audit a course must state their intention at the time of registration. A change to, or from, auditor status is not permitted once a semester has begun. Students who audit a course are required to pay full tuition and fees. There is no tuition remission allowable for audited courses. Audited courses cannot be counted in determining full-time status.

TRANSFER STUDENTS
Students enrolled in graduate programs at other institutions may apply for transfer to NJIT by completing the normal admission procedure. Transfer students may apply for credit for courses taken at other U.S. educational institutions by following procedures outlined in "Transfer of Credits from Outside NJIT" in the Academic Policies and Procedures section of this catalog. In addition, international students wishing to transfer from other educational institutions in the United States must:

- Demonstrate a cumulative GPA of at least 3.0 in graduate courses taken at other U.S. educational institutions;
- Complete the required immigration procedures for transfer; and
- Be eligible for admission to the NJIT program of their choice.

To transfer to NJIT from an other institution in the U.S., international students must already have been placed into SEVIS, The Student and Exchange Visitor Information System. NJIT will ask the "leaving institution" to verify the student's current standing in F-1 or J-1 status under immigration regulations. All financial and academic requirements must be completed before admission will be granted and the I-20 or DS-2019 issued.

INTERNATIONAL STUDENTS AND TOEFL

New Jersey Institute of Technology welcomes applications from international students with records of superior academic achievement. In addition to the procedures stated below, international students are required to provide evidence of English language proficiency by submitting either the Test of English as a Foreign Language (TOEFL) or the International English Language System (IELTS) scores

For further information about taking the TOEFL, contact: TOEFL/TSE Services, P.O. Box 6151, Princeton, NJ 08541; (609) 771-7100 Monday-Friday, between 8 a.m. and 8:00 p.m. New York time, for recorded information or personal assistance; or see www.toefl.org.

For further information about taking the IELTS, contact IELTS; www.ielts.org.

Students with TOEFL scores of 550 (Paper-based); 213 (Computer-based); 79 (Internet-based); 6.5 (IELTS) or better are not required to take an ESL course but are encouraged to improve their English-language skills by doing so voluntarily.

All ESL courses are graded on an S/U (Satisfactory/Unsatisfactory) basis. The course credits count towards the 9 credits required for full-time status; however, the credits do not count toward degree credits.

International Students Who Seek Financial Support
Those seeking financial support from NJIT at the time of admission will be required to achieve a TOEFL score of at least 550 (Paper-based); 213 (Computer-based); 79 (Internet-based). Students who may be offered Teaching Assistant or similar positions are required to be tested for spoken English proficiency in advance of classroom or laboratory placement. The test is offered at NJIT after admission. New international students offered TA or similar awards must also participate in the teaching assistant training program offered by ESL staff in advance of the first semester (usually in August.) All new TAs must register for ENG 599 in their first TA assigned semester.

INTERNATIONAL STUDENT FINANCIAL STATEMENT
In accordance with Department of Homeland Security, Bureau of Citizenship and Immigration Services requirements, international students must also submit to the Office of University Admissions an International Student Financial Statement to demonstrate financial resources sufficient to meet the academic and living costs of their anticipated stay at the university. International students should note that they will be required to pay non-resident tuition rates. Immigration papers (e.g., I-20, DS-2019) will NOT be issued until the International Student Financial Statement is on file with the Office of University Admissions.

Academic Credential Equivalents for International Students
Undergraduate degrees must be equivalent to the typical four-year program in the United States. NJIT is working with a number of countries and universities to provide a transition from two- and three-year degree programs to baccalaureate and later graduate study. To be eligible for admission to graduate study at NJIT, international students must have the following minimum academic qualifications.

Argentina	Licenciatura
Bahamas	Honors bachelor's degree
Barbados	Honors bachelor's degree
Bolivia	Licenciatura
Brazil	Bacharel or Licenciado
Canada	Honors bachelor's degree or equivalent
Chile	Bachillarato, Licenciatura? or Titulo of at least four-year duration
People's Republic of China	Bachelor's degree
Colombia	Licenciatura or Titulo
Dominican Republic	Licenciatura of at least four-year duration
Ecuador	Licenciatura or Titulo
Egypt	Bachelor's degree
El Salvador	Licenciatura

France	Maitrise or equivalent
Germany	Ptychion
Guatemala	Licenciatura
Haiti	Diplome d"EtudesSuperieures or Licence of at least four-year duration
Honduras	Licenciatura of at least four-year duration
Hong Kong	Honors bachelor's degree
India	Bachelor's degree(first class) in Engineering or Architecture, master's degree in other?
Indonesia	Sarjana or Insinyur
Iraq	Bachelor's degree
Isreal	Bachelor's degree
Italy	Laurea
Jamaica	Honors bachelor's degree
Japan	Bachelor's degree
Jordan	Bachelor's degree
Korea	Bachelor's degree (Taehak Taehakkyo)
Kuwait	Bachelor's degree
Lebanon	Bachelor's degree, Licence of at least four-year duration, or Maitrise
Libya	Bachelor's degree
Malaysia	Bachelor's degree
Mexico	Licenciatura of at least four-year duration
Morocco	Licence or Ingenieur d'Etat
Netherlands	Doctorandus, Ingenieur or Meester
Nicaragua	Licenciatura
Nigeria	Honors bachelor's degree
Norway	Cand. Mag
Pakisthan	Bachelor's degree in engineering or other four-year bachelor's degree or master's degree
Panama	Licenciatura
Paraguay	Licenciatura? of at least four-year duration
Peru	Bachillerato, Licenciatura or Professor from four-year university program
Philippines	Bachelor's degree
Saudi Arabia	Bachelor's degree
Singapore	Honors bachelor's degree
Sweden	Filsofie Kandidatexamen or Ekonoexamen
Switzerland	Licence or Diplom of at least a four-year duration
Syria	Lisentiate or bachelor's degree
Rep. of China	Bachelor's degree
Thailand	Bachelor's degree
Trinidad and Tobago	Honors bachelor's degree
Turkey	Lisans or Bachelor's degree
United Kingdom	Honors bachelor's degree
Uruguay	Licenciatura of at least four-year duration
Venezuela	Licenciatura or equivalent

Students from countries whose universities do not provide transcripts, or who experience exceptional difficulty in obtaining transcripts, should contact the Office of University Admissions for special instructions. Students whose credentials cannot be evaluated by the Graduate Admissions Committee will be required to submit a Credential Evaluation Report from an approved agency. For further information, contact World Education Service, Inc., Old Chelsea Station, P.O. Box 745, New York, NY 10113-0745, (212) 966-6311; e-mail: info@wes.org

Campus 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

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, Division of	5612
Biomedical Engineering, Department of	5268
Bookstore	3200
Bursar, Office of the	3157
Campus Center	3605
Career Development Services, Division of	3100
Chemical Engineering, Otto H. York Department of	3568
Chemistry and Environmental Science, Department of	3595
Civil and Environmental Engineering, Department of	2444
College of Computing Sciences, Office of the Dean	5304
College of Science and Liberal Arts, Office of the Dean	3677
Computer Science, Department of	3366
Computing Help Desk	2900
Continuing Professional Education, Division of	3061
Cooperative Education and Internships, Office of	3100
Electrical and Computer Engineering, Department of	3513
Employment, Student	3474
Engineering Science Program	3228
Engineering Technology, Department of	3228
Financial Aid, Office of	3479
Graduate Studies, Office of	3462

History, Federated Department of	3377
History, Federated Department of Rutgers-Newark	353-5410
Honors College, Albert Dorman	642-4448
Human Resources, Office of	3140
Humanities, Department of	3266
Industrial and Manufacturing Engineering, Department of	3660
Information Systems Department of	3368
Information Technology Program	5764
Intellectual Property, Office of	5825
International Students and Faculty, Office of	3579
Library, Architecture	3083
Library, Robert W.Van Houten	3206
Mathematical Sciences, Department of	5782
Mechanical Engineering, Department of	3331
Microelectronics Fabrication Center (MFC)	5696
New Jersey School of Architecture, Office of the Dean	3080
Newark College of Engineering, Office of the Dean	3226
Physical Education and Athletics	3636
Physics, Department of	3562
Public Safety, Department of	3111
Registrar, Office of	3236
Research and Development, Office of	3429
Residence Life	3039
School of Management, Office of the Dean	3019
University Advancement, Office of	3400
University Communications, Office of	3433

Continuing Professional Education/Online Learning

NJIT's Division of Continuing Professional Education provides enriching career-long learning opportunities through extension programs, Online Learning, graduate certificates, and through its professional development training and corporate customized training.

Professional development programs include short courses, certificates and license reviews, with some leading to the award of continuing education units (CEUs). The CEU is used nationally to document the type, quality and duration of study. In general, a CEU is defined as being equal to classroom hours. 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.

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. Since 1990, NJIT has trained over 63,000 professionals as part of over 550 training initiatives for 300 different companies conducting business in New Jersey.

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

Online Learning

Online Learning offers five graduate degrees (MS in Computer Science, MS in Engineering Management, MS in Information Systems, MS in Management and MS in Professional and Technical Communication), select Graduate Certificates, and graduate courses in many disciplines including communication, computer science, information systems, information technology, humanities, management, and engineering management. Online Learning offerings can be viewed at http://adultlearner.njit.edu/locations/onlinelearning.php.

Online Learning provides students the opportunity to earn college credit through enrollment in online electronic-based courses. These courses are virtual learning communities with instructor-led online classrooms that utilize various technologies such as WebCT or Moodle for presenting course material, online quizzes, asynchronous and synchronous communication. Online courses are flexible and rigorous educational experiences suited to motivated students.

The program's reach is worldwide. Course material can be accessed through the Internet via learning managements systems utilizing multimedia presentations. Material is also downloadable as podcasts through NJIT on iTunes U and other venues as well streaming video, CD ROM and DVD..

Online Learning furnishes a convenient alternative to graduate distance learners and students who have scheduling conflicts. For more information, contact the Division of Continuing Professional Education at (800) 624-9850 or email cpe@njit.edu.

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
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
OSHE	Occupational Safety and Health Engineering
PhEn	Pharmaceutical Engineering
Phys	Physics
Tran	Transportation

NUMERICAL CODE

Numbers from 500 to 599 (500G to 599G for Architecture) indicate entry-level graduate courses normally offered for students who require additional background for admission to 600- or 700-level courses.

Numbers from 600 to 699 indicate regular-level graduate courses normally associated with master's-level study.

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

Rutgers-Newark Courses

The current Rutgers-Newark Schedule of Courses can be viewed for cross-registration along with the Rutgers catalog when planning for cross-registration.

School of Management

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Executive MBA Program

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The EMBA is intended for accomplished and high potential professionals, managers, and entrepreneurs. The 18 month accelerated(Saturday) program is tailored for working professionals.

- Request Information

The NJIT EMBA

Program Objective

The NJIT EMBA is designed to prepare a new generation of technology savvy business leaders and entrepreneurs with the skills to succeed in an increasingly complex and competitive business environment. The curriculum prepares students to think strategically about business and technology.

The cost of the EMBA is comparable to that of many "traditional" MBA programs.

Our View of Executive Education

Our philosophy of management education is based on relevance, practicality, and innovation. The EMBA is designed to meet these objectives while also meeting the needs of people working in challenging and demanding careers.

An Innovative Curriculum: Directed Study, Blended Learning, and Saturday Classes

From the day we launched the EMBA, we learned that one of the most important take-aways for students is knowledge that translates directly into the workplace. We are building on past successes with directed study which refers to projects that link course concepts to work-related issues and problems that students face every day. These projects are guided by the instructor who serves as a mentor and advisor.

We have also learned that there is a considerable difference between course contact hours and quality contact hours. The most common EMBA schedule consists of full-day classes (every other Friday and Saturday). Our extensive experience employing learning technologies led us to blended learning as a better model which combines a mixture of face-to-face classes, online interaction, and directed study.

Quality and Rankings

The NJIT School of Management has been identified as a top 10 global research center in the management of technology in a study[1] published in the Journal of Product Innovation Management, a top-tier scholarly journal. The school is accredited by AACSB International--The Association for the Advancement of Collegiate Schools of Business. Only one third of US business schools are able to meet the rigorous quality standards of the AACSB.

[1] PERSPECTIVE: Ranking Business Schools on the Management of Technology, J.D.Linton, 2004.

Financial Support

Financial Support and Graduate Awards

Various financial support and graduate award options are available to NJIT graduate students. Financial support comes from either NJIT internal funds or from external sources. Information on need-based support is detailed on the office of Financial Aid Services Web site. Eligibility and selection criteria are summarized in the following table for both need-based and merit-based support. Funds for these are not guaranteed.

Type of Support	Contact	Who is Eligible
Federal Loans	Financial Aid 973-596-3479	US citizens, permanent residents; students enrolled at least half time, based on financial need; must file the Free Application for Federal Student Aid.
Private Loans	Financial Aid 973-596-3479	US citizens, permanent and non-resident students enrolled at 3 credits; need is not a factor and filing a Free Application for Federal Student Aid (FAFSA) is not a requirement.
Industry Co-op	Career Development Services 973-596-3100	Full-time students, based on position availability; master's students; doctoral students only by exception with approval by the associate provost of graduate studies
Work-study	Financial Aid 973-596-3479	US citizens, permanent residents, international students, full-time and part-time students, based on position availability.
Scholarships, Fellowships, Grants	Graduate Studies 973-596-3462	Based on funding source, full-time students, often supporting under-represented groups.
Assistantships	Graduate Studies 973-596-3462	Full-time, based on academic merit or priorities and on funds available.

NJIT AWARDS

Close to 400 teaching, research and graduate assistantships, based on academic merit, are awarded to qualified full-time students.

Prospective students can apply for financial support by using the Application for Admission to Graduate Study. Prospective students seeking financial support are urged to apply no later than 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.

Prospective students seeking financial support should indicate their interest on the admissions application form. Continuing students seeking need-based support should contact the Office of Financial Aid. Continuing students seeking merit-based financial support should contact the Office of Graduate Studies. GRE and GMAT scores as required for admission to graduate study at NJIT are acceptable for consideration of applications for merit-based support. It is noted that Master's students whose last degree was from an institution within the United States are not required to supply GRE or GMAT scores as a general university requirement for admission and need not additionally supply these for financial support consideration unless specifically requested by the program or funding source. However, specific Master's programs within NJIT may require GRE or GMAT scores for admission consideration to the specific program. All Master's program applicants whose last degree was from an institution outside of the United States and all PhD program applicants are required to provide GRE or GMAT scores as a requirement of the admissions process.

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 $24,000 stipends ($2,000 per month) are offered to outstanding doctoral students. Funding for room and board, research activities, supplies, travel, and other supplemental needs can supplement the stipend. Full tuition and fee support is provided.

Provost Fellows
A Provost Fellowship provides a $2,000 tuition award each semester to qualified students at the time of admission to full-time study toward a Master's degree; students who are already admitted are not eligible. To be considered for a fellowship, applicants must meet the following criteria: completion of an earned baccalaureate degree from an accredited college or university; achievement of an undergraduate cumulative GPA of at least 3.0 (or its equivalent); and submission of official GRE or GMAT results.

A Provost Fellowship is sustainable for a maximum of three consecutive semesters of full-time study (four semesters for students enrolled in the MBA program; six semesters for students enrolled in the Master of Architecture program) in a student's initial Master's program at NJIT. Students receiving a fellowship must maintain a cumulative graduate GPA of 3.25 or better, and make satisfactory progress toward the Master's degree during enrollment at NJIT. Academic records will be reviewed at the conclusion of each semester to determine a student's eligibility for the subsequent semester. Students who wish to pursue a second master's degree at NJIT and applicants for doctoral study are not eligible for this award.

The Office of Graduate Admissions will review all admitted students who satisfy the criteria. Recipients will be notified in writing. No special application is required.

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.

Unemployed or Displaced Workers
Students receiving tuition support because of an unemployed or displaced worker's program are alerted to potential loss of this form of support because of any salary or stipend that may be received for any form of on-campus or off-campus employment.

Stipend Support Levels

Teaching/Research Assistant (not supported by grants):

Master's students	$ 9,000	9 months at $1,000/month
Doctoral students	$ 18,000	9 months at $2,000/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)

Doctoral Students	$26,000 (12 months)

Partial awards are possible for all categories of awards. Award periods are scheduled for two consecutive 4 and ½ month periods for 9 month awards and any following summer periods

Maximum Annual Support
While NJIT does allow multiple sources of support for individual students, there is an annual limit established each year for the maximum amount of support that an individual student may receive from all sources. The limit is established at a reasonably high and competitive level in comparison to reported maxima provided by a number of federal support programs. Students who are receiving support from outside NJIT must report this to their graduate program advisor and to the Graduate Studies Office to assure their not exceeding NJIT limits. Total support that would be in excess of the NJIT limit may require an adjustment in the support provided by NJIT sources. Excess support can also negatively impact need-based support arrangements.

Summer Support
Depending on availability of funds, students may be eligible for stipends and tuition support for June, July and August. NJIT has two summer award periods, the first covering late May and June, the second covering July and most of August. The split of summer award periods is based on the combination of the semester-based academic calendar used at NJIT and the changeover to a new fiscal year on July 1. Interested students should consult their faculty advisors in March or April.

International Students
Private loans are available through the Office of Financial Aid. These loans require a cosigner who is a U.S. citizen or permanent resident alien.

International students may not receive NJIT support or be employed on-campus during periods of practical training. International students must be in status with the United States Citizenship and Immigration Services (USCIS). International students are eligible only for merit-based NJIT financial support and not for need-based state or federal finds.

USCIS regulations require that international students attest to having funds sufficient to cover the expense of the entire course of study before they will grant a visa. Students are expected to demonstrate the availability of funds for the duration of studies at NJIT as a requirement for admission to the university.

GOVERNMENT-FUNDED SUPPORT FOR GRADUATE STUDIES

NSF and NRC Programs
The National Science Foundation (NSF) and the National Research Council (NRC) support doctoral stipends and tuition. 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. NJIT participates in regional consortia for the Bridges to the Doctorate and Alliance for Graduate Education for the Professorate supported by the NSF.

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

Federal Direct and Perkins Loans, and Work-Study Programs
US 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 complete entrance counseling. The FAFSA is available at www.fafsa.gov.

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.

Students must take the GRE or GMAT and arrange to have official score reports to be sent to NJIT before they may become eligible to receive awards. Although there is no minimum eligibility score for the GRE or GMAT, NJIT may establish them for certain awards. For instance, GRE mathematical scores between 700 and 800 are typical of NJIT award recipients.

Graduate students who have not already received awards or had not been offered an award on admission must attain a minimum GPA of 3.5 for first-time support from internal funds and 3.0 for first-time support from external funds. Any graduate or undergraduate course taken by a student in graduate studies at NJIT is counted in the GPA (as calculated by the Office of Financial Aid Services) for evaluating selection criteria, including courses that were repeated or excluded. GPAs are checked at the beginning of each support period to verify that awards are warranted. GPAs only establish eligibility and neither guarantee nor entitle students to receive financial support.

The Office of Graduate Studies evaluates criteria for support from internal funds each year. The criteria reflect both average grade point performance levels and availability of funds. A student who has received support from NJIT funds for one degree cannot receive NJIT support for another degree of the same or lower level or type. Criteria and full details of terms and conditions of awards are available from the Office of Graduate Studies.

Need-based support programs administered by the Office of Financial Aid and by the Office of Student Employment have different criteria for selection. These offices should be consulted for further information. Funds distributed for hourly employment through the Office of Student Employment are not considered awards. The Provost Fellowship program for applicants to master's program is coordinated by the office of Graduate Admissions.

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, for Fall and Spring semetser awards. Students are therefore required to work during semester breaks, either for their supervisor or, with the consent of the supervisor, on their own research.
- Students not receiving the maximum award for their award category and degree status are required to work a prorated number of hours (less than 20) based on a comparison of their award to the stipend level allowed for that award. A maximum of 35 hours per week, with appropriate increase in support level, may be permitted for service during the two summer award periods.
- Full-time registration in one of NJIT's graduate degree programs must be maintained at all times throughout the period of an award. Full-time status is accorded to those who complete at least 9 credits per semester, or to those who are certified by the Office of Graduate Studies or designated as full-time students. Students should review "Refunds for Withdrawal" and "Enrollment Status" in the Tuition and Fees section and the Academic Policies and Procedures section respectively in this catalog to be assured that they are following full-time certification requirements.
- Students who initially register for a full-time load but withdraw during a semester and thus become part-time cannot receive tuition remission for that semester and may have their tuition award terminated and stipend award curtailed.
- No other work for compensation, whether on- or off-campus, may be undertaken during the period of the award unless approved by the associate provost 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 associate provost 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.
- Teaching assistants are required to register for ENG 599: University Teaching Methods / Communication Skills in their first semester.

Tuition Remission Awards
Tuition support has no service condition associated with it. Students accepting this support must not leave the program for which the support is offered without the approval of the support sponsor and the associate provost 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. Departments may set higher but reasonable standards (typically 3.5 or above cumulative GPA) for continuation of awards.

Effect of Incomplete Grades and Grade Changes
Students whose transcripts show incomplete (I) grades in the semester before being selected or becoming eligible for an award must resolve them within the four weeks after grades are posted. This also applies to changes in grades that would affect eligibility.

Extension of the deadline to beyond the fourth week of the semester will be considered if the student and the instructor provide written justification. Otherwise, any award offer for that semester will be withdrawn and tuition remission cancelled. Students will be billed for tuition accordingly and will be responsible for payment in full.

Award Duration and Renewal
Student eligibility for awards is evaluated each semester, 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. The Provost Fellowship, as described earlier, is sustainable for a longer period of time.
- Students enrolled in doctoral degree programs may not receive NJIT-funded, full or partial, assistantship or fellowship support for more than four academic years. This is defined as eight semesters and four summers.
- Students enrolled in the 97-credit Master of Architecture program may not receive NJIT-funded, full or partial assistantship or fellowship support for more than three academic years. Three academic years are defined as six semesters and three summers.
- Students enrolled in the Master in Infrastructure Planning program are considered as master of science students for award

duration.

- Full-time master's students in the B.S./M.S. program are eligible to receive three semesters and one summer of financial support from internal funds.
- U.S. nationals and permanent residents enrolled in master of science programs who are members of underrepresented groups are eligible for three semesters and one summer of financial support from internal funds.
- Doctoral students who fail their qualifying examinations may not receive further awards from NJIT funds until they pass. Departments may request a review and continuation of their financial support status if they pass some but not all parts of qualifying examinations.
- When eligibility for NJIT-funded awards is completed, students may receive additional support from external sources. Check with the Office of Graduate Studies to obtain further details.
- Master's students are eligible to receive awards for a maximum of four semesters and two summers from all sources. This does not apply to students in the Master of Architecture program. Doctoral students are eligible to receive awards for a maximum of 10 semesters and 5 summers from all sources.
- No student may receive support for more than 12 semesters and 6 summers from any combination of sources or for any number of degrees.
- The university expects that students receiving NJIT-funded support move off that type of support to external source support no later than two years after the initiation of NJIT-funded support.

Resignations
Students who wish to resign from an award should inform their advisor and the associate provost 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 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.

Tuition remission is allowed for courses taken at other institutions in which there is a cross-registration agreement with NJIT. These courses must be part of the student's degree program and approved by the student's advisor.

A flat rate exists for a range of credits representative of full-time registration. Any credits over that range will not be included in tuition remission awards. Students will be billed for credits in excess of their awards.

GRADUATE COOPERATIVE EDUCATION

Graduate students have the opportunity to work off-campus while studying full-time through the cooperative education program administered by the Office of Career Development Services (CDS). Policies on eligibility, application for participation, procedures, and required regular and co-op course registrations are defined in a detailed statement developed by the Graduate Studies Office (GSO), CDS, and the Office of International Students (OIS). This opportunity is especially valuable for international students, pursuing the Master's degree, and for some PhD students lacking other forms of support. CDS should be contacted by students interested in this option. Each year, a large number of international graduate students are involved in cooperative education under Curricular Practical Training. Students pursuing this option are required to be registered in specifically numbered graduate courses for co-op as defined in each program's course listing.

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:

Applied Statistical Methods
Biostatistics Essentials (NEW)
Business and Information Systems Implementation (REVISED) *
Business and Computing (NEW) *
Construction Management *
Critical Infrastructure Lifestyle & Security Management (NEW)
Data Mining *
Emergency Management & Business Continuity (NEW)
Emergency Management & Information Assurance (NEW)
Environmental Sustainability (NEW)
Finance for Managers (NEW) *
Information Management for Managers
International Commerce (NEW) *
Management Essentials *
Management of Technology *
Network Security & Information Assurance
Pharmaceutical Management
Pharmaceutical Manufacturing
Pharmaceutical Technology
Practice of Technical Communications *
Project Management *
Sustainable Design
Venture and Innovation Management (NEW) *

*** Now or shortly available entirely online**

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 jointly or in cooperation with Rutgers-Newark and with UMDNJ as part of continuing collaborations. Graduate programs at NJIT are overseen by the Office of Graduate Studies, Fenster Hall, Room 140, 973-596-3462.

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 masters degree programs offered at NJIT are listed below. All doctoral programs lead to the Doctor of Philosophy (PhD) degree. Master's programs lead to either the Master of Arts (MA), Master of Arts in Teaching (MAT), Master of Architecture (M.Arch.), Master in Infrastructure Planning (MIP), Master of Public Health (MPH), Master of Science (MS), or the Master of Business Administration (MBA) degree, as indicated below. Numerous dual degree options exist that allow dual use of courses in one degree program toward a second degree program. The Office of Graduate Studies may be consulted about BS/MS, MS/MS, BS/PhD and similar combinations.

- Applied Mathematics (MS)
- Applied Physics (MS, PhD) joint with Rutgers-Newark
- Applied Statistics (MS)
- Architecture (M.Arch.)
- Architectural Studies (MS)
- Bioelectronics (MS)
- Biology (MS, PhD) joint with Rutgers-Newark
- Biomedical Engineering (MS)
- Biomedical Engineering (PhD) joint with UMDNJ
- Biostatistics (MS)
- Business and Information Systems (MS)
- Chemical Engineering (MS, PhD)
- Chemistry (MS, PhD)
- Computational Biology (MS) joint with Rutgers-Newark
- Computing and Business (MS)
- Computer Engineering (MS, PhD)
- Computer Science (MS, PhD)
- Civil Engineering (MS, PhD)
- Electrical Engineering (MS, PhD)
- Emergency Management & Business Continuity (MS)
- Engineering Management (MS)
- Engineering Science (MS)
- Enterprise Development (MS)
- Environmental Engineering (MS, PhD)
- Environmental Policy Studies (MS)
- Environmental Science (MS, PhD) joint with Rutgers-Newark
- Healthcare Systems Management (MS)
- History (MA, MAT) joint with Rutgers-Newark
- Industrial Engineering (MS, PhD)
- Information Systems (MS, PhD)
- Infrastructure Planning (MIP)
- International Business (MS)
- Internet Engineering (MS)
- Management (MS)
- Management of Technology (MBA)
- Manufacturing Systems Engineering (MS)
- Materials Science and Engineering (MS, PhD)
- Mathematical Sciences (PhD) joint with Rutgers-Newark
- Mechanical Engineering (MS, PhD)
- Occupational Safety and Health Engineering (MS)
- Pharmaceutical Engineering (MS)
- Power and Energy Systems (MS)
- Professional and Technical Communication (MS)
- Public Health (MPH) joint with Rutgers-Newark and UMDNJ
- Telecommunications (MS)
- Transportation (MS, PhD)
- Urban Systems (PhD) with joint Rutgers-Newark and UMDNJ

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 PhD 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.

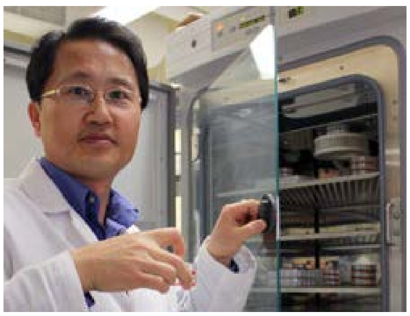
NJIT New Jersey Institute of Technology

Research Centers and Specialized Labs

Research Centers and Specialized Labs

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

Applied Life Sciences



- **Biomedical Engineering**: Stem cell applications in tissue regeneration, vision and neural engineering, bioMEMS, motion analysis and rehabilitation engineering, biomaterials and biopolymers.
- **Center for Applied Genomics**: Development and application of DNA microarray technology.
- **The Medical Device Concept Laboratory** : Synthetic materials in biomedicine.
- **Membrane and Separation Technologies**: Micro- and nanoporous filters for medicine and pharmaceutical manufacture.
- **ProjectFusion**: Technologies to support SmartCampus, a mobile, wireless NJIT campus community system with applications to protect privacy and maintain security.
- **The Vision and Neural Engineering Lab**: Oculomotor dynamics, vergeance eye movements.

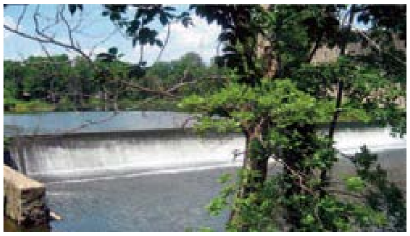
Architecture and Design

- **Center for Architecture and Building Science Research:** Educational facilities, health care and aging environments, developmental disabilities planning, historic preservation, housing and community development.
- **Concrete Testing Laboratory:** Reinforced and high-strength concretes.
- **Imaging Laboratory**: Computer-aided design in architecture.

Computing, Mathematics, and Telecommunications

- **Center for Applied Mathematics and Statistics:** Mathematical biology, fluid dynamics, wave propagation.
- **Center for Wireless Communications and Signal Processing Research:** Multi-carrier systems, Turbo Coding techniques, ultra-wideband communications, MIMO systems.
- **Collaborative Hypermedia Laboratory:** Asynchronous learning systems, online communities, digital libraries.
- **Cryptography & Telecommunication Laboratory:** Cryptography, computer security and telecommunications networks.
- **Data and Knowledge Engineering Laboratory:** Data mining, bioinformations, computational biology.
- **electronic Arts Habitat (eArtH):** Multimedia, social computing, human-computer interaction.
- **New Jersey Center for Wireless Networking and Internet Security:** Intrusion detection, watermarking, mobile networks.

Environmental Science and Engineering



- **York Center for Environmental Engineering and Science:** Hazardous substance management, pollution remediation and prevention, sustainable manufacturing.
- **Center for Airborne Organics:** Detecting and tracing organic pollutants, preventing pollutant emissions.
- **Northeast Hazardous Substance Research Center:** Hazardous substance handling, reduction, assessment and management.
- **Geoenvironmental Engineering Laboratory:** Solid waste management and disposal, environmental systems, waste water treatment, site remediation.
- **Laboratory for Process and Field Analytical Chemistry:** On-line process analysis, environmental monitoring, portable instruments for on-sire environmental measurement.
- **Materials Characterization Laboratory:** Elemental. organic and structural analysis.

Materials Science and Manufacturing

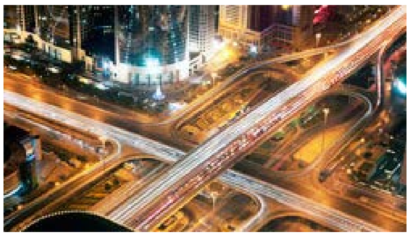
- **Bearings and Bearing Lubrications Laboratory:** Hydrodynamic, hydrostatic, rolling element bearings and novel designs of unique bearings.
- **Computational Fluid Dynamics:** Particulate flows, mixing enhancement, suppression/enhancement of turbulence, drag minimization, thermal management.
- **Dynamic Systems and Control Laboratory:** Design, control and integration of mechanical, robotic and electromechanical systems.
- **Center for Manufacturing Systems:** Advanced technology center with a dual mission of providing manufacturing support for university research programs and offering design and manufacturing expertise to small and mid-size companies.
- **Electro-hydrodynamics Laboratory:** Sensors and separation devices for a wide variety of systems for environment monitoring, health care, and medical diagnostics
- **Electronic Imaging Center:** Infrared filters, sensors and detectors utilizing terahertz radiation, carbon nanotubes.
- **W.M. Keck Laboratory:** Manipulation of liquid flows and the small particles/microorganisms they transport in biological and biomedical technologies.
- **ManufactureNJ (MNJ):** is one of several New Jersey Talent Networks each of whose focus is on the specific needs of other key industries including: Financial Services; Health Care; Transportation, Logistics, and Distribution' Life Sciences; Hospitality and Retail; and Technology and Entrepreneurship.
- **Metal Combustion Laboratory:** Propellants, explosives, pyrotechnics, and incendiaries.
- **Microelectronics Fabrication Center:** Application-specific integrated circuits, optical switches, pressure sensors, and MEMS for biomedical, biometrics, and microfluidics application.
- **Microgravity Research Laboratory:** High energy density additives to propellants and explosives, gas sensors, fuel cells, and ultra-hard material coatings
- **New Jersey Center for Engineered Particulates:** Tailored particle coatings for pharmaceuticals, food, cosmetics, ceramics, defense, electronics and specialty chemicals.
- **New Jersey Center for Microflow Control:** Fluidic devices, with a focus on miniaturized flows, and miniaturized sensors and actuators.
- **Optical Science and Engineering:** optoelectronics, environmental monitoring, industrial process monitoring and position control, and ultrafast optical and optoelectronic phenomena.
- **Polymer Processing Institute:** Modification of polymers processing into special property products for the medical, health care, automotive, electronics, construction, and packaging industries
- **Vincent A. Stabile Lab:** "Hands-on" training in solving practical problems using robotics for today's automated manufacturing.
- **Waterjet Technology Lab:** Waterjet machining and cleaning applications.

Solar Physics

- **Center for Solar Research:** Solar optical astronomy, solar radiophysics, terrestrial science.
- **Big Bear Solar Observatory:** Solar observation, helioseismology.

- **Owens Valley Solar Array:** Transient energetic phenomena, coronal magnetic fields.
- **The Frequency-Agile Solar Radiotelescope (FASR) Project:** Nature and evolution of coronal magnetic fields, physics of solar flares, drivers of space weather, the quiet Sun.
- **Global High-Resolution H-Alpha Network:** Round-the-clock solar observation.
- **Space Weather Project:** Monitoring and forecasting solar activity that may affect Earth's climate and technologies.

Transportation



- **International Intermodal Transportation Center:** Freight transportation, brownfields and passenger transportation
- **National Center for Transportation and Industrial Productivity:** Freight movement at domestic and international gateways, global competitiveness, intermodal passenger and freight transportation systems.
- **North Jersey Transportation Planning Authority:** Maintaining and improving transportation systems.
- **Transportation, Economic and Land Use System (TELUS):** Computerized transportation planning and programming.

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

Residence Life

Over 1450 students live on campus in four co-ed residence halls. Approximately 50 graduate students live on campus. Rooms are fully furnished, air-conditioned and wired for networking to the University's main computer system and to the Internet. Each hall has common areas and facilities including lounges, study areas, kitchens and laundry rooms. Rooms are wired for phone and provided approximately 50 cable TV channels. Other services include: washers and dryers, snack and soda machines, recreational equipment (pool, ping-pong, large screen televisions, etc.) and mail service Monday-Friday. Graduate students are not required to have meal plans.

Graduate students usually live in Laurel or Oak halls.

Laurel Hall is a suite-style building with approximately 582 upper class students in single, double and triple rooms. Any combination of two types of rooms can make a suite. Suites have a shared bathroom and foyer.

Oak Hall has approximately 213 upper class and graduate students housed in both suite-style rooms and apartments. Each suite-style room has a kitchenette and shared bathroom. Each apartment has a kitchen, living room and bathroom. Suites are comprised of two doubles or a double and triple bedroom. Apartment can have: a single with a double bedroom, two doubles or a double with a triple bedroom.

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

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

Once you have been admitted to NJIT, you can complete the Housing Application and Contract located on our website: https://mis3.njit.edu/housingapplication/login.aspx. A $50 non-refundable deposit is required and can be paid by credit card or check/money order payable to NJIT. Checks/money orders must be sent to the Residence Life Office, 180 Bleeker Street, Newark, NJ 07103-3514.

Applications for graduate students are assigned housing based on the distance you live from campus, need and date of application. We anticipate a wait list for the fall for all students. You may also be assigned to a triple room. We will send a confirmation letter three-four weeks after receiving your application.

While some graduate students choose to live on campus, many live off campus. Off-campus housing is available in a number of towns in close proximity to NJIT. Monthly rents typically begin at $300 and increase depending on the specific living conditions. Most rental space will require one month's rent and one month's deposit before moving in. Have a sufficient amount of money available when you begin your apartment search. It is recommended that you arrive as early as possible to allow yourself time to search for suitable accommodations (temporary housing is available (http://oisf.njit.edu/new_students_prearrival.php). The Residence Life Office provides an "Off-Campus Housing" newsletter and a list of available rentals in the area (updated weekly). You can view the newsletter and the list of available rentals by visiting http://www.njit.edu/reslife/offcampus.php. In addition, Residence Life staff will be available to assist you in finding housing upon your arrival. You can email the Off Campus Housing Coordinator in the Residence Life Office at offcampus.housing@njit.edu with any questions. For additional information please review our website http://www.njit.edu/reslife For additional questions, contact us via email reslife@njit.edu or call 973.596.3039.

Food Services

Dining facilities are located in the Campus Center. NJIT's private food services vendor, Gourmet Dining Services, operates the Dining Room, The Highlander Club, Leafs, Grains, The Grill, The Tech Café, Hershey's Ice Cream, the Trattoria and the Convenience Store.

For 2008-2009 the "all you can eat" board plan will feature continuous dining with unlimited returns. This means if you are on

Meal Plans A-E, you have unlimited access to the board dining area all day long, seven days a week. The board plan dining hall will feature the following food service stations that will be open various times during the day:

- Bread and Breakfast
- Grill
- Halal Grill
- Fruitopia
- Waffle Bar
- Deli and Panini's
- Organic "Steamed to Perfection"
- Salad Bar
- Sweet Dreams
- Beverage Stations
- Create Your Own Soup
- Pasta
- Vegan
- International
- Chef's Choice Entrees
- Baked to Perfection
- Baked Potato Bar
- Brick Oven Pizza
- Make Your Own Pizza
- Wok It Up
- Sushi
- Carving and Rotisserie
- Fajita Island
- Beverages

Flex dollars can be used at the Dining Room, The Highlander Club, Leafs, Grains, The Grill, The Tech Café, Hershey's Ice Cream, the Trattoria and the Convenience Store. For hours and a complete listing of what is available via flex, please check http://www.njitdining.com.

Special Programs

BS/MS and Dual Degree Programs

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

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

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

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

BS/PhD Programs

Undergraduate students with GPAs of 3.5 or greater may wish to consider a direct path from completion of the bachelor's degree into a doctoral program. Students approved for this option may be able to take 12 graduate credits while an undergraduate and use these for completion of the bachelor's degree and later toward the PhD program. The Graduate Studies Office will invite students to consider this option after reviewing undergraduate records each semester. GRE scores will be needed for formal admission to the PhD program.

MS/MS and Dual Master's Programs

The MS/MS program allows students to pursue a second NJIT master of science degree on completion of the first and to count two courses (6 credits) from the first degree toward the second. The option must be exercised within two years of completion of the first degree. The approval of the advisors of the two programs is required. The Office of Graduate Studies will direct the registrar on transfer of the two dual-use courses to the second program. The MS/MS program option is not intended for students who have left the doctoral program without completion of the degree. Up to 6 credits may be transferred to the second master's degree from outside NJIT. Thesis, project, pre-doctoral research, independent research and similar courses may not be used.

Several other master's degree combinations can allow more than 6 credits to count toward both degrees. In general these apply to situations in which the first or the second degree programs requires considerably more than 30 credits. Examples are the master of Architecture and the Master of Business Administration programs. The allowable dual counting of credits for the Master of Architecture in combination with other programs is described in the catalog sections on Architecture and Infrastructure Planning. Subject to specific course approval and the two year time limit for MS/MS as described above, up to 12 credits from a previously completed NJIT MS program in Computer Science, Information Systems, or Engineering Management may be applied toward completion of the 48 credit master of Business Administration degree program. Subject to course approval, up to 18 credits may be used from a previously completed NJIT MS program in Management toward the completion of the 48 credit Master of Business Administration degree program.

The Collaborative Doctorate

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 PhD 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.

Student Exchange/Study Abroad

NJIT offers a number of international exchange opportunities for both undergraduate and graduate students throughout the world. 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 time academic year. NJIT students pay tuition and fees at NJIT and room and board at the host institution. Financial aid may be applied to these expenses.

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

For further information, contact the Office of International Students and Faculty, (973) 596-2451 or visit http://oisf.njit.edu/study_abroad.php.

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.

Bursar

Policies and Procedures
About the Bursar's Office
Bursar Communications
Staff
1098-T
FAQ
How To Tutorials
Tuition and Fees Fall and Spring
Undergraduate 2013-2014
Undergraduate 2012-2013
Graduate 2013-2014
Graduate 2012-2013
Tuition and Fees Summer and Winter
Refund Information
Payment Plan Information

2012-2013 Graduate Tuition & Fees

Home » Bursar » Tuition and Fees Fall and Spring » Graduate 2012-2013

Tuition & Fees Assessed *(Per Semester)*

	In-State			Out-of-State		
Credits	Tuition	Fees	Total	Tuition	Fees	Total
1	915.00	242.00	1,157.00	1,286.00	242.00	1,528.00
1.5	1,372.50	299.50	1,672.00	1,929.00	299.50	2,228.50
2	1,830.00	357.00	2,187.00	2,572.00	357.00	2,929.00
3	2,745.00	472.00	3,217.00	3,858.00	472.00	4,330.00
4	3,660.00	587.00	4,247.00	5,144.00	587.00	5,731.00
5	4,575.00	702.00	5,277.00	6,430.00	702.00	7,132.00
6	5,490.00	817.00	6,307.00	7,716.00	817.00	8,533.00
7	6,405.00	932.00	7,337.00	9,002.00	932.00	9,934.00
8	7,320.00	1,047.00	8,367.00	10,288.00	1,047.00	11,335.00
9	8,235.00	1,162.00	9,397.00	11,574.00	1,162.00	12,736.00
10	9,150.00	1,277.00	10,427.00	12,860.00	1,277.00	14,137.00
11	10,065.00	1,392.00	11,457.00	14,146.00	1,392.00	15,538.00
12-19						

(full-time)	8,418.00	1,159.00	9,577.00	12,185.00	1,159.00	13,344.00

e-Tuition Program **$1,043.00 per credit (Graduate Out-of-State Students Only)**

Executive Management Program **$57,500.00 or $3,593.75 per course** Please **click here** for more information on the EMBA Program

Health Insurance Fees: Full-Time students will be assessed a **$828.00 Health Insurance fee** in the Fall and coverage lasts 1 full year. International students on F-1 and J-1 visas will be assessed a **$912.00 fee** when registered for 3 or more credits. You may waive this fee by providing proof of coverage and filling out a waiver form ONLINE ONLY. Please click here for more information: **Health Insurance**

Additional credits above 19 are assessed at the appropriate per credit rate.
NOTE: Full-Time status varies: 12 credits for billing purposes
9 credits for academic and Financial Aid purposes

Academic Fees Itemized *(Per Semester)*

Part-time Fee Structure	Full-time Fee Structure
Flate-Rate ($127 *most students):	
$105.00 Registration Fee	$105.00 Registration Fee
$22.00 Health Services Fee	$546.00 Academic Facilities Fee
	$70.00 Student Services Fee
$65.00 Non-Matriculation Fee	$44.00 Graduate Association (Activities) Fee
	$160.00 Athletics Fee
$125 International Student (only) Fee	$210.00 Technology Infrastructure Fee
Per-credit ($108):	$24.00 Health Services Fee
$58.00 Academic Facilities Fee	$65.00 Non-Matriculation Fee
$9.00 Student Services Fee	$125 International Student (only) Fee
$5.00 Graduate Association (Activities) Fee	
$14.00 Athletics Fee	
$29.00 Technology Infrastructure Fee	

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

Summer / Winter Session Fees
During the summer & winter sessions there is a flat fee of $192.00 in lieu of the fees noted above. Full-time Tuition rates do not apply during the summer/winter sessions. The fees are broken down as follows: Registration $105, Academic Facilities $58 and Technology Infrastructure $29

Additional Fees

$65.00 Application/Readmit
$120.00 Commencement Fee
$100.00 Payment Plan
$85.00 Distance Learning Fee
$100.00 Late Payment Fee
$125.00 International Student Fee
$50.00 Maintaining Registration Fee Graduate
$125.00 BJUT English Placement Test

$195.00 Parking Full-time
$100.00 Parking Part-time
* 7% Commuter Parking Tax
$25.00 Schedule Change Fee
$75.00 Master Thesis - Binding Fee

$100.00 Dissertation - Binding Fee
$225.00 Reinstatement Fee (in addition to Late Payment and Late Registration Fees)

* The state of New Jersey mandates a 7% sales tax for commuter students parking on campus

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

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Foundation Chair of Membrane Seperations

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Foundation Professor of Communications & SIgnal Processing

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Vice President, University Advancement

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Associate Vice President, Distance And Continuing Professional Education

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Executive Director

Kathleen Hoffman
Director, Student Support Services Program

Craig A. Stanley
Director, Consortium for Pre-College in Newark

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Acting Director, Student Fiancial Aid Services

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University Registrar

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Alexis Schug
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- Bylaws (pdf, 27 KB)
- Excellence in Research Prize and Medal
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- Organizational Chart (pdf)

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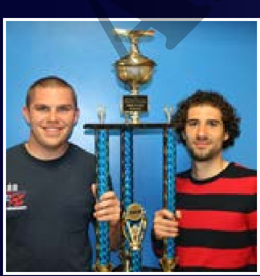

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- July 25, 2013 -- Public Session Document
- June 06, 2013 -- Public Session Document
- May 23, 2013 -- **Special Meeting Notice**
- Apr 12, 2013 -- Public Session Document
- Mar 06, 2013 -- **Special Meeting Notice**

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- Organizational Chart (pdf)

Emeritus Faculty

Badenhausen, Otto
Assistant Professor Emeritus, Federated History (1967).
Hamilton College, B.A., 1954.
Berlin Free University, M.A., 1959.

Barkan, Herbert
Professor Emeritus, Mathematical Sciences, Mathematical Sciences (1946).
Brooklyn College, B.A., 1944.
Columbia University, M.A., 1945.

Bertsch, Carl V.
Emeritus Professor
University of Michigan, B.S., 1928.
University of Michigan, M.S., 1931.
University of Michigan, Ph.D., 1937.

Buteau, Leon
Professor, Physics (1959).
Newark College of Engineering, B.S.M.E., 1958.
Stanford University, M.S., 1959.
University of Florida, Ph.D., 1963.

Camp, James E.
Professor Emeritus (1963).
Louisiana State University, B.A., 1949.
University of Michigan, Ph.D., 1965.
Columbia University, M.A., 1952.

Carluccio, Joseph
Associate Professor Emeritus, Electrical & Computer Engineering (1957).
Newark College of Engineering, B.S., 1946.
Newark College of Engineering, M.S., 1952.

Carr, William
Professor, Electrical & Computer Engineering (1986).
Carnegie Institute of Technology, B.S., 1959.
Carnegie Institute of Technology, M.S., 1959.
Carnegie Institute of Technology, Ph.D., 1962.
Southern Methodist University, M.S., 1966.

Chakrabarti, Alok
Distinguished Professor, School of Management (1989).
Foundation Chair, Management of Technology
Jadavpur University, B.Ch.E., 1963.
Indian Institute of Technology, M.B.A., 1966.
Northwestern University, Ph.D., 1972.

Cohen, Edwin
Professor Emeritus, Electrical & Computer Engineering (2002).

Deutschman, Aaron
Professor Emeritus, Mechanical and Industrial Engineering

DiMatteo, John
Associate Professor Emeritus, Mechanical and Industrial Engineering (1966).
Cooper Union, B.S., 1931.
Stevens Institute of Technology, M.S., 1950.

Droughton, John
Professor Emeritus, Mechanical and Industrial Engineering (2004).

Duursema, Charles H.
Associate Professor Emeritus
Newark College of Engineering, B.S., 1933.
Montclair State College, M.S., 1936.

Elwell Jr., David
Associate Professor, College of Architecture and Design (1975).
Yale University, B.S., 1957.
Cambridge University, B.A., 1963.
Princeton University, M.F.A., 1965.

Engler, Peter
Associate Professor Emeritus, Biomedical Engineering (1984).
McGill University, B.Eng., 1957.
Cornell University, M.S.E.E., 1961.
State University of New York at Buffalo, Ph.D., 1974.

Fenster, Saul
President and Professor Emeritus, Mechanical and Industrial Engineering (1978).
City College of New York, B.M.E., 1953.
Columbia University, M.S., 1955.
University of Michigan, Ph.D., 1959.

Frank, Joseph
Associate Professor Emeritus, Electrical & Computer Engineering (1968).
City College of New York, B.E.E., 1952.
Columbia University, M.S.E.E., 1960.
Polytechnic Institute of New York, Ph.D., 1975.

Gage, Howard
Associate Professor Emeritus, Industrial and Manufacturing Engineering (1972).
City College of New York, B.M.E., 1960.
New York University, M.M.E., 1965.
New York University, Ph.D., 1972.

Getzin, Donald
Associate Professor, Chemistry and Environmental Science (1965).

Goldberg, Vladislav
Distinguished Professor Emeritus, Mathematical Sciences (1982).
Moscow State University, M.S., 1958.
Moscow State University, Ph.D., 1961.

Granik, Gerald
Professor Emeritus, Mathematical Sciences (1952).
Newark College of Engineering, B.S., 1950.
Newark College of Engineering, M.S., 1954.
Stevens Institute of Technology, M.S., 1958.
Stevens Institute of Technology, Sc.D., 1965.

Greenfeld, Joshua
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Ohio State University, PhD
Ohio State University, MSc
Tel Aviv University, BA

Greenfield, Sanford
Professor Emeritus, College of Architecture and Design (1981).
Massachusetts Institute of Technology, B.Arch., 1952.
Massachusetts Institute of Technology, M.Arch., 1954.
Harvard University, Ed.M., 1975.

Grow, James
Professor, Chemistry and Environmental Science (1977).
Oregon State University, PhD, 1974.
University of Wisconsin, MS, 1972.
University of Illinois at Urbana-Champaign, BS, 1968.

Helfgott, Roy
Distinguished Professor Emeritus, School of Management (1968).
City College of New York, B.S., 1948.
Columbia University, M.A., 1949.
New School for Social Research, Ph.D., 1957.

Herman, Harry
Professor Emeritus, Mechanical and Industrial Engineering (1964).
Cooper Union, B.M.E., 1948.
Columbia University, M.S., 1956.
Polytechnic Institute of Brooklyn, Ph.D., 1964.

Hiltz, Starr Roxanne
Distinguished Professor, Information Systems (1985).
Vassar College, A.B., 1963.
Columbia University, M.A., 1964.
Columbia University, Ph.D., 1969.

Hodge, Elizabeth
Professor Emeritus, Humanities (2007).

Hrycak, Peter
Professor Emeritus, Mechanical and Industrial Engineering (1993).
University of Minnesota, PhD, 1960.
University of Minnesota, MS, 1955.
University of Minnesota, BS, 1954.

Hsieh, Jui S.
Professor Emeritus, Mechanical and Industrial Engineering (1960).
Wuhan University, B.E., 1943.
University of Kentucky, M.S., 1950.
Ohio State University, Ph.D., 1955.

Huang, Ching-Rong
Professor Emeritus, Chemical Biological and Pharmaceutical Engineering (1966).
National Taiwan University, B.S., 1954.
Massachusetts Institute of Technology, M.S., 1958.
University of Michigan, M.S., 1965.
University of Michigan, Ph.D., 1966.

Jaffe, William J.
Distinguished Professor Emeritus (1946).
Columbia University, M.S., 1941.
New York University, B.S., 1930.
New York University, Engr.Sc.D., 1953.
Columbia University, M.A., 1931.

Johnson, Clarence S.
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Rutgers University, Ed.D., 1957.

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Professor Emeritus, Mechanical and Industrial Engineering (1962).
Newark College of Engineering, B.S., 1962.
Newark College of Engineering, M.S., 1964.
Rutgers University, Ph.D., 1968.

Krantz, Charles
Associate Professor Emeritus, Federated History (1968).
City College of New York, B.A., 1956.
University of Connecticut, M.A., 1958.
University of Rochester, Ph.D., 1964.

Kuo, Marshall
Professor Emeritus, Electrical & Computer Engineering (2002).

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Distinguished Professor Emeritus, Civil and Environmental Engineering (1947).
City College of New York, B.C.E., 1938.
Massachusetts Institute of Technology, S.M., 1939.
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University of Oslo, B.A.Hist., 1946.
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McCormick, John
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Meola, Robert
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Newark College of Engineering, B.S., 1946.
Stevens Institute of Technology, M.S., 1949.

Mihalasky, John
Professor Emeritus, Industrial and Manufacturing Engineering

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Rosemont College, B.S., 1960.
Pennsylvania State University, Ph.D., 1964.

Kingery, Bernard
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Georgia Southern University, B.S., 1948.
Columbia Univesity's, M.S., 1949.

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Newark College of Engineering, B.S.Ch.E., 1937.
Montclair State College, M.A., 1941.

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Associate Chairperson, Biomedical Engineering, Biomedical Engineering (2002).
Brooklyn College, B.S., 1958.
New York University, M.S., 1966.
New York University, Ph.D., 1969.

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Upsala College, B.B.A., 1952.
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Rutgers Unviersity, Ph.D., 1962.

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City College of New York, B.S.E., 1935.
City College of New York, M.C.E., 1937.

McMillan, Robert
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Louisiana State University, B.S., 1942.
California Institute of Technology, M.S., 1950.
Newark College of Engineering, Ph.D., 1970.

Meyer, Andrew
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Northwestern University, M.S., 1958.
Northwestern University, Ph.D., 1961.

Miller, Edward
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(1956).
Newark College of Engineering, B.S.M.E., 1951.
Newark College of Engineering, M.S., 1954.
Rutgers University, M.B.A., 1956.
New York University, M.I.E., 1960.
Columbia University, Ed.D., 1973.

(1948).
Newark College of Engineering, B.S., 1948.
University of Delaware, M.M.E., 1949.
Columbia University, M.A., 1951.
Stevens Institute of Technology, M.S., 1952.
New York University, M.Aero.E., 1959.

Monack, Albert J.
Professor Emeritus (1954).

Monahan, Edward
Professor Emeritus, Civil and Environmental Engineering (1958).
Newark College of Engineering, B.S.C.E., 1958.
Newark College of Engineering, M.S.C.E., 1961.
Oklahoma State University, Ph.D., 1968.

Moshos, George
Professor Emeritus, Computer Science (1968).
University of Michigan, B.S., 1949.
University of Michigan, M.S., 1949.
Case Institute of Technology, Ph.D., 1965.

Napier, James
Professor Emeritus, Humanities (1955).
University of Pennsylvania, A.B., 1949.
University of Pennsylvania, A.M., 1950.
University of Pennsylvania, Ph.D., 1959.

Natapoff, Marshall
Associate Professor Emeritus, Physics (1956).
Cornell University, B.S., 1948.
New York University, M.S., 1954.
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Opie, John
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University of Pennsylvania, M.S., 1947.
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Pawel, Hans
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Newark College of Engineering, M.S., 1966.
Rutgers University, Ph.D., 1974.

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New York University, B.S., 1956.
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New York University, Ph.D., 1962.

Rausen, John
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Columbia University, M.A., 1948.
Columbia University, Ph.D., 1966.

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Cooper Union, B.S.Ch.E., 1938.
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Massachussetts Institute of Technology, MS, 1963.
Brooklyn Polytechnic Institute, BS, 1962.

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Rutgers University and University of Medicine and Dentistry of New Jersey, Ph.D.; joint degree, 2000.

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Rutgers University, B.S., 1941.

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Newark College of Engineering, B.S., 1944.

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Stevens Institute of Technology, M.E., 1954.
Harvard University, M.S., 1958.
Stevens Institute of Technology, Sc.D., 1967.

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Michigan State University, B.F.A., 1984.
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Delhi University, B.Sc., 1957.
Indian Statistical Institute, M.S., 1960.
Purdue University, Ph.D., 1968.

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Columbia College, A.B., 1964.
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Master of Science in Applied Mathematics

This program is intended for students with a strong interest in Applied Mathematics. Applied Mathematics is the application of classical and modern mathematical techniques to the solution of practical problems in the physical and biological sciences and engineering. The applied mathematician develops and analyzes mathematical models of physical and biological phenomena and engineering systems, interprets solutions to mathematical problems and uses the results to identify relationships, patterns, and the effects of altering one or more variables or modeling assumptions. Many of the courses in the program illustrate how mathematics can be used to predict the behavior of physical, biological, and engineering systems.

The Master of Science in Applied Mathematics, with its areas of specialization in analysis, applied mathematics, computational methods, and mathematical biology is designed to serve the needs of students who may be interested in pursuing a doctoral degree in the mathematical, physical, or biological sciences. The program also strengthens the quantitative and analytical skills of students with a baccalaureate degree who are planning to work in industry, commerce, or education, as well as practicing engineers and others already employed in industry and commerce.

Admission Requirements:
It is expected that students applying for admission will have an undergraduate education in mathematics, the physical or biological sciences, or engineering. For additional information, see the Admissions section of this catalog. An undergraduate GPA of at least 2.8 on a 4.0 scale or equivalent is normally required. GRE scores are required for those students applying for financial support, or if the most recent degree was earned at a school outside the United States. Applications are considered on a case-by-case basis.

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. (Advisor's permission is required)

Seminar: In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll every semester in Math 791 Graduate Seminar.

Core:
15 credits:

		Math 613	Advanced Applied Mathematics I: Modeling (3 credits)
		Math 631	Linear Algebra (3 credits)
	*	Math 645	Analysis I (3 credits)
		Math 656	Complex Variables I (3 credits)
		Math 689	Advanced Applied Mathematics II: Ordinary Differential Equations (3 credits)

Project, Thesis (optional):

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

Required Courses in Areas of Specialization:
6 credits:
Analysis:

		Math 745	Analysis II (3 credits)
		Math 756	Complex Variables II (3 credits)

Applied Mathematics:

		Math 614	Numerical Methods I (3 credits)
		Math 690	Advanced Applied Mathematics III: Partial Differential Equations (3 credits)

Computational Mathematics:

		Math 614	Numerical Methods I (3 credits)

		Math 712	Numerical Methods II (3 credits)

Mathematical Biology:

		Math 635	Analytical Computational Neuroscience (3 credits)
		Math 637	Foundations of Mathematical Biology (3 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 advanced courses from biology, physics, computer science, and engineering, for example. 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.

Students specializing in Applied Mathematics or Computational Mathematics may take Math 545 Introductory Mathematical Analysis and Math 546 Advanced Calculus, instead of Math 645 and 3 credits of elective.

Master of Science in Applied Statistics

The objective of the Master of Science in Applied Statistics is to prepare students for a wide range of professional activities as practicing statisticians in both academia and industry. A statistician develops and analyzes models of data-driven situations where uncertainty of the outcomes plays a major role, identifies statistical relationships among observable variables, forecasts probable future outcomes, and draws inferences about background parameters that impact the phenomenon of interest. Thus the program is designed to provide students with the comprehensive knowledge and technical skills that are needed for the planning, execution, and analysis of statistical studies. These statistical studies are increasingly used as advisory instruments for policy decisions in the corporate and other sectors of the economy.

The Master of Science in Applied Statistics program will serve the needs of students with a baccalaureate degree who are planning to work in industry, commerce, or education, as well as practicing engineers and others already employed in industry and commerce. The program also strengthens the analytical and quantitative skills of graduate students who may be interested in pursuing a doctoral degree in Applied Probability and Statistics, since it equips them with basic training in the foundations of statistics in preparation for further advanced studies and research.

Admission Requirements:
Applicants must have a degree from an accredited institution with at least 12 credits in mathematics, including calculus. Students who do not meet these requirements may be admitted if they satisfy the university's requirements for admission. An undergraduate GPA of at least 2.8 on a 4.0 scale or equivalent is normally required. GRE scores are required for those students applying for financial support, or if the most recent degree was earned at a school outside the United States. Applications are considered on a case-by-case basis.

Bridge Program: Students who do not satisfy the credit requirement in mathematics will be required to take a bridge program of six credits in appropriate mathematics courses. Such courses do not count towards a graduate degree.

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 (3 credits) ***or***
		Math 630	Linear Algebra and Applications (3 credits)
		Math 644	Regression Analysis Methods (3 credits)
	**	Math 661	Applied Statistics (3 credits)

		Math 662	Probability Distributions (3 credits)
		Math 664	Methods for Statistical Consulting (3 credits)
		Math 665	Statistical Inference (3 credits)
		Math 699	Design and Analysis of Experiments (3 credits)

Project, Thesis (optional):

		Math 700	Master's Project (3 credits)
		Math 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 that have a significant statistics content. 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.

Math 661 and Math 663 cannot both be used toward degree credits at NJIT. The requirements of Math 661 may, in individual cases, be substituted by Math 663, at the discretion of the Graduate Advisor.

Master of Science in BioStatistics

The Master of Science program in Biostatistics will provide advanced graduate education and training to students interested in applying statistical methods to the health sciences in general and clinical studies in particular. It will focus on training students in quantitative methods that will prepare them for careers in the health, life sciences, and pharmaceutical areas. Graduates, upon satisfactory completion of the degree program, are expected to have acquired appropriate skills in data analysis and computing that are typically required in their profession. This program will address the growing demand for trained biostatisticians in these fields, especially in New Jersey.

Admission Requirements:
Applicants must have a baccalauareate degree in Statistics, Mathematics, Sciences, or Engineering, with at least 12 credits in mathematics, including calculus and at least one upper division course in statistics. Applicants with other baccalaureate degrees will also be considered and may be subject to a suitable bridge program. An undergraduate GPA of at least 3.0 on a 4.0 scale or equivalent is required.

Bridge Program: Students who do not satisfy the credit requirement in mathematics will be required to take a suitable bridge program of appropriate mathematics/statistics courses. Such courses do not count towards the graduate degree.

Degree Requirements:
A minimum of 30 credits is required for the degree. Bridge courses, if any, will not count toward degree credits. The graduate curriculum consists of seven core courses in background statistical theory and biostatistics, as described in the curriculum below. The remaining courses are electives, chosen in consultation with a departmental graduate advisor and consist of topics courses in statistics, biostatistics, epidemiology and biology that have significant statistics content or/and applications thereof. Students will be encouraged to choose courses in application areas. Courses offered by appropriate departments at NJIT, UMDNJ, and Rutgers University-Newark can be used as electives within the limits of the NJIT transfer policy. A masters project is optional, and is in addition to the minimum 30 approved credits, required for the degree.

Core:

		Math 644	Regression Analysis Methods (3 credits)
		Math 654	Clinical Trials Design and Analysis (3 credits)
		Math 659	Survival Analysis (3 credits)
		Math 662	Probability Distributions (3 credits)
	**	Math 663	Introduction to Biostatistics (3-0-3)
		Math 665	Statistical Inference (3 credits)

		Math 699	Design and Analysis of Experiments (3 credits)

Electives:

At least three from the following illustrative list:

		Math 664	Methods for Statistical Consulting (3 credits)
		Math 691	Stochastic Processes with Applications (3 credits)
		Math 698	Sampling Theory (3 credits)
		Math 707	Advanced Applied Mathematics IV: Special Topics (3 credits)
		Math 763	Generalized Linear Models (3 credits)
		Math 786	Large Sample Theory and Inference (3 credits)
		Math 787	Non-Parametric Statistics (3 credits)
		UMDNJ	(UMDNJ Courses)
		PHCO-0502J	(Introduction to Epidemiology) (3 credits)

Electives are chosen in consultation with a departmental graduate advisor. Subject to such approval, 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.

Math 661 and Math 663 cannot both be used toward degree credits at NJIT. The requirements of Math 663 may, in individual cases, be substituted by Math 661, at the discretion of the Graduate Advisor.

Master of Science in Mathematical and Computational Finance (33 credits)

In the past several decades the field of Mathematical and Computational Finance has developed into a well established discipline of great importance within the financial, investment and banking industries and increasingly in regulatory agencies. Practitioners of this field combine high-level analytical, computational and modeling skills with a thorough understanding of financial markets and instruments to assess value and risk. These assessments are needed to structure solutions to financial problems, to manage risk and to identify and exploit financial opportunities. As the financial industry is highly concentrated around the New York City area, practitioners of Mathematical and Computational Finance are in high demand locally.

The M.S. in Mathematical and Computational Finance delivers the theoretical knowledge, the practical methods and the essential skills needed for students to begin or enhance careers as quantitative analysts in the financial industry. Students graduating from this program will possess a broad knowledge of financial and capital markets including understanding of systemic risks, the ability to develop quantitative models of financial markets and instruments and the analytical, statistical and computational capabilities to analyze those models to obtain practical information of value in the financial industry. Due to the evolving nature of financial markets and institutions, practitioners in this field must be ready to learn new ideas and methods across a broad range of disciplines including mathematics, statistics, computational science, finance, and economics. The program aims to provide the multidisciplinary foundations preparing quantitative analysts for this life-long development of skills and understanding and for responsible participation in the financial system.

Admission Requirements:
Applicants must have earned an undergraduate degree with an overall GPA of 2.8 (on a 4.0 scale) and are expected to have fulfilled the following program prerequisites:

- undergraduate finance (FIN 315 or equivalent),
- practical computer programming skills in C/C++,
- two semesters of calculus-based undergraduate courses in probability or statistics,
- undergraduate calculus and multivariate calculus (Math 111, Math 112 and Math 213 or equivalent),
- undergraduate differential equations (Math 222 or equivalent),
- undergraduate linear algebra (Math 337 or equivalent),
- experience with partial differential equations as models such as is typical in undergraduate courses in electromagnetism, heat transfer, fluid dynamics, elasticity and quantum mechanics.

A GPA of at least 3.0 (on a 4.0 scale) is expected in the courses fulfilling these prerequisites. GRE or GMAT scores are required for those students applying for financial support, or if the most recent degree was earned at a school outside the United States. Applications are considered on a case-by-case basis. Required courses for the program are generally offered in the evenings and part-time study is possible.

Bridge Program: Students with a baccalaureate degree not fully covering the prerequisites listed above may be admitted and required by the department to take an individually-designed program of courses that may include undergraduate courses before proceeding to the graduate curriculum. Such courses do not count towards a graduate degree.

Degree Requirements:
The Master of Science in Mathematical and Computational Finance requires 33 credits: 27 credits in core courses, 3 credits in an approved elective, and 3 credits in a project course.

SEMESTER I

		Fin 641	Derivatives Markets (3 credits)
		Math 605	Stochastic Calculus (3 credits)
		Math 611	Numerical Methods for Computation (3 credits)
		Math 646	Time Series Analysis (3 credits)

SEMESTER II

		Fin 642	Derivatives and Structured Finance (3 credits)
		Fin 643	Term Structure of Interest Rates (3-0-3)
		Math 608	Partial Differential Equations for Finance (3 credits)
{		CS 666	Simulation for Finance (3 credits) ***or***
		Math 666	Simulation for Finance (3 credits)

SEMESTER III

		Fin 644	Credit Risk Modeling (3-0-3)
		Elective	(Approved Elective)
		Project	(Mathematical and Computational Finance Project)

For students having already successfully completed the equivalent of a course required for the program, more advanced courses can substituted with departmental approval.

Electives must be selected with the approval of the Program Director/Advisor; potential electives include:

		EM 602	Management Science (3 credits)
		Fin 624	Corporate Finance II (3 credits)
		Fin 626	Financial Investment Institutions (3 credits)
		Fin 650	Investment Analysis and Portfolio Theory (3 credits)
		Math 644	Regression Analysis Methods (3 credits)
		Math 647	Time Series Analysis II (3 credits)
		Math 662	Probability Distributions (3 credits)
		Math 665	Statistical Inference (3 credits)
		Math 668	Probability Theory (3 credits)
		Math 691	Stochastic Processes with Applications (3 credits)
		Math 699	Design and Analysis of Experiments (3 credits)
		Math 712	Numerical Methods II (3 credits)

Doctor of Philosophy in Mathematical Sciences

The Doctor of Philosophy in Mathematical Sciences is offered in collaboration with the Department of Mathematics and Computer Science at Rutgers University-Newark. The doctoral program in Mathematical Sciences is designed to prepare students for a wide range of professional activities in science and engineering. Prospective students must choose one of the following tracks:

- Applied Mathematics
- Applied Probability and Statistics
- Pure Mathematics

The doctoral program reflects the research interests of the faculty and is focused on the development and use of mathematical tools for solving modern scientific, technological and industrial problems, and advancing the research knowledge and methodology in various fields of specialization.

The Applied Mathematics track emphasizes the applications of mathematical methods to the physical and biological sciences and engineering, including acoustics, electromagnetics, fluid dynamics, materials science, biology, and medicine. Mathematical modeling, asymptotic analysis, and scientific computing are emphasized. Students are expected to develop a broad range of capabilities both in mathematics and in an area of application.

The Applied Probability and Statistics track emphasizes directed instruction and independent research in areas that are specializations of the faculty. Current research interest areas of the faculty include applied probability, non-parametric statistics, and statistical reliability theory and applications

The Pure Mathematics track offers research opportunities in many fields of specialization, including representation theory, number theory, low-dimensional topology, Riemann surfaces and Kleinian groups, geometric group theory, and 4-manifolds.

Admission Requirements:
Admission to the program is based on a review of the applicant's credentials and interests as expressed in academic transcripts, GRE scores, letters of recommendation, statement of interests, and TOEFL scores (for students whose native language is not English). Applicants with strong academic records whose abilities and interests complement the research of the faculty are sought. In general, applicants should have a bachelor's or master's degree in mathematics, an engineering discipline, or a branch of the natural sciences. Students choosing the Applied Mathematics track or the Applied Probability and Statistics track must fulfill the admissions requirements specified in the Admissions section of this catalog.

Students interested in either the Applied Mathematics track or the Applied Probability and Statistics track should apply to NJIT. Students interested in the Pure Mathematics track should apply to Rutgers-Newark.

Degree Requirements:

Applied Mathematics Track (NJIT)

Students choosing the applied mathematics track must fulfill the requirements for the doctor of philosophy as specified in this catalog. Specific courses of study are planned in consultation with a faculty advisor and are subject to approval. In general, students are encouraged to take courses both in mathematics and in areas of application.

Seminar: In addition to the minimum degree credits required, all doctoral students must enroll each semester in Math 791 Graduate Seminar.

Courses: A typical schedule of courses for the first four semesters in Applied Mathematics consists of the following:

Semester I

		Math 599	Teaching in Mathematics (3 credits)
		Math 613	Advanced Applied Mathematics I: Modeling (3 credits)
		Math 631	Linear Algebra (3 credits)
		Math 645	Analysis I (3 credits)
		Math 651	Methods of Applied Mathematics I (3 credits)

Semester II

		Math 614	Numerical Methods I (3 credits)
		Math 656	Complex Variables I (3 credits)
		Math 689	Advanced Applied Mathematics II: Ordinary Differential Equations (3 credits)
		Math 745	Analysis II (3 credits)

Semester III

		Math 671	Asymptotic Methods I (3 credits)
		Math 676	Advanced Ordinary Differential Equations (3 credits)

		Math 690	Advanced Applied Mathematics III: Partial Differential Equations (3 credits)
		Math 712	Numerical Methods II (3 credits)

Semester IV

		Math 707	Advanced Applied Mathematics IV: Special Topics (3 credits)
		Math 713	Advanced Scientific Computing: Multi-Dimensional Finite-Difference Schemes and Spectral Methods (3 credits)
		Math 756	Complex Variables II (3 credits)
		Elective	(Course from Natural Sciences or Engineering relevant to student's Interests.)

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

- Mathematical Fluid Dynamics I and Mathematical Fluid Dynamics II (Math 715, Math 716)
- Mathematical Biology (Math 637 , Math 672 , Math 673)
- Wave Propagation (Math 722)
- Asymptotic Methods II (Math 771)
- Mathematical Modeling II (Math 639)
- Partial Differential Equations (Math 675)
- Inverse Problems and Global Optimization (Math 717)

Also, there are special topics courses in:

- computational electromagnetics
- computational fluid dynamics
- computational neuroscience
- financial mathematics
- integral equations
- materials science
- microwave processing of materials
- courses in probability and statistics

Qualifying Examination: The qualifying examination for the applied mathematics track consists of a preliminary examination in three parts and an oral examination. The three components of the preliminary examination are: Applied Mathematics, Analysis, and Linear Algebra-Numerical Methods. Students must achieve a grade of A in each component to pass the preliminary examination and proceed to the oral examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components before taking the oral examination. The qualifying examination must be passed by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Applied Mathematics (January and May), Analysis and Linear Algebra-Numerical Methods (May and August). The oral examination is usually offered in January and May. The following courses will be useful in helping students to prepare for the preliminary examinations: Math 613 and Math 651 for Applied Mathematics; Math 645, Math 656, and Math 745 for Analysis; Math 614 and Math 631 for Linear Algebra-Numerical Methods. Topics for the oral examination are Applied Mathematics, based on the courses Math 689 and Math 690, choice of two out of the following three: Ordinary Differential Equations, based on Math 676; Asymptotic Methods, based on Math 671; Numerical Methods, based on Math 614 and Math 712.

It should be noted that taking the above courses is not mandatory but students are strongly encouraged to take them before attempting the qualifying examinations. The scope of the qualifying examinations is not limited to the specific list of topics covered in these courses, but these topics are indicative of the overall scope of the examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. According to the regulations specified in this catalog, doctoral students are required to have a dissertation advisor selected, a dissertation committee formed, and research proposal approved within one year of passage of the qualifying examination.

Dissertation Proposal: Doctoral students must prepare a research proposal for approval by their dissertation committee. The student must offer an oral defense of this proposal before the dissertation committee and obtain its approval within one year of passing the qualifying examination. The committee determines if the proposal has an appropriate objective, if there is a reasonable plan to reach that objective, and if the student possesses the knowledge and skills needed to carry out the plan. The dissertation proposal can only be approved by unanimous consent of the committee members.

Dissertation Defense: A public oral defense of the dissertation before the dissertation committee is required. All members of the committee must be present for the defense. Success of the defense is determined by a majority vote of the dissertation committee.

Applied Probability and Statistics Track (NJIT)

Students choosing the applied probability and statistics track must fulfill the requirements for the doctor of philosophy as specified in this catalog. Specific courses of study are planned in consultation with a faculty graduate advisor and are subject to approval. In general, students are encouraged to take courses both in mathematics and in areas of application.

Seminar: In addition to the minimum degree credits required, all doctoral students must enroll each semester in Math 791 Graduate Seminar

Courses: A typical schedule of courses for the first four semesters in Applied Probability and Statistics consists of the following:

Semester I

		Math 599	Teaching in Mathematics (3 credits)
		Math 631	Linear Algebra (3 credits)
		Math 644	Regression Analysis Methods (3 credits)
		Math 645	Analysis I (3 credits)
		Math 662	Probability Distributions (3 credits)

Semester II

		Math 665	Statistical Inference (3 credits)
		Math 699	Design and Analysis of Experiments (3 credits)
		Math 745	Analysis II (3 credits)
		Math 768	Probability Theory (3 credits)

Semester III

		Math 659	Survival Analysis (3 credits)
		Math 691	Stochastic Processes with Applications (3 credits)
		Math 707	Advanced Applied Mathematics IV: Special Topics (3 credits)
		Elective	(Course in statistics/mathematics/engineering/computing sciences relevant to student's interest.)

Semester IV

		Math 664	Methods for Statistical Consulting (3 credits)
		Math 698	Sampling Theory (3 credits)
		Electives	(Two Courses in statistics/mathematics/engineering/computer science relevant to student's interest.)

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

- Time Series Analysis (Math 646)
- Clinical Trials Design and Analysis (Math 654)
- Statistical Reliability Theory and Applications (Math 761)
- Large Sample Theory and Inference (Math 786)
- Non-Parametric Statistics (Math 787)

Qualifying Examination: The qualifying examination for the applied probability and statistics track consists of a preliminary examination in three parts and an oral examination. The three components of the preliminary examination are: Probability Distributions and Regression Analysis Methods, Real Analysis and Statistical Inference, Probability Theory and Design and Analysis of Experiments. Students must achieve a grade of A in each component to pass the preliminary examination and proceed to the oral examination. Components may be passed at different times. However, a student may attempt each component at most twice and must pass all three components before taking the oral examination. The qualifying examination must be passed by the end of the second year in the program. Typically, two opportunities to take each component are provided each year: Probability Distributions and Regression Analysis Methods (January and May), Real Analysis and Statistical Inference and Probability Theory and Design and Analysis of Experiments (May and August). The oral examination is usually offered in January and May.

The following courses will be useful in helping students to prepare for the preliminary examinations: Math 644 and Math 662 for Probability Distributions and Regression Analysis Methods; Math 645, Math 665, and Math 745 for Real Analysis and Statistical Inference; Math 699 and Math 768 for Probability Theory and Design and Analysis of Experiments. Topics for the oral examination are Stochastic Processes, based on Math 691; Survival Analysis, based on Math 659; Generalized Linear Models, based on Math 707.

It should be noted that taking the above courses is not mandatory but students are strongly encouraged to take them before attempting the qualifying examinations. The scope of the qualifying examinations is not limited to the specific list of topics covered in these courses, but these topics are indicative of the overall scope of the examinations.

Dissertation Committee: The dissertation committee is an important resource for the doctoral student in the conduct of research for their dissertation. According to the regulations specified in this catalog, doctoral students are required to have a dissertation advisor selected, a dissertation committee formed, and a research proposal approved within one year of passage of the qualifying examination.

Dissertation Proposal: Doctoral students must prepare a research proposal for approval by their dissertation committee. The student must offer an oral defense of this proposal before the dissertation committee and obtain its approval within one year of passing the qualifying examination. The committee determines if the proposal has an appropriate objective, if there is a reasonable plan to reach that objective, and if the student possesses the knowledge and skills needed to carry out the plan. The dissertation proposal can only be approved by unanimous consent of the committee members.

Dissertation Defense: A public oral defense of the dissertation before the dissertation committee is required. All members of the committee must be present for the defense. Success of the defense is determined by a majority vote of the dissertation committee.

Pure Mathematics Track (Rutgers-Newark)

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

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* Students specializing in Applied Mathematics or Computational Mathematics may take Math 545 Introductory Mathematical Analysis and Math 546 Advanced Calculus, instead of Math 645 and 3 credits of elective.

** Math 661 and Math 663 cannot both be used toward degree credits at NJIT. The requirements of Math 661 may, in individual cases, be substituted by Math 663, at the discretion of the Graduate Advisor.

Architecture

Administered By: College of Architecture and Design

Administration

Dean	Urs P. Gauchat
Associate Dean for Academic Affairs	John M. Cays
Associate Dean for Administrative Affairs	Margaret Fitzpatrick
Director for School of Architecture	Darius T. Sollohub
Director, Graduate Architecture Programs	Keith A. Krumwiede
Manager of Graduate Programs	Frederick A. Little

Faculty

Distinguished Professor	Zeynep Celik, G M. Mostoller
Professors	Karen A. Franck, Urs P. Gauchat, Glenn Goldman, David L. Hawk*, Peter C. Papademetriou, Antonio P. De Sousa Santos
Associate Professors	Gabrielle Esperdy, Sandy Moore, Anthony W. Schuman, Darius T. Sollohub, Donald R. Wall, Michael S. Zdepski, Richard J. Garber, Georgeen Theodore, John R. Russo, Keith A. Krumwiede
Assistant Professors	Andrzej Zarzycki, Matther Burgermaster, Martina Decker, Jesse W. Lecavalier
Research Professors	Ervin Bales

Advisors

Lead Undergraduate Advisor	Frederick A. Little
Undergraduate Advisor	Amada Belton

* Joint appointee with the School of Management.

Degrees Offered: Master of Architecture (professional and post-professional options); Master of Science in Architecture; 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

Graduate architectural education exposes students to the broad intellectual inquiry of the academy and the specific technical knowledge required in the world of professional practice. Sustainable design is a basic attitude which informs our entire curriculum. Communication skills move from basic visual literacy to instruction in the principles and techniques of digital design: computer-aided design (CAD), computer-aided manufacturing (CAM), three-dimensional digital rendering, and digital animation. Students gain experience through individual design studio projects that range from the small-scale design and manufacture of a single object to a large-scale design of communities.

Our location-five minutes from Newark Penn Station by subway, and thirty minutes from Midtown Manhattan-gives students access to a faculty drawn from the largest concentration of design professionals in the country, and enables those faculty to treat design as a diverse series of real projects on real sites in a vital metropolitan region. In combination with the unparalleled internship opportunities available in New York and Northern New Jersey and the availability of dual degree programs, this approach allows students to both prepare for a career in architecture and to find a direction within the field. The architect envisions and imagines both what is possible, and what ought to be. As a process, design gives form to society and the economic and technological aspects of environmental order.

For students in the Professional M.Arch. Program, partnerships through dual degree tracks in infrastructure planning, management and civil engineering can broaden a general education in architecture. Post-professional opportunities for specialized career directions, scholarly inquiry and research are also offered through degree programs in architectural studies and infrastructure planning.

The faculty comprises practitioners and scholars whose expertise and professional reputation are based on both breadth and depth of achievement. Their work directly engages the architectural discourse through research, publication, public lectures, symposia and professional practice. Many members have received scholarly recognition and design awards.

The New Jersey School of Architecture offers the only publicly supported professional program in New Jersey and is committed to NJIT's reputation as a nationally recognized technological university.

To become registered as a licensed architect in the State of New Jersey, you must earn a degree accredited by the National Architectural Accrediting Board (NAAB). NJIT's M.Arch. degree program is one of only two NAAB-accredited degree programs in the State of New Jersey.

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

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

The NJIT Master of Architecture (M.Arch.) is a professional degree fully accredited by the NAAB.

Master of Architecture (M.Arch.)

There are two degree options in the M.Arch. program: professional M.Arch. and post-professional M.Arch.

Professional M.Arch.: For students with undergraduate or graduate degrees who do not have previous architectural design courses or experience; the full-time program of study comprises six semesters and meets the education requirements for the Architecture Registration Examination (ARE). It is also appropriate for students who have undergraduate degrees in architecture or related fields, those who have a non-NAAB accredited architecture degree, and all international students who would enter the program with advanced placement. Advanced placement, which reduces the 102-credit degree requirement, is determined at the time of admission through an evaluation of previous academic work.

Post-professional M.Arch.: For students who have an NAAB-accredited professional Bachelor of Architecture (B.Arch.) or an equivalent international degree. International students who intend to pursue professional licensure in the U.S. should apply to the Professional M.Arch Program.

Dual Degree M.Arch. and Master of Infrastructure Planning (M.I.P.): Open only to students in the M.Arch. program options studio sequence, the dual degree program permits students to earn credits towards both M.Arch and M.I.P degrees simultaneously and obtain an M.I.P. in substantially less time than if taken separately. Also see the program description under "Infrastructure Planning" in this catalog.

Dual Degree M.Arch. and M.S. in Management: Open only to students in the M.Arch. program studio options sequence, the dual degree program permits students to obtain an M.S. in Management in substantially less time. Also see the program description under "Management" in this catalog.

Dual Degree M.Arch. and M.S. in Civil Engineering: Open only to students in the M.Arch. program studio options sequence. The dual degree program permits students to obtain an M.S. in Civil Engineering in substantially less time. Also see the program description under "Civil Engineering" in this catalog.

Admission Requirements for all M.Arch. Programs:

In addition to completing the application required by NJIT's Office of University Admissions, M.Arch. applicants must also submit School of Architecture supplementary materials forms. To ensure prompt consideration, students should request the forms when they apply for admission to the university.

Applicants are expected to have a minimum undergraduate GPA of 3.0. GRE (general test) scores are required. Applicants to the M.Arch./M.S. in Management degree option may submit GRE scores in lieu of the GMAT scores which are normally required for admission to the M.S. in Management program. Exclusive of the GMAT/GRE requirements, dual degree applicants must satisfy admission requirements for both the School of Architecture and the School of Management.

Admission to the M.Arch. program is based on the applicant's personal statement, letters of recommendation, design portfolio, and previous academic and work experience. Applicants should have completed a minimum of one semester each of college-level physics and calculus; students who lack such a background will be expected to take equivalent course work before entering the second year of the M.Arch. program. Applicants from non-architectural backgrounds are strongly advised that coursework in design, drawing, and/or studio art is useful preparation for graduate study in architecture, and helpful in the process of generating work for inclusion in the portfolio required as an element in all applications. International students with professional degrees in architecture are required to have transcripts evaluated by Educational Credential Evaluators (information is included with School of Architecture supplementary materials). Aggregate TOEFL scores of 80 or higher are required for all international students.

Graduate Certificate Programs: A 12-credit graduate certificate in Sustainable Architecture is available as a step toward either the Post-Professional M.Arch. or the MSArch degree. Students in the Professional M.Arch. Program may use some or all of the courses in this certificate program to satisfy upper-level architecture and free electives. See Graduate Certificates in this catalog for further information. For more information on continuing and distance education, contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

Degree Requirements for Professional M.Arch.:
This 102-credit program consists of a 72-credit core and an options sequence of 30 credits including 12 studio and 18 elective credits. Students are expected to complete the core sequence in a minimum of two years. Before registering for courses, all students must consult with the graduate advisor to plan an appropriate course of study.

Students must submit a portfolio of design work at completion of the core courses. The portfolio will be reviewed in connection with advising students on their further program of study.

Core courses in the M.Arch. program represent the minimum background necessary to meet NAAB standards. If students demonstrate that they have previously completed equivalent course work, degree credit requirements may be reduced to less than the 102 credits required for the program.

To remain in good academic standing, students must maintain a cumulative GPA of 3.0 in graduate courses. Students must repeat any design studio course in which they receive a grade of C. A grade of C+ in any design studio must be followed by a subsequent grade sufficient to raise the annual cumulative design studio GPA to 2.75. Incomplete (I) grades for studio and prerequisite courses must be removed before students will be permitted to register for continuing course work in the program.

Degree credits appear in parentheses following the course titles below.

CORE:
72 *credits as follows:*

Arch 500G	Advanced Architectural Graphics (3 credits)
Arch 501G	Architectural Design I (6 credits)
Arch 502G	Architectural Design II (6 credits)
Arch 503G	Architectural Design III (6 credits)
Arch 504G	Architectural Design IV (6 credits)
Arch 541G	Construction I (3 credits)
Arch 542G	Integrated Building Technologies (3 credits)
Arch 543G	Environmental Control Systems I (3 credits)
Arch 544G	Environmental Control Systems II (3 credits)
Arch 545	Case Studies in Architectural Technology (3-0-3)
Arch 548G	Structures II (3 credits)
Arch 547G	4D Integration (3 credits)
Arch 528G	History of Architecture I (3 credits)

		Arch 529G	History of Architecture II (3 credits)
		Arch 555G	Architectural Graphics (3 credits)
		Arch 569G	Building and Development (3 credits)
		Arch 579G	Professional Architectural Practice (3 credits)

6 additional credits of architectural history, including one course in non-western, regional, or vernacular architecture, and 3 credits in contemporary architectural theory. All to be selected in consultation with the graduate advisor.

With the exception of History/Theory Selectives, Arch 569G, and Arch 579G, all core courses must be completed before proceeding to the options sequence.

Option Sequence:
Required:
30 *credits minimum:*

		Arch 505G	Advanced Design Options I (6 credits)
		Arch 506G	Advanced Design Options II (6 credits)
		Arch 507G	Advanced Design Options III (6 credits)
		MARC 701	Master's Thesis (6 credits)

Elective:
18 credits selected in consultation with the 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 including two design studios Master's Thesis maybe be substituted for one studio.

Required:

		Arch 505G	Advanced Design Options I (6 credits)
{		Arch 506G	Advanced Design Options II (6 credits) ***or***
		MARC 701	Master's Thesis (6 credits)

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

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:

		MIP 631	History and Theory of Infrastructure (3 credits)
		MIP 652	Geographic Information Systems (3 credits)
		MIP 673	Infrastructure Planning in Practice (3 credits)
		MIP 674	Infrastructure and Architecture (3 credits)
		MIP 675	Elements of Infrastructure Planning (3 credits)

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

		MIP 601	Interdisciplinary Infrastructure Studio I (6 credits)
		MIP 602	Interdisciplinary Infrastructure Studio II (6 credits)

MIP 612	Introduction to Environmental Policy Studies (3 credits)
EPS 622	Sustainable Politics & Policy (3 credits)
MIP 655	Land Use Planning (3 credits)

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 (3 credits)
Arch 651	Real Estate Analysis for Architects (3 credits)
Arch 652	Architectural Project Management (3 credits)
Fin 516	Principles of Financial Management (3 credits)
HRM 601	Organizational Behavior (3 credits)
Mgmt 680	Entrepreneurial Strategy (3 credits) ***or***
Mgmt 692	Strategic Management (3 credits)

Required:
3 credits:

Fin 618	Public and Private Financing of Urban Areas (3 credits)

Elective:
9 credits from:

Acct 615	Management Accounting (3 credits)
Fin 624	Corporate Finance II (3 credits)
Mgmt 640	New Venture Management (3 credits)
Mgmt 645	New Venture Finance (3 credits)
MIS 645	Information Systems Principles (3 credits)
Mrkt 630	Models of Consumer Behavior (3 credits)
Mrkt 638	Sales Management for Technical Professionals (3 credits)

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 (3-0-3)
		CE 200A	Surveying Laboratory (0-3-1)
		CE 501	Introduction to Soil Behavior (3 credits)
		Math 105	Elementary Probability and Statistics (3-0-3)
		MATH119	

Core:

		CE 610	Construction Management (3 credits)
		CE 611	Project Planning and Control (3 credits)
		CE 616	Construction Cost Estimating (3 credits)
		EM 632	Legal Aspects in Construction (3 credits)

Required:
12 credits:

		Arch 650	Economy of Building (3 credits)
		Arch 652	Architectural Project Management (3 credits)
		Arch 675	Elements of Infrastructure Planning (3 credits)
		MIS 645	Information Systems Principles (3 credits)

Elective:
6 credits from:

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

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 Architecture (MSARCH)

A non-professional, non-design degree program for careers in architectural research and scholarship. Studies often involve interdisciplinary course work.

Admission Requirements:
Applicants are expected to have either an NAAB-accredited B.Arch., or a bachelor's degree in architecture or disciplines related to production, operation or use of buildings.

In addition to completing the application required by NJIT's Office of University Admissions, M.S.ARCH applicants must also submit School of Architecture supplementary materials forms. To ensure prompt consideration, students should request the forms when they apply for admission to the university.

Applicants are expected to have a minimum undergraduate GPA of 3.0. GRE (general test) scores are required.

Degree Requirements:
The program consists of 30 credits of required and elective courses and may be taken either full- or part-time. Students in preparation for further study at the doctoral level may be required to complete an additional 6 credit thesis. Students are required to design their programs in consultation with the graduate advisor and lead faculty member in the area of specialization. Among the available areas of concentration are Sustainable Architecture, Resilient Architecture, Architectural History, Digital Design, and Urban Systems

To remain in good academic standing, students must maintain a cumulative GPA of 3.0 in graduate courses.

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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.

** 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.

*** Or appropriate substitute selected with approval of Graduate Advisor

Catalog and curricula information approved by the relevant academic department.

Bioinformatics

Administered By: Department of Computer Science

Adminstration

Chairperson:	Michael A. Baltrush
Associate Chairperson:	James M. Calvin
Director of Bioinformatics:	Usman W. Roshan

Faculty

Distinguished Professors:	Joseph Y. Leung
Professors:	Narain Gehani, James Geller, James McHugh, Ali Mili, Yehoshua Perl, Frank Y. Shih, athomas, verkhovs, Jason T. Wang
Associate Professors:	Michael A. Baltrush, James M. Calvin, Alexandros Gerbessiotis, Daochuan Hung, Marvin K. Nakayama, David Nassimi, Chengjun Liu, John W. Ryon, Vincent Oria, Edward Sarian, Andrew Sohn, Dimitrios Theodoratos
Assistant Professors:	Cristian M. Borcea, Barry Cohen, Usman W. Roshan, Guiling Wang, Zhi Wei
Special Lecturers:	George Blank, Osama Eljabiri, Jonathan J. Kapleau, Dionissios Karvelas, Morty D. Kwestel, Theodore L. Nicholson, Kurban K. Niroomand, Wallace Rutkowski

Advisors:

Bioinformatics Advisors:	Amanda D. Ackerman, Casey L. Hennessey, George W. Olsen
Graduate Advisors:	Amanda D. Ackerman, Casey L. Hennessey

Admission Requirements:

- BS or BA Degree is Computing, Biology, or related discipline. TOEFL and GRE required for international students..
- Computer courses in programming & data structures equivalent to CS 113 & CS 114.
- One or more courses in genetics or molecular biology, equivalent to R120:352 Genetics or R120:356 Molecular Biology or BNFO 501 Molecular Biology for CS.
- Mathematics courses in calculus equivalent to Math 111 & Math 112.

If the prerequisites are not fulfilled, completion of specific bridge courses will be required as a condition of admission.

Degree Requirements:

A minimum of 30 credits is required for the degree, excluding bridge courses. The graduate curriculum consists of five core courses and additional elective courses, with an optional thesis (six credits) or research project (three credits).

M. S. in Bioinformatics

Curriculum:

Core Courses

		BNFO 601	Foundations of Bioinformatics I (3 credits)
		BNFO 602	Foundations of Bioinformatics II (3 credits)
		BNFO 615	Data Analysis in Bioinformatics (3 credits)
		BNFO 644	Data Mining and Management in Bioinformatics (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)

Electives:

NJIT Courses

		bme661	(Neural Engineering) (3-0-3)
		BME 671	Biomechanics of Human Structure and Motion (3 credits)
		Chem 658	Advanced Physical Chemistry (3 credits)
		Chem 673	Biochemistry (3 credits)
		Chem 677	Introduction to Medicinal Chemistry (3-0-3)
		CS 631	Data Management System Design (3 credits)
		CS 632	Advanced Database System Design (3 credits)
		CS 659	Image Processing and Analysis (3 credits)
		CS 634	Data Mining (3 credits)
		CS 681	Computer Vision (3-0-3)
		CS 731	Applications of Database Systems (3 credits)
		CS 782	Pattern Recognition and Applications (3 credits)
		IS 634	Information Retrieval (3 credits)
		ECE 609	Artificial Neural Networks (3 credits)
		ECE 640	Digital Signal Processing (3 credits)
		ECE 673	Random Signal Analysis I (3 credits)
		Math 635	Analytical Computational Neuroscience (3 credits)
		Math 636	Systems Computational Neuroscience (3 credits)
		Math 637	Foundations of Mathematical Biology (3 credits)
		Math 662	Probability Distributions (3 credits)

Rutgers Courses

		R120:512	Mammalian Physiology (3 credits)
		R120:515	Molecular Biology of Eukaryotes (3 credits)
		R120:516	Microbial Ecology (3 credits)
		R120:526	Cell Biology (3 credits)
		R120:548	Biology of Cancer (3 credits)
		R120:573	Pharmacology (3 credits)

UMDNJ Courses

		UMD5002	
		UMD5030	
		UMD5200	

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* These courses have previously been offered as Special Topics in CS.

Catalog and curricula information approved by the relevant academic department.

Biology

Administered By: Division of Biological Sciences / Department of Mathematical Sciences

Administration

Chair	Jorge P. Golowasch
Academic Coordinator	Karen Roach

NJIT Faculty

Distinguished Professor	Gene M. Jonakait
Professor	Farzan Nadim
Associate Professor	Jorge P. Golowasch, Gareth J. Russell
Assistant Professor	Andrew Hill, Daniel E. Bunker
Lecturers	Darshan J. Desai, Maria L. Stanko, Christopher M. Trimby, Ellen M. Wisner
Laboratory Coordinator	Maria L. Stanko
Research Associate	Kimberly N. Russell

Rutgers-Newark Faculty

Chair.	Edward M. Bonder
Professors	Ann Cali(Prof. Emaritus), Harvey Feder(Associate Provost), Gerald Frenkel, David Kafkewitz, Edward Kirby(Dean: FASN), Judith Weis, Wilma Friedman
Associate Professors	Edward M. Bonder, John Crow, Lion Gardiner, Andrew Kasper, John Maiello, Douglas Morrison, Haesum Kim, Claus Holzapfel
Assistant Professors	Nihal Altan-Bonnet, Nan Gao, Tracy Tran, Alexis Rodriguez, Patrice Maurel, Karina V. R. Shafer

Advisors

Undergraduate Advisor	Jorge P. Golowasch
Undergraduate Advisor	Gene M. Jonakait
Undergraduate Advisor	Gareth J. Russell
Undergraduate Advisor	Karen Roach
Undergraduate Advisor	Andrew Hill
MS Advisor	Kimberly N. Russell
PhD Advisor	Susan Seipel (Rutgers)
University Pre-Health Advisor	Darshan J. Desai

Master of Science in Biology

MASTERS OF SCIENCE

GRADUATE PROGRAM IN BIOLOGY
COURSE OF STUDY AND PROGRAM REQUIREMENTS

ADVISEMENT

In the first year of study, students are advised on all academic matters by the MS Program Coordinator. During the first year of full-time study (or part-time equivalent), students complete sufficient course work to fulfill most core curricular requirements and to develop a potential research project (library or laboratory) that will serve as the basis of the capstone Thesis requirement. By the start of the second year, students must choose a faculty member to serve as advisor during their laboratory or bibliographic thesis research project.

CURRICULUM-COURSE AND CREDIT REQUIREMENTS

The program requires successful completion of a minimum of 30 credits of graduate-level work. These must include at least one 3-credit course in each of four of the following five core areas: (1) cell biology/biochemistry, (2) molecular biology, (3) computational biology, (4) ecology/evolution, (5) plant biology. A partial list of courses offerings in each of these areas is appended. When nearing completion of, the minimum 30 required credits for the MS, Rutgers students must submit and Application for Admission to Candidacy for the Degree of Master of Science to the Graduate Program Director listing courses complete (totaling 30 credits) and offered toward the degree. NJIT students must complete an application for graduation and submit it to the Graduate Program Director for signature.

CURRICULUM-THESIS REQUIREMENT

Students can fulfill the written thesis requirement either by conduction laboratory or library research. Important to successful completion of the thesis requirement is early identification of a thesis advisor such that proper planning is in place to complete research requirements in a timely and effective manner. The basic requirement and process for these two thesis pathways is presented below:

Laboratory or field research thesis option: Students selecting the experimentally-based **research thesis option** must successfully complete a minimum of 24 credits of course work and 6 credits in research (26:120:701,702 for RU-N students, BIOL 700,701 for NJIT students) with a graduate faculty of the department. Under the guidance of this faculty member the student will perform original research. The thesis resulting from this research is expected to be presented as an hypothesis-driven scholarly work, with conclusions clearly derived from the experimental research and published background information. Students will write a scholarly thesis demonstrating the ability to write clearly and scientifically and based on experimental laboratory and/or field project research.

Upon completion of the written thesis, the student will defend the thesis publicly on the topic of their research, followed by a Q&A session with the examination committee. The thesis committee must be approved by the Graduate Program Director and will consist of the primary advisor and at least one other faculty reader who are full members of the Graduate Faculty. If a research plan requires the expertise of a non-graduate faculty advisor the committee will consist of three members-two from the graduate faculty and the advisor. Format and style of the final document must be in accordance with the guidelines set by an available at the office of graduate studies of the respective institutions.

Bibliographic thesis option: Students selecting the bibliographic-based **research thesis option** must successfully complete a minimum of 27 credits of coursework and 3 credits of Independent Study (BIOL 725 for NJIT students, 120:844 Research Internship for Rutgers students) with a graduate faculty member of the department. Under the guidance of this faculty member, the student will write a scholarly review of the literature on a scientific topic of interest. The thesis resulting from this research is expected to be a scholarly work, with conclusions clearly derived from the published information referred to by the author. This thesis should demonstrate the ability of the student to write scientifically, bringing together facts interpretations relevant to that topic, in a clear, scholarly manner. Upon completion of the written thesis, the student will defend it publicly, followed by a Q&A session with the examination committee. The thesis committee must be approved by the Graduate Program Director and will consist of the primary advisor and at least one other faculty reader who are full members of the Graduate Faculty. If a research plan requires the expertise of a non-graduate faculty advisor the committee will consist of three members-two from the graduate faculty and the advisor. Format and style of the final document must be in accordance with the guidelines set by and available at the office of the graduate studies of the respective institutions.

ADDITIONAL CURRICULUM OPTIONS

RU-N students:

- After completing 12 graduate credits in the program, a student may solicit the Graduate Program Director to transfer up to 9 relevant graduate credits from another institution toward the 30 credits need for MS.
- No undergraduate credits are allowed for credit towards the MS degre.

NJIT students:

- *Credits already taken:* Up to nine (9) credits may be transferred for credit toward the 30 credits need for the MS provided that they were taken at an accredited college or university in the United States or Canada, were not used in fulfillment of a previous degree awarded, earned a final grade of 3.0 or above on a scale whose maximum is 4.0, were earned in graduate level course(s) for which full academic credit was awarded, were in units of at least three (3) credits and were not earned more than seven years ago. Credits earned in quarter system will be converted to equivalent semester credits.
- *Credits Not Yet Taken*: Up to nine (9) credits may be transferred for credit provided that they are taken at an accredited college or university in the United States or Canada, earn a final grade of 3.0 or above on a scale whose maximum is 4.0, are in graduate level course(s) for which full academic credit is awarded, and are in units of at least three (3) credits. Credits earned in quarter systems will be converted to equivalent semester credits. Prior approval required.

PART-TIME STUDENTS

Part-time students are expected to fulfill exactly the same requirements as full-time students

OTHER SOURCE OF INFORMATION REGARDING THE PROGRAM'S REGULATIONS

The Rutgers-Newark Graduate School Catalog

(http:catalogs.rutgers.edu/generated/nwk-grad_current/pg155.html) and the NJIT Graduate Catalog http://catalog.njit.edu/graduate/ should be consulted for University regulations. The new department regulations outlined above for the Masters program in Biology apply to all students who enter the Program as of September 2010.

Doctor of Philosophy in Biology

Doctoral Program in Biology

PROGRAM PROCEDURES AND REQUIREMENTS

I. Graduate Standards Committee

The Graduate Standard Committee is responsible for monitoring and advising all graduate students through completion of the Thesis Prospectus stage of the program. The Committee meets with students each semester to evaluate coursework and research progress in an effort to provide advisement on course selections, first-semester mentoring, laboratory rotations, and potential thesis advisors. Records of Standards Committee meeting are kept on file via the Standards Committee Report form. Whenever necessary, the Committee will discuss student progress with faculty mentors and advisors to ensure proper and successful progress within the program. The ultimate charge of the Committee is to assist and guide the student toward successful completion of the Qualifying Exam and Thesis Prospectus.

II. Course Requirements

A. General Credit/Course Distribution

9 Credits (3 courses)	Three Biology Graduate Program Core Courses
9 Credits (3 courses)	Three Track Specific Core Courses
6 Credits (2 courses)	Two Semester Long Laboratory Rotations
12 Credits	Elective Courses (can be taken at Rutgers, UMDNJ, NJIT)
36 Credits	Total Required Course Credits
36 Credits	Total Required Research Credits

B. Program Core Courses
Effective College Teaching (26:120:560)
Critical Thinking for Life Sciences (48:120:630 or or NJIT:BIOL:630)
Approaches in Quantitative Analysis in Life Sciences (48:120:615 or NJIT:MATH:615 or equivalent by approval)

C. Trach-Specific Core Courses

Program Track in Cell Biology

Cell, Molecular, and Developmental Biology (26:120:524)
Molecular Biology of Eukaryotes (26:120:515)
Biochemistry (26:160:581)

Program Track in Ecology and Evolution

Biodiversity (26:120:523)
Evolution (48:120:622 or NJIT:BIOL:622)
Ecophysiology (26:120:593)

Program Track in Computational Neuroscience

Foundations of Mathematical Biology (48:120:502 or NJIT:MATH:637)
Analytical and Computational Neurosci. (NJIT:MATH:635) or Systems Computational Neurosci. (NJIT:MATH:636)
Systems Neuroscience (48:120:641 or NJIT:BIOL:641)

D. Elective Courses

All graduate students have the opportunity to add to their knowledge base by properly selecting elective courses. Elective course may be taken from offerings in the following graduate programs:

at Rutgers University, Newark -- Biology, Environmental Sciences, Integrative Neuroscience, and Chemistry.

at NJIT -- Applied Mathematics, Physics, Biomedical Engineering, and Computer Science.

at UMDNJ -- Program in Biomedical Sciences

at Rutgers University, New Brunswick and Camden -- various programs

Prior to enrolling in courses offered by graduate programs outside of the Graduate Program in Biology, students must receive permission from the Graduate Standards Committee if they are pre-qualifiers or from the Program Director if they are post-qualifiers. This is accomplished by completion of the Graduate Transfer Credit Form. Whenever appropriate the student should consult with his/her thesis research advisor. Please check course catalogs and online schedule of classes for specific course offerings on a semester-by-semester basis.

E. Notes on Grade Requirements in Coursework

Students are expected to successfully complete all of the core and elective credits taken within the graduate program. Course work provides the formal foundation upon which a successful dissertation project and thesis defense is built.

To remain in good standing, a GPA of 3.0 or better must be maintained for all courses taken as part of the graduate course of study. Courses cannot be repeated in order to improve on poor performance. Furthermore, while in the program a student can receive grades of C or C+ in a maximum of two courses, only one of which may be in the six Program and Track Core courses. Receipt of a grade of F in any course-core or elective - will under normal circumstances result in dismissal from the program at the end of the academic year.

III. Mentoring Laboratory

Incoming student will be assigned to a "mentor lab" during their first semester in the program. During this time, students are required to actively participate in lab meetings, journal clubs, and other general lab activities. Additionally, the student must participate in some "minimal form" of research work as determined by the faculty mentor. At the end of the semester, the student must submit a brief three page-maximum report on the research conducted and the mentor submits a Student Rotation/Mentoring Evaluation Form to the Graduate Standards Committee.

IV. Biology Colloquium

The biolody colloquium is a combined seminar and reading course that provides students exposure to modern day research in areas representing the three tracks of the Ph.D program. Every student is required to attend the weekly colloquium seminars while he/she is matriculated in the Doctoral Program in Biology. Failure to meet this obligation (missing three or more colloquia) can result in loss of financial support and suspension from the Program.

V. Laboratory Research Rotations

Laboratory rotations (Advanced Problems in Biology 120:509,510) provide opportunities for laboratory research and independent study with graduate faculty members. Students are required to complete a minimum of two rotations; it is expected that one of the rotations will be completed in the laboratory where the student plans to complete his/her thesis work. Students start the first of two mandatory semester long laboratory rotations in the spring semester of the first year in the program. Typically rotations are completed in the spring and summer of the student's first year in the program.

Selection of laboratory rotation is done in consultation with the Graduate Standards Committee and the appropriate faculty member. The student must submit a Rotation Prospectus Form to the Graduate Standards Committee prior to the start of the rotation. Completion of the laboratory rotation requires the student to prepare a written report that is to be submitted within one month following the end of the rotation. The rotation advisor decides upon the format, content, and anticipated outcome of the rotation report. Additionally, at the end of the rotation the advisor submits a Student Rotation/Mentoring Evaluation Form to the Graduate Standards Committee.

The anticipated outcomes of the rotation include, but are not limited to, development of laboratory/field/computational research skills, development of analytical and critical thinking skills, appreciation of a specific research field, and identification of a prospective thesis research lab. Under extraordinary circumstances, the Graduate Standards Committee may approve a student's request to conduct a third rotation that must be completed in the fall semester of the second year in the program.

VI. Selection of Dissertation Lab

Following completion of all laboratory rotations, students must select a graduate faculty member who will serve as his/her primary advisor during the research phase of the doctoral program. This process is typically completed by the beginning of the second year in the program at which time the student will commence developing and accumulating preliminary data for his/her thesis dissertation project.

VII. Qualifying Examination

The qualifying exam will be administered by the Qualifying Examination Committee, which consists of three faculty members from the student's intended research track within the Graduate Program in Biology. A student's thesis advisor may not be a member of her/his Qualifying Examination Committee. The Qualifying Examination will be administered during the first two weeks of June. Examination dates will be posted on the department's Academic Calendar. Students take the examination at the end of their fourth semester in the program following successful completion of all core course requirements, successful completion of two rotations, and identification of the thesis advisor.

The Qualifying Examination will consist of written and oral components. Before beginning to write the detailed research proposal, the student sends a one-page summary of the specific aims to the Qualifying Exam Committee (this summary is to be submitted by April 1st at the latest). The committee must approve the proposal; the committee may offer general feedback on the scope of the project and suitability of the aims. There is no specific restriction on the subject of the qualifying exam proposal other than it must be original and the work product of the student. The proposal is the detailed description of a feasible research project, including specific aims, background and significance, and research design and methods (10,000 words maximum). A good format to follow is that of a pre- or post-doctoral grant application submitted to the National Science Foundation (specific format information is available in the program office). Preliminary data are NOT required as part of the proposal. The full proposal must be sent to each of the examiners at least 14 days before the date of the exam. Submitting a proposal that is too long or too late is unprofessional and runs the risk of non-acceptance and examination failure.

The Qualifying Exam Committee will review the written proposal for clarity of presentation, scientific soundness, and understanding of the hypothesis being tested. The student prepares an oral introduction and overview of the project that sound last no more than 25 minutes. The examiners will interrupt with questions during the presentation, so the actual presentation component will take longer. The oral presentation generally takes the form of a PowerPoint presentation, but any format that effectively communicates the main ideas is acceptable, including overheads and writing on a board. While the written proposal is the main focus of the exam, students are expected to demonstrate substantial knowledge in the field of the proposal and in related scientific areas. For example, if the proposal was aimed at understanding information transfer along the pathway from retina to visual cortex in the adult rodent, it would be fair the examiners to ask questions concerning the cell and the developmental biology of the pathway, the synaptic connectivity along the pathway, the general principles of synaptic physiology, and how it is studied.

The outcome of the examination must persuade the committee that the student has a solid comprehension of general principles and phenomena in the biological sciences and that he/she can reason through an experimental problem. Results of the examination will be reported on the Qualifying Examination Committee Report form and submitted to the Program Administrator. If a student does not pass the written and/or oral component of the qualifying examination, the student may be offered a second attempt to complete the exam. The reasons and recommendation for a second exam will be made available to the student via the Qualifying Examination Committee Report form. The second attempt at completion of the Qualifying Exam will take place six weeks after the initial exam date. Results of the second examination will be reported by completion submission of the Qualifying

Examination Committee Report form. Failure to pass either the written or oral part of the qualifying examination on the second attempt will result in dismissal of the student from the program.

After successful completion of the Qualifying Examination, the student must submit to the Graduate Program Director either the Application for Admission to Candidacy for the Doctoral Degree (Rutgers matriculated students) or the Ph.D Examination Report Form (NJIT matriculated students) that was signed by all members of the Qualifying Examination Committee. After review and completion of the form by the Graduate Program Director, this application must be returned to the appropriate Office of the Graduate School Dean at Rutgers or the Office of Graduate Studies at NJIT.

VII. Thesis Prospectus and Dissertation Committee

Within six months of passing the Qualifying Examination, the student will prepare and submit a written thesis prospectus to her/his Dissertation Committee. The Dissertation Committee will be composed of the student's thesis advisor (who serves as committee chair), at least two other members of the Biology Graduate Faculty, and one member from outside the Rutgers_NJIT scholarly community; the external member may not be a member of the Graduate Program in Biology, he/she shall have demonstrated research expertise in the general area of prospective dissertation project, and he/she shall have no vested interest in the outcome of the dissertation research. The outside committee member may be appointed at any time but no later than one year prior to the dissertation defense. The Dissertation Committee is the primary advisor group responsible for supervision and guidance of the student during the research phase of the dissertation. The Dissertation Committee serves as the examination committee for the dissertation defense.

To establish Dissertation Committee, the student and advisor must submit the Ph.D Dissertation Committee Appointment Report for for approval from the Graduate Program Director. Students matriculated at NJIT are responsible for also completing the NJIT Ph.D Dissertation Committee Appointment Report and submitting this form to the NJIT Office of Graduate Studies; a copy is kept on file with the student's permanent record.

The written prospectus will follow the format of a NH or NSF postdoctoral fellowship application. The thesis prospectus meeting will determine the student's ability to conceive, design, and conduct the proposed research project. After completion of the Thesis Prospectus meeting, the outcome of the meeting must be recorded on the Dissertation Progress Report form and the completed form submitted to the Graduate Program Administrator for filling with the student's permanent record. Additionally for NJIT matriculated students, a Ph.D Proposal Defense Report must be completed; the signed original is returned to the NJIT Office of Graduate Studies and a copy is submitted to the Graduate Program Administrator.

During the course of the research thesis, the Dissertation Committee should regularly meet with the student (six month intervals is appropriate) to discuss research progress, experimental challengers, and potential changes to the original thesis prospectus. Meeting dates, recommendation, and outcomes will be recorded by the Thesis Advisor on the Dissertation Progress Report form and forwarded to the Program's Administrator for filling with the student's permanent record.

In the event a student does not successfully complete his/her thesis prospectus in a timely manner, the Standards Committee will convene a meeting with the student and his/her mentor to review the student's progress and to prepare a plan of action for completion of the prospectus requirement. A record of this meeting will be detailed on the Dissertation Progress Report form that becomes part of the student's permanent file.

Failure to comply with the above timelines and procedures can result in loss of departmental financial support and dismissal from the program.

IX. Dissertation Defense

Approximately six months prior to the Dissertation Defense, the Dissertation Committee will convene a meeting with the Ph.D candidate for a final progress report to the committee. The meeting should be attended by all members of the Dissertation Committee (internal and external), at which time the committee will evaluate if sufficient progress has been made to warrant the final preparation of the thesis and to establish an approximate timetable for completion of the thesis. The outcome of this meeting is recorded and reported on the Dissertation Progress Report form.

The completed dissertation must be submitted to all members the final Dissertation Committee at least one month prior to the scheduled Dissertation Defense. The Dean of the Rutgers-Newark and NJIT Graduate Schools, Program Director, and Department Chairs must be invited to attend and the event must be publicized and open to anyone wishing to attend. The public defense of the dissertation is followed by an oral examination by the Dissertation Committee. Following completion of the Dissertation Defense the student's advisor must complete and file a Defence Report form with the Graduate Program Administrator.

Upon successful defense of the dissertation, Rutgers matriculated students must retrieve the Application for Admission to Candidacy for the Doctoral Degree previously submitted to the Office of the Dean of Graduate School-Newark and present this to the Chair of the Dissertation Committee. The Dissertation Committee must sign the retrieved form, and the Program Director must sign Part II of the Application for Admission to Candidacy for the Doctoral Degree. Students matriculated at NJIT are required to file the Ph.D Dissertation Defense Report form, which must be signed by all Dissertation Committee member, the Graduate Program Director and the Department Chairman before returning the original to the NJIT Office of Graduate Studies; a copy is forwarded to the Graduate Program Administrator. The student should consult with the appropriate Office of the Dean well in advance of his or her anticipated completion date regarding submission deadlines for the Diploma Application, submission requirements for the dissertation, payment of the microfilming fee, and other matters.

In the event that the student fails to successfully defend the dissertation, one additional Dissertation Defense may be attempted. Reasons for the failure will be provided on the Ph.D. Dissertation Defense Report form. Failure on the second attempt will result in dismissal from the program. Appeals by the student should be directed to the Academic Standing and Student Review Committee of the Graduate School.

The Rutgers Graduate School has a seven-year limit for full time students for attaining a doctoral degree. The NJIT Office of Graduate Studies allows no more than six years of registration for doctoral dissertation.

X. Assistantships and Fellowships

Full-time matriculated students may be offered, on a competitive basis, assistantships or fellowships. These are academic or calendar year awards and are renewable on a yearly basis, usually for not longer than a total of five years. Students are encouraged to apply to national, regional, and state level funding agencies to obtain grant support to their intended research program.

XI. Teaching Duties

Students awarded teaching assistantships generally will be given teaching assignments each semester. Failure to perform adequately as a teaching assistant will result in revocation of the assistantship by the Program Director.

Students awarded graduate assistantship, research assistantship, or fellowships through the Department or who are supported by research grants or external fellowships will be expected to serve a total of not less than two semesters for a total of six to nine contact hours as teaching assistants, except in instances in which the assistantship or fellowship explicitly requires that the student not engage in any teaching activities. The Department Chair makes teaching assignments. Students awarded assistantships or fellowships are not permitted to hold employment outside the University. Failure to comply with this regulation will result in immediate revocation of the assistantship or fellowship.

XIII. Research Project Location

All thesis research must be performed on site with the student's advisor in University facilities. The term "on site" includes appropriate venues such as, but not limited to, field sites, research stations, museums, aquaria and other such locations.

XIV. Exceptions to Regulations

Exceptions to the foreign regulations may be granted by the Program Director, after consultation with the Admissions Committee and the Graduate Standards Committee, only in extremely unusual circumstances and only after rigorous justifications is presented in writing to the Program Directors.

Applications for performing research off-campus must include a detailed proposal for the research and the special facilities required for the project. A student may not register for "Matriculation Continued" unless he/she has been admitted to candidacy and has completed all coursework requirements (36 credits), rotations, and thesis prospectus,

XV. General Notes on Curriculum

Although the Program has three tracks and most students are likely to choose one track in which to concentrate, the Ph.D. program recognizes that some students may wish to establish an individualized course of study intermediate between the tracks. The individualized course of study must be developed in consultation with the student's major advisor and the Standards Committee with written approval of the Program Director.

XVI. Academic Integrity and Scholarly Ethics

All students, faculty and staff associated with the Graduate Program in Biology are expected to adhere to the highest standards of academic integrity and scholarly ethics. As a guide to academic integrity and scholarly ethics please refer to the following sites:

http://academicintegrity.rutgers.edu/integrity.shtml

http://integrity.njit.edu
http://uhr.rutgers.edu/ethics/

CLOSING NOTIFICATION
The official College closure notification is:
814 - KYW 1060 AM school closing number for day classes
2814 - KYW 1060 AM evening school closing number
GCC website: http://www.gccnj.edu
or call 856-468-5000 for a recorded message of school closure notification

LECTURE OUTLINE

There will be 4 lecture exams (a test will follow sections I-IV).

I. Test #1: The basis of cell structure and the structure and function of proteins, DNA and chromosomes will be discussed. Emphasis will be placed on the structure of DNA as it relates to replication, repair and recombination. **Chapters 1 & 4-6.**

II. Test #2: The regulation of transcription and translation in both prokaryotes and eukaryotes will be discussed with emphasis placed on laboratory techniques such as DNA cloning and manipulation will be discussed. **Chapters 7-8 & 10**.

III. Test #3: The structure of the plasma membrane and its use in both intercellular and intracellular transport will be discussed. **Chapters 11-12 & 15.**

IV. Test #4: The use of plasma membrane and the cytoskeleton in cell communication and cell division will be discussed. The molecular regulation of cell division and errors in cell division will also be covered. **Chapters 16-18 & 20.**

LABORATORY OUTLINE

I .Laboratories will be completed and handed in the day they are complete in their entirety.
II. Labs are found in your lab manual and should be read in time for the lab.
III. Students may work in groups of 2-3 and should remain lab partners for the semester, as you will be sharing lab equipment.
IV. The following labs will be covered during this semester (see calendar)

1. Protein Purification
2. Isolation of DNA from your cells and the Polymerase Chain Reaction
3. Analysis of your PCR reactions
4. Isolation and analysis of proteins from cells
5. Western Blotting
6. Cell Transformation
7. Analysis of Cell Transportation
8. Cell structure and communication
9. Analysis of common mutations in cancer cells
10. Capstone Lab: Restriction digests

Biomedical Engineering

Administered By: Department of Biomedical Engineering

Adminstration

Chairperson	Bharat Biswal
Undergraduate Program Director	Tara L. Alvarez
Undergraduate Program Coordinator	Alev K. Erdi
Ph.D. & MS Program Director	Treena L. Arinzeh
MS Program Coordinator	Max Roman

Faculty

Professor	Treena L. Arinzeh, Bharat Biswal, William C. Hunter
Associate Professors	Sergei Adamovich, Bryan J. Pfister, Tara L. Alvarez, Richard A. Foulds, Mesut Sahin
Assistant Professors	Cheul Cho, Eun J. Lee, Raquel Perez-Castillejos
University Lecturers	Bruno Mantilla, Naphtaly Ehrenberg, Joel Schesser
Research Professors	Hans R. Chaudhry, Xin Di, Michael Jaffe, George Collins
Distinguished Emeritus Professor	William C. Van Buskirk
Emeritus Professors	Peter Engler, David Kistol, Stanley Reisman

Advisers

Freshman, Sophomore, & Transfer Adviser	Alev K. Erdi
Bioinstrumentation Track Advisers	Tara L. Alvarez, Mesut Sahin
Biomechanics Track Advisers	Sergei Adamovich, Richard A. Foulds, William C. Hunter
Biomaterials/Tissue Engineering Track Advisers	Cheul Cho, Eun J. Lee, Raquel Perez-Castillejos
MS Adviser	Max Roman
Ph.D. Adviser	Treena L. Arinzeh

Degrees Offered: Master of Science in Biomedical Engineering

Biomedical engineering is currently the fastest growing field of engineering in the U. S. and requires an education that draws from advanced engineering and computing as well as the biological and medical sciences. NJIT offers an extremely flexible Masters program that encourages students to contribute to an individualized plan of study that builds upon the strengths of their B.S. and develop expertise in an area of concentration leading to careers in research and/or product development, or to prepare for further study in medicine, dentistry, law, and management, or for a Ph.D. in biomedical engineering. Major areas in which NJIT offers courses and conducts research are bioinstrumentation, biomaterials and tissue engineering, biomechanics, neural engineering and rehabilitation engineering.

Over the past several years, the M.S. in Biomedical Engineering program at NJIT currently has graduated the largest number of M.S. degrees in BME in the nation. The department offers a comprehensive set of courses specifically in biomedical engineering (usually 14-16 per semester), which are augmented by related engineering and life science courses taught in other departments. NJIT's location, in the middle of the nation's largest concentration of biomedical industries, provides access to expert instructors who offer specialized courses, which add to the richness of the academic environment. These industries also support graduate internships and thesis work, and often provide employment after graduation. The NJIT campus is within walking distance of both the University of Medicine and Dentistry of New Jersey flagship campus and Rutgers University-Newark. Graduate education at the three institutions is enhanced by collaboration agreements that allow cross-registration for courses, use of libraries, and opportunities for independent research. This benefits biomedical engineering by opening the possibilities for MS students to take advanced biological and medical science courses in addition to engineering courses.

The NJIT Department of Biomedical Engineering has a very active research program that is accessible to Masters students and provides opportunities for thesis or other independent study, which integrates engineering and the medical sciences. Research is conducted cooperatively between NJIT and the medical and dental schools of UMDNJ, the Kessler Institute for Rehabilitation, St. Barnabas Medical Center, Veteran's Administration Medical Center in East Orange, the Children's Specialized Hospital, the Public Health Research Institute, the Rutgers Center for Biological and Molecular Neuroscience and other institutions in the New Jersey-New York metropolitan area. In addition, cooperative research opportunities exist with a number of biomedical device and pharmaceutical companies within a short commuting distance from NJIT.

Aim of the Program

This program provides the opportunity for individuals with degrees in biomedical engineering to focus on a specialized area to a much greater degree than could be done in their undergraduate studies. Similarly, it also allows those with engineering and science backgrounds in other fields to acquire knowledge and skill that will allow them to join this growing field. Unlike many other graduate programs, the NJIT BME M.S has no core requirements. Each student develops an individualized plan of study with his.her advisor that is based on prior study, past work experience and career goals. The intentional flexibility in the selection of courses reflects the expected maturity of the graduate students as they assume significant responsibility for planning their concentrations. This flexibility also encourages students to exhibit some curiosity about unfamiliar areas of biomedical engineering and allows them to take two courses that may be peripheral to their academic focus.

The opportunity to pursue a thesis has the benefit of allowing students to choose a topic in which they will demonstrate the ability to integrate what they have learned, execute a 2-semester technical project, and communicate their results. Students not electing to pursue a thesis may choose three additional courses (replacing the 6-credit thesis) that increase their depth in engineering and breadth in the life sciences.

Eligibility for the Program

Students who have a B. S. degree in science or engineering are eligible. In general, those with a B.S. in biomedical, mechanical, electrical, computer or chemical engineering will be well prepared to enter the program. Exceptional students with undergraduate degree in the life sciences with sufficient background in mathematics will also be considered for admission.

All applicants must have had courses in scientific computer programming, differential equations, statistics, and physiology. Students who are missing one or more of these can be conditionally admitted with a requirement to take undergraduate bridge courses, which are in addition to the 30-credit graduation requirement. Certain graduate courses or concentrations may require additional background, such as, statics and/or dynamics, thermodynamics, and electronics. Students who do not have these prerequisites may be asked to take additional courses or acquire the necessary material through tutoring and independent study. Prospective students may contact the MS Program Director for advice regarding their specific needs.

Students selected for admission should have earned a minimum undergraduate G.P.A. of 3.0, and have GRE Math and Verbal scores higher than 670 and 400, respectively. GRE scores are required for all international applicants, and are optional for graduates of U.S. universities and colleges.

Course Offerings

The courses offered through this program allow students to choose concentrations that genuinely reflect their needs and interests. The sample course concentrations listed below reflect a curriculum that is rich in cutting edge engineering and science, and deep in its content. This critical mass of courses at NJIT, UMDNJ and Rutgers allows students to acquire a level of expertise that is uncommon among most biomedical engineering programs. The students in this program are nearly evenly split between those continuing their education immediately following their BS and those who are returning to study after a number of years of employment. The same is true for the educational backgrounds of the students, with approximately half having studied biomedical engineering and the other half coming from different fields. Most candidates for the Masters degree enroll as full-time students. However, the degree can be completed on a part-time basis for those who wish to study while continuing to work. Most courses are offered in the late afternoon and in the evening.

The BME graduate courses listed in this catalog are each offered at least once per academic year. This listing is frequently updated to avoid the potential of including courses that are no longer offered. Potential applicants are encouraged to view the current academic year's course schedule and course enrollments at http://www.njit.edu/registrar/schedules/index.php

Course are taught by faculty who have considerable expertise. BME faculty and lecturers from nearby medical institutions offer graduate courses that are related to their ongoing research areas, while lecturers from industry bring experience from a corporate sector.

Approximately 30% of BME M.S. students complete a thesis, which is a mentored two-semester research/development experience. Many students (particularly those with experience in industry) may already have experienced the equivalent of an in-depth, year-long project, and can be better served by taking additional courses. Students considering a thesis are directed to the NJIT Library's web site where most recent theses are available online. Those

Those who have questions about the scope and content of biomedical engineering theses should review several that fall within their areas of interest. These can be found at http://www.library.njit.edu/etd/list-majors.cfm?d=Biomedical-Engineering

The department's Graduate Seminar is a weekly opportunity for students to be exposed to current topics in biomedical engineering and develop an appreciation for the breadth of this exciting field. These lectures are given by visiting scholars and industry experts. The department website offers a current listing of seminar speakers and topics. Please visit http://biomedical.njit.edu/

In addition to the department seminar, the Graduate Biomedical Engineering Society (GMBES) operates its own lecture series that focuses on BME in industry (http://www.njit-gbmes.org/). Montly speakers discuss product development and applied research. Many speakers are NJIT BME alumni with whom current students can network.

Co-op Opportunities and Internships

Students have the opportunity to participate in the co-op and internship programs at neighboring medical institutions or at biomedical engineering firms to gain practical experience. NJIT is situated in an area that contains many major biomedical engineering and pharmaceutical companies. The biomedical engineering department has a part-time advisor for co-op and internship experiences.

Prospects for Employment

Considerable opportunity exists in the field of biomedical engineering. This takes the form of basic and applied research and product development. Employment may be found in medical institutes, government agencies, corporations and hospitals, all of which are involved in the design, manufacture and utilization of equipment and procedures intimately involved in health care improvement. Many students go on to obtain professional degrees in medicine, dentistry, law or administration for which an engineering background is becoming ever more important.

Specifics of the M.S. in Biomedical Engineering

Admission Requirements:
Prospective students seeking admission to the Program must have an undergraduate degree in engineering, science or mathematics and satisfy the admission and academic requirements of the Graduate School.

1. General Guidelines:
Each program of study must satisfy the Graduate School academic requirements (see the latest graduate catalog at www.njit.edu).
2. Prerequisite Courses
Minimum Undergraduate Requirements for the Program: B.S. in Biomedical, Chemical, Electrical, Computer, or Mechanical Engineering. Applicants with a B.S. in Computer Science are expected to have had Calculus through differential equations, one full year of Physics, one full year of Chemistry, and a course in Physiology. Applicants with strong life science or medical education, including the equivalent of one full year of Physics as well as Calculus through differential equations, will be considered on a case-by-case basis. Conditional admission may be granted to applicants lacking full preparation with a requirement to take undergraduate bridge courses that will not carry graduate credit.

Admitted students who have not previously taken an upper level physiology course will be required to take BME 669-Engineering Physiology or an equivalent course as one of their graduate courses.

Specific Program Requirements:

Thesis Option 30 Credits
Required Graduate Courses:
21 credits Seven graduate courses appropriate for Biomedical Engineering.

3 credits One graduate course in experimental design, biostatistics or clinical studies.
BME 701 Thesis (6 credits)
BME 791 Graduate Seminar--required for two semesters (0 credits)

Non-Thesis Option
Required Graduate Courses:
27 credits Nine graduate courses appropriate for Biomedical Engineering (may include a 3-credit project)
3 credits One graduate course in experimental design, biostatistics or clinical studies.
BME 791 Graduate Seminar--required for two semesters (0 credits)

Area of Concentration:
Unlike many other programs in biomedical engineering, the NJIT M.S. Program does not require prescribed core courses. Students are given the responsibility of planning a concentration of a minimum of six (6) courses (18 credits) that define a concentration that meets their career goals and intellectual needs. Possible areas of concentrations include:

Neural Engineering
Biomaterials and Tissue Engineering
Biomechanics
Bioinstrumentation
Rehabilitation Engineering
Biomedical Imaging

Novel Concentrations can be customized to address new cross-disciplinary areas or can be further specialized to focus on either research or product design.

Breadth Courses:
Students may enroll in two (2) graduate courses (6 credits) in areas outside of their concentration but appropriate for the M.S. in Biomedical Engineering. Alternatively, these two courses could be selected as additional courses within the concentration.

Life and/or Medical Science Courses:
Within the eight (8) courses of the Thesis Option or the eleven (11) courses of the Non-Thesis Option described above, students are strongly encouraged to take at least one (1) course in an area of life or medical science that supports the concentration. Non-Thesis students may wish to take additional life or medical science courses. This emphasizes the important link between engineering and the biological and medical sciences and can include basic or clinical science courses at the University of Medicine and Dentistry of New Jersey and Rutgers University-Newark, which are available to NJIT students via a cross-registration agreement.

Seminars:
MS students are required to register for the 0 credit graduate seminar in each of a minimum of two semesters. This is a non-additive credit (i. e. it does not count toward the 30 required credits), however participation in the seminar is required for graduation. Graduate seminars are offered weekly during the semesters and include guest speakers as well as NJIT graduate students. The Department also maintains lists of seminars in other departments and in neighboring institutions that are of interest to biomedical engineering. Part-time graduate students may request a waiver of this requirement.

Thesis Requirement:
The Thesis Option **requires** a six (6) credit thesis. Because biomedical engineering exists at the intersection of several traditional engineering and computing fields, and the biological and medical sciences, the thesis demonstrates the student's ability to define a problem, plan two semesters of independent work in an interdisciplinary environment, and execute a research and/or design that meets NJIT's standards for a Masters Thesis. The thesis document conforms to the format of the Office of Graduate Studies and is evaluated by a committee of three members, two of whom must be from the NJIT biomedical faculty. External members from industry, medicine or other universities are encouraged. An oral defense before the committee and the departmental community is also required. All NJIT theses are archived in the University Library and are available via the Library's web site.

Thesis topics are selected by the student in consultation with faculty and other potential advisors. Thesis content can include a research study, the development/design of new technology including software, or the design, execution and evaluation of an experiment. A thesis may be conducted in an NJIT laboratory or in another institutional or industrial facility. The individual nature of the work must be clearly identifiable, as should its novelty and importance to biomedical engineering.

In cases where the intellectual property of an industrial sponsor may be in conflict with the public presentation of the thesis or its availability through the NJIT Library, special arrangements can be made by the MS Program Director to protect the firm's property.

Planning of Courses:
Students are responsible for identifying their area of concentration and proposing a coherent collection of courses to the MS Program Director or other designated advisor. The Department maintains an? electronic list of graduate courses appropriate to biomedical engineering, which are offered at NJIT, UMDNJ and Rutgers-Newark on a semester by semester basis on the department web site. Course descriptions are available elsewhere in the catalog. Students are advised to continually review their selected set of courses, as there is generally some variability in the scheduling of established and new courses. The Program Director and/or other designated advisor will be available to assist in planning the course selection.

Sample clusters of courses are shown below for different areas of concentration. These clusters are intended to serve as examples of the flexibility students have in choosing a balanced set of courses to meet their educational objectives. **They are not program requirements**. Students may propose considerably altered clusters that better meet their academic needs. Note: only the Thesis Option is shown. the Non-Thesis Option replaces the six-credit thesis with two additional courses (totaling 6 credits). MATH 663 is shown as a representative course in statistics. Other appropriate courses may be substituted. Additional special topics courses may be offered each semester which are not specially listed in the graduate catalog. These topics carry a BME 698 ST and BME 788 ST designation. The program director will provide course descriptions for any special topics course being offered. There is no limit to number of special topics course that a student may take.

BME MS students are encouraged to consider appropriate courses offered by other NJIT departments as well as by departments at Rutgers-Newark and UMDNJ. **Students are cautioned that such courses may have prerequisites and other enrollment restrictions, are advised to check with the appropriate department for clarification.** The procedures for cross-registration at Rutgers-Newark and UMDNJ are explained elsewhere in this catalog.

Neural Engineering

		BME661	
		BME 687	Design of Medical Instrumentation (3 credits)
		BME 680	BioMEMS Design and Applications (3 credits)
		BME 668	Medical Imaging Systems (3 credits)
		BME 673	Biorobotics (3 credits)
		Math 635	Analytical Computational Neuroscience (3 credits)
		BME 674	Principles of Neuromuscular Engineering (3 credits)
		BME 774	Principles of Neurorehabilitation (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		BME 701	Master's Thesis (6 credits)

Biomaterials and Tissue Engineering

		BME 672	Biomaterials (3 credits)
		BME 651	Principles of Tissue Engineering (3-0-3)
		BME 677	CAD for Biomechanics and Biomaterials (3-0-3)
		BME 655	Advanced Characterization of Biomaterials (3-0-3)
		BME 652	Cellular and Molecular Tissue Engineering (3 credits)
		BME 680	BioMEMS Design and Applications (3 credits)
		BME 653	Micro/Nanotechnologies for Interfacing Live Cells (3 credits)
		BME 670	Introduction to Biomechanical Engineering (3 credits)
		BME 684	Medical Device Development (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		BME 701	Master's Thesis (6 credits)

Biomechanics

		BME 670	Introduction to Biomechanical Engineering (3 credits)
		BME 671	Biomechanics of Human Structure and Motion (3 credits)
		BME 672	Biomaterials (3 credits)
		BME 673	Biorobotics (3 credits)

		BME 654	Cardiovascular Mechanic (3 credits)
		BME 680	BioMEMS Design and Applications (3 credits)
		BME 676	Computational Biomechanics (3 credits)
		BME 678	Design of Orthopedic Implants (3-0-3)
		BME 679	Advanced Design of Orthopedic Implants (3-0-3)
		BME 684	Medical Device Development (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		BME 701	Master's Thesis (6 credits)

Biomedical Instrumentation

		BME 687	Design of Medical Instrumentation (3 credits)
		BME 686	Intro. to Instrumentation for Physiomeasurements (3-0-3)
		BME 680	BioMEMS Design and Applications (3 credits)
		BME 667	Bio-Control Systems (3 credits)
		BME 653	Micro/Nanotechnologies for Interfacing Live Cells (3 credits)
		BME 668	Medical Imaging Systems (3 credits)
		BME 672	Biomaterials (3 credits)
		BME 675	Computer Methods in Biomedical Engineering (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		BME 701	Master's Thesis (6 credits)

Rehabilitation Engineering

		BME 671	Biomechanics of Human Structure and Motion (3 credits)
		BME 686	Intro. to Instrumentation for Physiomeasurements (3-0-3)
		BME 678	Design of Orthopedic Implants (3-0-3)
		BME 673	Biorobotics (3 credits)
		IE 661	Man-Machine Systems (3 credits)
		BME 674	Principles of Neuromuscular Engineering (3 credits)
		BME 774	Principles of Neurorehabilitation (3 credits)
		BME 677	CAD for Biomechanics and Biomaterials (3-0-3)
		BME 701	Master's Thesis (6 credits)

Biomedical Imaging

		BME 681	Medical Imaging (3 credits)
		BME 698	Selected Topics (3 credits)
		BME 687	Design of Medical Instrumentation (3 credits)
		BME661	
		PHYS671	
		PHYS675	
		BINF5035	
	*	Math 663	Introduction to Biostatistics (3-0-3)
		BME 701	Master's Thesis (6 credits)

The blank table below can be used to start building a personal concentration of courses that supports individual educational objectives. Note that courses are generally offered only once in each academic year so there could be conflicts. Occasionally courses are discontinued and new courses are added. Please check the list of courses that is posted online by the NJIT Registrar prior to each semester.

Personal Concentration (Thesis Option 8 courses plus thesis)

		*	(Course with statistical/experimental design content)
		BME 701	Master's Thesis (6 credits)

Personal Concentration (Non-Thesis Option 11 courses)

		*	(Course with statistical/experimental design content)

Ph.D. in Biomedical Engineering

The Doctor of Philosophy in Biomedical Engineering is jointly offered by NJIT and the University of Medicine and Dentistry of New Jersey (UMDNJ). It offers advanced graduate education providing students with the skills necessary for careers in basic and applied research, as well as the intellectual foundation to provide leadership in academia and industry. This program emphasizes an integration of engineering and the life sciences to address complex problems Students are admitted to either institutions and receive the same degree with a joint diploma. Course requirements are the same regardless of admission. The UMDNJ description of this program can be found at http://njms.umdnj.edu/gsbs/academic_programs/phd/bio_engineering/index.htm

The recent National Research Council Ph.D. rankings placed it 26th out of 74 U.S. BME Ph.D. programs.

Aims of the Program

This joint program builds upon the synergistic relationship between NJIT and UMDNJ. The physical proximity of the two institutions facilities access to courses, laboratories, libraries, and seminars, as well as blending scientific and clinical opportunities in education and research. In addition, the location of NJIT and UMDNJ in Newark promotes interaction with New Jersey's pharmaceutical and medical device industries and medical facilities. As the preparation for the Ph.D. involves an extensive research apprenticeship in the form of dissertation, the program is closely linked to the areas of biomedical engineering research at NJIT and UMDNJ. This research is clustered in the following areas.

Biomaterials and Biocompatibility
Tissue Engineering and Regenerative Medicine
Cellular and Orthopedic Biomechanics
Biomedical Signal Processing, Imaging and Instrumentation
Neural and Neuromuscular Engineering

The program requires a minimum of 78 credits beyond the B.S. or 60 credits beyond an M.S. degree in biomedical engineering or closely related field. For the post MS student, 24 credits must be in advanced graduate level courses with 12 credits in biomedical engineering and 12 credits in life sciences. The post B.S. student must take an additional 18 credits in approved courses.

The remaining 36 credits are comprised of mentored dissertation research, in which the student demonstrate aptitude for independent research of publishable nature. Individuals completing this degree are well-prepared for employment in academia, industry and government laboratories, or for post-doctoral study.

Eligibility for the Program

Prospective students seeking admission to the joint Ph.D. Program should have an undergraduate degree in engineering, basic science or mathematics, and satisfy the admission and academic requirements of the NJIT Graduate School and the UMDNJ Graduate School of Biomedical Sciences. In general, applicants are expected to have had Calculus through differential equations equations, one full year of physics, one full year of chemistry, and a course in physiology as part of their prior engineering studies. Non-engineering applicants with strong life science or medical education, with the same physics, chemistry, math and physiology background, but who do not have experience in essential engineering sciences, will be considered on a case-by-case basis. These applicants may be asked to pursue and MS in BME prior to admission to the Ph.D. program. Alternatively, conditional admission may be granted to applicants lacking full preparation, the a requirement to take undergraduate bridge courses that will not carry graduate credit. Admitted students who have not previously taken an upper level physiology course will be required to take BME 669- Engineering Physiology or an equivalent course as one of their graduate courses.

Applicants are expect to have a minimum G.P.A of 3.5 in their most recent degree (B.S. or M.S.) and minimum GRE Math and Verbal scores of 750 and 500. The GRE is required for all applicants, and TOEFL is required for all international students.

The program has a joint admission committee, which reviews all application, thus allowing students to apply to either institution. The host institution for a student may be changed depending upon the eventual research advisor and/or the institutional source of the research funding. The only significant institutional difference in the application process is that UMDNJ only admits students in the spring for the upcoming fall semester. NJIT can admit students who are beginning in either the fall or spring semesters. In general, however, spring admissions are rare.

As the Ph.D. program is significantly based on faculty research, admission depends upon available opportunities and funding in individual laboratories, in addition to prior academic performance. A very limited number of teaching assistantships and university fellowships are available for begging students, with subsequent years of research supported by faculty grants.

Laboratory and funding opportunities vary considerably from year to year. Serious potential applicants are encouraged to contact the Ph.D. program director at either NJIT or UMDNJ to discuss the current factors influencing admission.

Specifics of the Ph.D. in Biomedical Engineering

Prior to the first semester of study, the student meets with the Ph.D. Program Committee and develops an individualized learning contract. This document maps the student's plan of study to math career goals with the Ph.D. curriculum. The development of the learning contract involves reviewing the student's prior courses, assessing future course needs, planning for qualifying exams and lab rotations, and initiating discussion of research interests. If a student enters the program with a research and mentor identified, that mentor is also included in the planning.

This learning contract is revised during each semester's advising period and it is updated as necessary. The academic Progress Committee, comprised of NJIT and UMDNJ faculty, monitors the progress of students in the completion of their degrees.

Graduate Courses

Students entering the program following an MS in biomedical engineering are required to take a minimum of 24 credits of advanced courses. Twelve credits of advanced biomedical engineering shall be selected in the field of specialization chosen by the student. Generally, these courses will come from those offered at NJIT and which are listed elsewhere in this Catalog. Courses from other engineering departments are considered on a case basis. The remaining 12 credits will be in advanced life sciences. These include GSDN 5200Q Introduction to Biomedical Sciences, which is referred as the "Core" course and is required of all Ph.D. students in the Graduate School of Biomedical Sciences. This 5-credit course is augmented by a 1-credit BME 611-Engineering Aspects of Molecular and Cellular Biology. The remaining 6 credits of life sciences courses should reinforce the student's area of specialization.

UMDNJ-GSBS life science courses can be found at:

http://njms.umdnj.edu/gsbs/current_students/description.html

While most students take GSBS life science courses, students may propose alternative courses taken at Rutgers University-Newark's Institute of Molecular and Behavioral Neuroscience

https://cmbn.rutgers.edu/Lists/Course%20Descriptions/AllItems.aspx

NJIT/Rutgers Federated Department of Biology

http://newarkbioweb.rutgers.edu/department

The UMDNJ in the School of Health-Related Professions:

http://shrp.umdnj.edu/general/virtualCatalog/index.html

Students entering with a BS biomedical engineering will work with their advisor to select an additional 18 credits of biomedical engineering and life science course that will serve as foundation (similar to an MS) for the advanced courses and dissertation research.

In addition to the required 24 (with BS) course requirements, all Ph.D. students must register for GSDN 5001Q Ethics in Science, Research and Scholarship, and two laboratory rotations (one at NJIT and one at UMDNJ). Ph.D students are encouraged to attend, but are not required to register for the BME Graduate Seminar at NJIT.

Qualifying Examinations:

Before becoming a doctoral candidate, a student must demonstrate his/her ability to integrate the knowledge acquired studies in the Qualifying Examination. This examination is offered each June and included a day-long written portion consisting of integrative questions. Shortly after the date of the written exam, students are examined orally by the Academic Progress Committee on the same questions. Students discuss and expand upon their written answers, and demonstrate their ability to engage in scholarly discussions.

Dissertation:

The dissertation represents original research, and reflects a student's ability to critically understand the significance of a problem and conduct novel, high quality, and independent research, which advances the state of the art.

Before beginning the dissertation the student will select a dissertation committee, to be chaired by the student's primary advisor, and prepare a dissertation proposal. The proposal is organized using the format of an NIH Fellowship application, identifying a unique scholarly problem, providing a critical review of related literature, proposing an appropriate hypothesis, and presenting a methodology to address the problem. The proposal is defended before the dissertation committee.

Doctoral study concludes with a written dissertation and an oral defense. All students must complete 36 credits of dissertation research.

Biopharmaceutical Engineering

Administered By: Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering

Administration

Program Director	Piero M. Armenante
Associate Director	Laurent Simon

Program Objective

The Master of Science Program in Biopharmaceutical Engineering is a program developed and administered by the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering at NJIT. The primary objective of the program is to educate professionals by providing them with the skills required to work in the bioprocessing and biomanufacturing, biopharmaceutical production, and biological/biochemical development.

New Jersey is considered a "hot bed" for pharmaceutical, health care, and bioscience companies, and examples of large and small companies having major facilities in New Jersey abound. The use of microbial/biological systems and the manipulation of biological systems for the production of pharmaceutical products and therapeutic agents are becoming increasingly important for these companies and for the health care industry as a whole. The Biopharmaceutical Engineering program is designed to address the engineering component of the educational needs in this area: students are trained in areas such as microbial and cell growth operations, bioreactor and bioprocess design, fermentation and cell culture processing, recovery and bioseparation processes, and validation and regulatory issues for biological production. Since this program is strongly tied to the pharmaceutical engineering and chemical engineering programs, Biopharmaceutical Engineering students are able to benefit from the use of basic chemical/pharmaceutical engineering approaches, such as transport phenomena, (bio)reaction engineering and unit-operations principles, to understand and design bioprocesses for new biotherapeutics.

NJIT'd M.S. program in Biopharmaceutical Engineering provides the intellectual climate and the necessary tools needed to prepare students for positions and career advancement within the industry, based on the rigorous technological requirements of this highly regulated work environment.

Master of Science in Biopharmaceutical Engineering

Admission Requirements:

An undergraduate degree in chemical engineering or, in most cases, mechanical engineering, with a cumulative grade point average (GPA) of at least 3.0 on a 4.0 scale is usually required. Applicants with: (1) a science degree, (2) engineering degree in a discipline other than chemical engineering, or (3) a GPA bellow 3.0 but at least 2.8, may be conditionally admitted to the program. Conditions may involve completion of a bridge program designed on a case-by-case basis, and typically requiring taking extra bridge courses, as further explained bellow. Depending on the background of the student, admission conditions may additionally require taking undergraduate course (e.g., chemistry) or graduate courses. Bridge courses and undergraduate courses do *not* count toward degree credit; graduate-level courses do.

Submission of Graduate Record Examination (GRE) score is encouraged in all cases, but it is required of those seeking financial support and those whose last prior degree is from an institution outside United States. International students must also submit scores from the Test of English as a Foreign Language (TOEFL). According to University policy, a minimum score of 79 (internet-based TOEFL) or 213 (computer_based TOEFL) is required for all international applicants.

Bridge Program

The Biopharmaceutical Engineeringprogram has been designed so that applicants with different backgrounds can be admitted. Nevertheless, the program is strongly oriented toward the *engineering* and *processing* components of "Biopharmaceutical Engineering". In addition, since the biopharmaceutical industry is a chemistry/biology-based industry a chemical or biochemical engineering background is the most appropriate to enter the program. This implies that students who have science background (e.g., a chemistry or pharmacy B.S. degree) or an engineering degree in a discipline other than chemical, biochemical or, possibly, mechanical engineering, may be required to take a bridge program. Depending on the background of the applicant, this bridge program may consist of up to (but generally speaking less than, 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. The 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).

A grade point average of at least 3.0 must be achieved in the bridge courses. Students should pay special attention to the successful completion of the bridge courses, since failure to do so may preclude them from enrolling in regular PhEn courses. PhEn 500 and PhEn 501 can and should be taken concurrently. Successful completion of both PhEn 500 and PhEn 501 is required to enroll in PhEn 502. Students must take the bridge courses before taking any other PhEn courses, with the exception of PhEn 601 and PhEn 604, which can be taken concurrently with the bridge courses. As mentioned, admission conditions may also include taking undergraduate or graduate courses, if needed.

Degree Requirements

The Master of Science in Biopharmaceutical Engineering is a 30-credit program, including 21 credits worth of core courses. Students have the option of fulfilling six (6) of the nine (9) credit of electives by doing a Master's Thesis. The thesis option is primarily, but not exclusively, meant for full time students. Full-time students receiving support (full or partial) must complete a Master's Thesis. Part-time students working in the Pharmaceutical industry are encouraged to pursue a Master's Thesis, possibly conducted at their and in collaboration with their supervisor.

Students must maintain an overall cumulative grade point average of at least 3.0 throughout their academic career.

Students are certified for graduation only if they:

- Achieve an overall cumulative grade point average of at least 3.0; and
- Achieve a grade point average of at least 3.0 in the required core courses; and
- Achieve a grade point average of at least 3.0 in the bridge courses (if taking the bridge courses is required).

Students may not repeat a course without approval of both the Program Director and the Office of Graduate Studies. If a student repeats a course, the grades received in the first two repeated courses will replace the original grades in the calculation of the cumulative grade point average, although the old grades will still appear on the transcripts. However, the grades received in all repeated courses beyond the first two will count in the calculation of the cumulative grade point average. Students who receive an F in a course are required to repeat the course.

Program of Study/Curriculum

A minimum of 30 credits is required for degree completion. Of these, 21 credits must be obtained by taking seven (7) prescribed Core Courses, which include Pharmaceutical Bioprocessing (PhB) courses as well as Pharmaceutical Engineering (PhEn) courses. In addition, engineering applicants with little or no biology background, but not biology or pharmacy applicants, may be required to take an additional Foundation Course (PhB 505 - Principles of Pharmaceutical Microbiology an Biochemistry), which *will* count toward the 30 credits required to complete the PhB program. The remaining credits needed to achieve the required 30 credits may be obtained by taking either elective courses only or a combination of an elective course and M.S. Thesis credits. As already indicated, applicants with a science background or an engineering degree in a discipline other than chemical engineering may be required to additionally take one or more bridge courses. Bridge courses do *not* count toward the 30 credits required to complete the program.

Course Requirements:

Bridge Courses (9 Credits; typically required for non-engineering applicants only. Bridge courses do **not** count toward the 30 credits required to complete the program).

		PhEn 500	Pharmaceutical Engineering Fundamentals I (3 credits)
		PhEn 501	Pharmaceutical Engineering Fundamentals II (3 credits)
		PhEn 502	Pharmaceutical Engineering Fundamentals III (3 credits)

Foundation Course (3 Credits; required for engineering applicants with little or no biology background, but not for biology or pharmacy applicants. This course counts towards the 30 credits required to complete the PhB program):

		PhB 505	Principles of Pharm. Microbiology and Biochemistry (3 credits)

Core Courses (21 Credits):

		PhEn 601	Principles of Pharmaceutical Engineering (3 credits)
		PhEn 604	Validation and Regulatory Issues in the Pharmaceutical Industry (3 credits)
		PhEn 603	Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems (3 credits)
		PhEn 618	Principles of Pharmacokinetics and Drug Delivery (3 credits)
		PhB 610	Biotechnology-Biopharmaceutical, Processes and Products (3 credits)
		PhB 615	Bioseparation Processes (3 credits)
		PhB 630	Pharmaceutical Bioprocess Engineering (3 credits)

Electives (as appropriated to achieve the required total number of credits):

- Electives can be selected from among *appropriate* courses in disciplines including but not limited to pharmaceutical engineering, chemical engineering, mechanical engineering, industrial engineering, engineering management, pharmaceutical system management, biomedical engineering, chemistry, biology, mathematics and others. A partial list of electives is provided below. Students are encouraged to choose electives from a variety of offering departments. In general, all technical and scientific courses that are relevant to the program could be selected, typically in consultation with the Program Advisor.

M.S. Thesis: Full-time students receiving full or partial financial support must complete a Master's Thesis. Part-time students can also complete a Master's Thesis if they so choose. *Part-time* students working in industry are also eligible, and encouraged, to pursue the thesis option, possibly even conducted at their site and in collaboration with their supervisor. Students doing a thesis must select a Thesis Advisor who will guide them trough their thesis work. The students must also complete a form indicating the three (3) faculty members composing their MS Thesis Committee, to be selected in consultation with their Thesis Advisor. Students who are required, or choose, to do a thesis must take six (6) credits of Master's Thesis (PhB 701) in lieu of six (6) credits worth of electives courses, and must choose their remaining elective course(s) in concultation with their Thesis Advisor. NJIT requires that students who elect to do a thesis must register for thesis during the last semester before graduation, even if this requires taking addition thesis credits beyond the required six (6) credits. Completion of the thesis requirements also includes: (a) writing the thesis document, to be approved by the Thesis Committee, and (b) making a final oral presentation to the MS Thesis Committee.

Partial List of Elective Courses

The following is a partial, non-exhaustive list of courses that can be taken as electives courses [all courses are 3-credits unless otherwise stated]:

		PhEn 698	Special Topics in Pharmaceutical Engineering I (3 credits)
		PhEn 699	Special Topics in Pharmaceutical Engineering II (3 credits)
		PhB 701B	Master's Thesis (3 credits)
		PhB 701C	Master's Thesis (6 credits)
		PhB 702	(Selected Topics in Pharm Bioprocessing) (3-0-3)
		PhB 725	Independent Study I (3 credits)
		PhEn 602	Pharmaceutical Facility Design (3 credits)
		PhEn 605	Pharmaceutical Packaging Technology (3 credits)
		PhEn 606	Pharmaceutical Unit Operations: Solids Processing (3 credits)
		PhEn 612	Pharmaceutical Reaction Engineering (3 credits)
		PhEn 614	Pharmaceutical Separation Processes (3 credits)
		BME 627	Introduction to Biomedical Engineering (3 credits)

		BME 651	Principles of Tissue Engineering (3-0-3)
		BME 672	Biomaterials (3 credits)
		ChE 611	Thermodynamics (3 credits)
		ChE 624	Transport Phenomena I (3 credits)
		ChE 626	Mathematical Methods in Chemical Engineering (3 credits)
		ChE 656	Industrial Catalysis: Fundamentals & Applications (3 credits)
		ChE 675	Statistical Thermodynamics (3 credits)
		ChE 681	Polymerization-Principles and Practice (3 credits)
		Chem 601	Special Topics in Chemistry I (3 credits)
		Chem 602	Advanced Organic Chemistry II: Reactions (3 credits)
		Chem 603	Advanced Organic Chemistry Laboratory (3 credits)
		Chem 605	Advanced Organic Chemistry I: Structure (3 credits)
		Chem 606	Physical Organic Chemistry (3 credits)
		Chem 658	Advanced Physical Chemistry (3 credits)
		Chem 661	Instrumental Analysis Laboratory (3 credits)
		Chem 664	Advanced Analytical Chemistry (3 credits)
		Chem 673	Biochemistry (3 credits)
		Chem 677	Introduction to Medicinal Chemistry (3-0-3)
		EM 636	Project Management (3 credits)
		EM 637	Project Control (3 credits)
		EM 640	Distribution Logistics (3 credits)
		EM6P1	
		IE 604	Advanced Engineering Statistics (3 credits)
		IE 605	Engineering Reliability (3 credits)
		IE 618	Engineering Cost and Production Economics (3 credits)
		IE 672	Industrial Quality Control (3 credits)
		IE 673	Total Quality Management (3 credits)
		IE 674	Quality Maintenance and Support Systems (3 credits)
		IE 704	Sequencing and Scheduling (3 credits)
		Math 613	Advanced Applied Mathematics I: Modeling (3 credits)
		Math 635	Analytical Computational Neuroscience (3 credits)
		Math 637	Foundations of Mathematical Biology (3 credits)
		Math 654	Clinical Trials Design and Analysis (3 credits)
		Math 661	Applied Statistics (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		Math 664	Methods for Statistical Consulting (3 credits)
		ME 664	Experiments and Simulations in Particle Technology (3 credits)
		R120:512	Mammalian Physiology (3 credits)
		R120:515	Molecular Biology of Eukaryotes (3 credits)
		R120:601	Human Molecular Genetics (3 credits)

Student Involvement in Research

In addition to taking courses, students have the opportunity to work, one-on-one, with faculty members on research projects in areas of common interest, allowing maximum flexibility for independent work, and providing students with valuable research experience. Students have the option to complete a Master's Thesis. Part-time students working in the pharmaceutical industry are encouraged to pursue a Master's Thesis, possibly conducted at their site and in collaboration with their supervisor.

Qualified and research oriented students have the option of continuing their studies at NJIT by pursuing a Ph.D. in chemical engineering, industrial engineering, chemistry, or related disciplines. The NJIT-Industry Collaborative Ph.D. Program allows greater flexibility to industrial students who are interested in pursuing their Ph.D. while working *full-time* in industry.

For further information please contact:

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Management

Administered By: School of Management

Administration

Dean	Pius J. Egbelu
Associate Dean	Lisa B. Axe
Sponsored Chairs	Katia Passerini(Hurlburt Professor)* , William V. Rapp(Henry J. Leir Chair in International Business)
Director, Executive Program	Delores E. Frazier

Advisors

Undergraduate Advisor	Michael T. Sweeney
Graduate Advisor	Lilia A. Lozarito

Faculty

Distinguished Professors	Pius J. Egbelu
Professors	Asokan Anandarajan, Jerry L. Fjermestad* , Shanthi Gopalakrishnan, Kenneth D. Lawrence, Rajiv Mehta, Hindy L. Schachter, Mark Somers, Cheickna Sylla
Associate Professors	Theologos H. Bonitsis, Katia Passerini* , Marguerite A. Schneider, Stephan P. Kudyba, Yi Chen
Assistant Professors	Michael A. Ehrlich, Wei Xu, Zhipeng Yan, Ronald Sverdlove, Ellen Thomas, James E. Cicon, Cesar Bandera
Special Lecturer	Jose C. Casal, Porchiung B. Chou, Diana Walsh, Karen P. Schoenebeck

* 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; Master of Science in International Business.

Master of Business Administration in Management of Technology (48 credits)

NJIT's MBA in the Management of Technology is designed to prepare a new generation of technology savvy business leaders.The curriculum integrates fundamental business knowledge with applications of technology to business to prepare students to think strategically about business and technology.The program is built upon four themes that are transforming business: a) the transition to a knowledge based economy; b) the emergence of the digital firm; c) the globalization of business; and d) innovation as the primary source of competitive advantage.

Concentration areas are offered in Management Information Systems, Marketing, and Finance.

Admission Requirements:
Applicants to the MBA must submit complete transcripts of all undergraduate work and scores on the Graduate Management Admissions Test (GMAT). The GMAT is required of all applicants except those holding master's or doctoral degrees from an

accredited U.S. university. Up to nine credits of graduate work may be transferred from another school, provided that they are not counted towards a terminal degree at that school.

MBA Pre-Qualifying Requirements : Students are expected to demonstrate competency in the area of accounting, finance, quantitive methods, information systems and economics. Depending on the applicant's undergraduate degree program all or part of the pre-qualifier requirements can be met with prior undergraduate course work. Applicants who do not meet pre-qualifying requirements will be required to complete a bridge course.

Degree Requirements:

Bridge Course (3 credits)

Mgmt 501	Management Foundations (3-0-3)

MODULE I : Core Courses (All courses required. No substitutions) 27 Credits:

	Acct 615	Management Accounting (3 credits)
	Fin 600	Corporate Finance I (3 credits)
{	Fin 624	Corporate Finance II (3 credits) ***or***
	Fin 610	Global Macro Economics (3 credits)
	Mrkt 620	Competing in Global Markets (3 credits)
	MIS 680	Management Science (3 credits)
	MIS 645	Information Systems Principles (3 credits)
	HRM 601	Organizational Behavior (3 credits)
	Mgmt 691	Legal and Ethical Issues (3 credits)
{	Mgmt 692	Strategic Management (3 credits) ***or***
	Mgmt 680	Entrepreneurial Strategy (3 credits)

MODULE II : Managing Knowledge and Information, Tech & Innovation, choose 4 courses (12 Credits)

Mgmt 650	Knowledge Management (3 credits)
Mgmt 635	Data Mining and Analysis (3 credits)
Mgmt 620	Management of Technology (3 credits)
MIS 648	Decision Support Systems for Managers (3 credits)
HRM 630	Managing Technological and Organizational Change (3 credits)
EM 636	Project Management (3 credits)

MODULE III : Concentration choose 3 courses in one concentration (9 Credits)
<u>MIS Concentration Courses - Choose 3 courses</u>

CS 631	Data Management System Design (3 credits)
CS 632	Advanced Database System Design (3 credits)
IS 631	Enterprise Database Management (3 credits)
IS 663	System Analysis and Design (3 credits)
IS 679	Information Systems Strategy (3 credits)
IS 684	Business Process Innovation (3 credits)
Mgmt 630	Decision Analysis (3 credits)
Mgmt 635	Data Mining and Analysis (3 credits)
Mgmt 650	Knowledge Management (3 credits)
MIS 648	Decision Support Systems for Managers (3 credits)

IS 631	Enterprise Database Management (3 credits)
IS 663	System Analysis and Design (3 credits)
IS 678	IT Service Management (3 credits)

		IS 680	Information Systems Auditing (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		IS 684	Business Process Innovation (3 credits)
		IS 685	Enterprise Architecture and Integration (3 credits)
		IS 690	Web Services and Middleware (3 credits)
		MIS 648	Decision Support Systems for Managers (3 credits)

Finance Concentration Courses- Choose Three Courses:

		Fin 624	Corporate Finance II (3 credits)
		Fin 626	Financial Investment Institutions (3 credits)
		Fin 627	International Finance (3 credits)
		Fin 634	Mergers, Acquisitions, and Restructuring (3 credits)
		Fin 641	Derivatives Markets (3 credits)
		Fin 642	Derivatives and Structured Finance (3 credits)
		Fin 650	Investment Analysis and Portfolio Theory (3 credits)
		Fin 660	Financial Planning and Decision Making (3 credits)

Marketing Concentration Courses - Choose Three Courses:

		Mgmt 635	Data Mining and Analysis (3 credits)
		EM 636	Project Management (3 credits)
		Mgmt 681	Project-Based Enterprise Development (3 credits)
		Mrkt 630	Models of Consumer Behavior (3 credits)
		Mrkt 631	Market Planning and Analysis (3 credits)
		Mrkt 636	Design and Development of High Technology Products (3 credits)
		Mrkt 637	Marketing Communications and Promotions (3 credits)
		Mrkt 642	International Marketing Management (3 credits)
		Mrkt 645	Internet Marketing Strategy (3 credits)
		Mgmt 670	International Business (3 credits)
		Mgmt 640	New Venture Management (3 credits)

Master of Science in Management (30 credits)

The Master of Science in Management is designed to allow students to build specialized knowledge in one of four concentration areas : Management Information Systems, Organization Management, Management of Technology and Finance. Specialized knowledge is augmented with a 15 credit management core that provides the general knowledge needed to manage technical and specialized units.

Admission Requirements:
Applicants to the MSM must submit complete transcripts of all undergraduate work and scores on the Graduate Management Admissions Test (GMAT). The GMAT is required of all applicants except those holding master's or doctoral degrees from an accredited U.S. university. Up to nine credits of graduate work may be transferred from another school, provided that they are not counted towards a terminal degree at that school.

MSM Pre-Qualifying Requirements : Students are expected to demonstrate competency in the area of accounting, finance, quantitive methods, information systems and economics. Depending on the applicant's undergraduate degree program, all or part of the pre-qualifier requirements can be met with prior undergraduate course work. Applicants who do not meet pre-qualifying requirements will be required to complete a bridge course.

Bridge Course: (3 credits)

		Mgmt 501	Management Foundations (3-0-3)

Module I: Core Courses: All required no substitutions (15 credits)

		Acct 615	Management Accounting (3 credits)

		Fin 600	Corporate Finance I (3 credits)
		HRM 601	Organizational Behavior (3 credits)
		MIS 645	Information Systems Principles (3 credits)
		Mrkt 620	Competing in Global Markets (3 credits)

Module II: Areas of Specialization (15 credits from 1 area)

Area 1: Global Project Management

*Note: One course must be either Econ 610 or Mgmt 641

	*	Econ 610	Managerial Economics (3-0-3)
		EM 637	Project Control (3 credits)
		EM 691	Cost Estimating for Capital Projects (3 credits)
		IE 618	Engineering Cost and Production Economics (3 credits)
		IE 659	Supply Chain Engineering (3 credits)
		IS 614	Command and Control Systems (3 credits)
		IS 684	Business Process Innovation (3 credits)
	*	Mgmt 641	Global Project Management (3-0-3)

Area 2: Finance

		Fin 624	Corporate Finance II (3 credits)
		Fin 626	Financial Investment Institutions (3 credits)
		Fin 627	International Finance (3 credits)
		Fin 634	Mergers, Acquisitions, and Restructuring (3 credits)
		Fin 641	Derivatives Markets (3 credits)
		Fin 642	Derivatives and Structured Finance (3 credits)
		Fin 650	Investment Analysis and Portfolio Theory (3 credits)
		Fin 660	Financial Planning and Decision Making (3 credits)

Area 3: Information Systems Management

*Note: One course must be MIS 648

		IS 631	Enterprise Database Management (3 credits)
		IS 663	System Analysis and Design (3 credits)
		IS 678	IT Service Management (3 credits)
		IS 680	Information Systems Auditing (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		IS 684	Business Process Innovation (3 credits)
		IS 685	Enterprise Architecture and Integration (3 credits)
		IS 690	Web Services and Middleware (3 credits)
	*	MIS 648	Decision Support Systems for Managers (3 credits)

Area 4: Environmental Management

* Note: One course must be Mgmt 641

		EPS 601	Research Methods for Environment & Sustainability Policy (3 credits)
		EPS 612	Introduction to Environmental Policy Studies (3 credits)
		EPS 614	Environmental Economics & Management (3 credits)

		EPS 622	Sustainable Politics & Policy (3 credits)
		EvSc 612	Environmental Analysis (3 credits)
		EvSc 613	Environmental Problem Solving (3 credits)
		EvSc 615	Global Environmental Problems (3 credits)
	*	Mgmt 641	Global Project Management (3-0-3)

Area 5: Web Systems and Media

*Note: One course must be Mrkt 637

		IS 686	Pervasive Computing: An HCI Perspective (3 credits)
		IS 688	Web Mining (3 credits)
		IS 690	Web Services and Middleware (3 credits)
	*	Mrkt 637	Marketing Communications and Promotions (3 credits)
		PTC 605	Elements of Visual Design (3 credits)
		PTC 606	Advanced Information Design (3 credits)
		PTC 650	ELearning Design for Mobile (3 credits)

Area 6: Business Analytics

*Note: One course must be Mgmt 630, Mgmt 635, Mgmt 710, Mis 648, Mis 680 or Mrkt 645

		CS 634	Data Mining (3 credits)
		IS 631	Enterprise Database Management (3 credits)
		IS 687	Transaction Mining and Fraud Detection (3 credits)
		IS 688	Web Mining (3 credits)
		Math 644	Regression Analysis Methods (3 credits)
		Math 646	Time Series Analysis (3 credits)
		Math 647	Time Series Analysis II (3 credits)
		Math 664	Methods for Statistical Consulting (3 credits)
		Mgmt 630	Decision Analysis (3 credits) ***or***
		Mgmt 635	Data Mining and Analysis (3 credits) ***or***
?		Mgmt 710	Forecasting Methods for Business Decisions (3 credits) ***or***
		MIS 648	Decision Support Systems for Managers (3 credits) ***or***
		MIS 680	Management Science (3 credits) ***or***
		Mrkt 645	Internet Marketing Strategy (3 credits)

Area 7: Network and Telecommunications Management

*Note: One course must be Mgmt 641

		CS 696	Network Management and Security (3 credits)
		ECE 637	Internet and Higher-Layer Protocols (3 credits)
		ECE 639	Principles of Broadband Networks (3 credits)
		ECE 642	Communication Systems I (3 credits)
		ECE 644	Wireless Communication (3 credits)
		ECE 683	Computer Network Design and Analysis (3 credits)
		IT 620	Wireless Networks Security and Administration (3 credits)
		IT 640	Network Services Administration (3 credits)
	*	Mgmt 641	Global Project Management (3-0-3)

** Should be taken only in the final semester

Executive MBA

Administered By: School of Management

Executive Master of Business Administration

Tailored to the demanding schedules of working professionals, the solution focused 18-month, 48-credit program is customized for career advancement without interruption of professional obligations. Built upon the hallmarks of Innovation, Immersion, and Integration, this practical and results-oriented option emphasizes the application of advanced management strategies to traditional business challenges. With the added bonus of Saturdays and on-line flexibility, the EMBA offers both breadth and depth of business experience in an accelerated mode of delivery. Students are assigned independent and group projects emphasizing the employment of innovative management strategies in traditional corporate settings. Further, the students represent diverse industries and job functions, providing an enriching experience and balanced perspective. The curriculum consists of **4 Thematic Areas**: Leadership, Globalization, Creativity and Innovation, and Business and Government Relations.

EMBA candidates have the opportunity to participate in a 7-10 day international study tour. Meeting with business leaders in their work environments, students learn first-hand the opportunities and issues posed by today's volatile-yet-exciting international business climate. Recent tours have included Brazil, France, The Czech Republic, Russia, Estonia, Chile, Argentina, and China. Students have called the trips "invaluable." *[I gained] "critical insight….we would never have learned in any classroom or textbook."*

Professional Leverage

The program offers the additional benefit of PMP or Risk Management certification training. This new program feature represents an integration of the EMBA with industry recognized professional qualifications.

Admission Requirements: These criteria are standard admission guidelines; however, each candidate is evaluated based upon his/her individual profile.

Candidates must have an earned bachelor's degree (4 year US equivalent) and must take the GMAT (minimum score of 500); the GRE (with a comparable score) is also acceptable.

GMAT Waivers:

Candidates with an earned Master's or PhD from a US or Canada based "accredited" program

Candidates with a minimum GPA of 2.8 from a US based research intensive University

Candidates [without masters degrees], who have "significant" management experience, may appeal to the EMBA admission committee for a GMAT waiver; **there is no waiver guarantee**.

Core Courses:

		HRM 601	Organizational Behavior (3 credits)
		Acct 615	Management Accounting (3 credits)
		Fin 600	Corporate Finance I (3 credits)
		Mrkt 620	Competing in Global Markets (3 credits)
		Econ 610	Managerial Economics (3-0-3)
		Mgmt 630	Decision Analysis (3 credits)

		MIS 645	Information Systems Principles (3 credits)
		Mgmt 692	Strategic Management (3 credits)

Concentration in Business and Government Relations

		Mgmt 656	Public Policy and Business (3-0-3)
		Mgmt 686	Corporate Governance (3 credits)

Concentration in Global Business

		Mgmt 641	Global Project Management (3-0-3)
		Mgmt 670	International Business (3 credits)

Concentration in Innovation and Business Development

		Mgmt 649	Convention, Creativity and Innovation (3-0-3)
		Mgmt 640	New Venture Management (3 credits)
		Mgmt 650	Knowledge Management (3 credits)
		Fin 655	Financial Innovations and Market Failures (3-0-3)

Catalog and curricula information approved by the relevant academic department.

Business and Information Systems

Administered By: Department of Information Systems, College of Computing Sciences, http://is.njit.edu

Administration

Interim Dean, College of Computing Sciences	James Geller
Associate Dean, College of Computing Sciences	Barry Cohen
Assistant to the Dean, College of Computing Sciences	Serena Branson
Chair, Information Systems Department	Yi-fang Wu
Assistant to the Chair, Information Systems	Michelle D. Craddock-Bouler
Director of Undergraduate HCI Program	Quentin Jones
Director of Undergraduate IS Programs	Lin Lin
Director of Master's Programs	Michael P. Bieber
Director of Emergency Management & Business Continuity	Michael J. Chumer
Director of PhD Program	Michael P. Bieber
Secretary	Patricia B. Lundberg

Faculty

Professors Emeriti	S R. Hiltz, Marilyn Tremaine, Murray Turoff
Professors	Michael P. Bieber, Fadi Deek
Associate Professors	Quentin Jones, Michael L. Recce, Julian M. Scher, Yi-fang Wu
Assistant Professors	Lian Duan, Songhua Xu
Senior University Lecturers	Richard W. Egan, Lin Lin, Keith A. Williams

Advisors

Advisor B.A./ B.S.	Amanda D. Ackerman, George W. Olsen, Casey L. Hennessey
Advisor M.S.	George W. Olsen
Advisor Ph.D.	Michael P. Bieber

The M.S. in Business and Information Systems teaches students concepts in both business and information systems. The focus of the degree is on the application of computing and information systems in business, government, and non-profit organizations. Besides learning about information systems topics such as databases, application development tools, web design, software use and evaluation, management information and decision support systems, students will learn business topics such as accounting, management, marketing, finance, and business operations.

Technology and science are dramatically changing our economy and our society. This is creating new business opportunities and needs, with an increasing push for computing employees to be more involved in designing and evaluating business information systems for both small companies as well as major corporations. Information systems employees must have a solid understanding of business fundamentals to succeed. Specifically designed to address this issue, the M.S. in Business and Information Systems is primarily for students who want to prepare for careers where they will do requirements analysis and application systems design and development, as well as use, analyze and evaluate computing applications and systems in a business environment. The U.S. Bureau of Labor Statistics points to very strong need for managers with technical skills well into the next decade.

Admission Requirements (The program is offered both on-campus and online)

The field of IS is broadly interdisciplinary. Applicants with degrees in any field are therefore welcome to apply for the MSBIS program. A series of "bridge courses" are used to develop the required skills of incoming students who may not have been exposed to some parts of the IS curriculum.

Master of Science in Business and Information Systems (30 Credits)

Bridge Program

	CS 100	Roadmap to Computing (3-0-3) ***or***
	CS 113	Introduction to Computer Science (3-0-3) ***or***
	CS 505	Programming, Data Structures, and Algorithms (3 credits)
	Math 111	Calculus I (4-1-4) ***or***
	Math 138	General Calculus I (3-0-3)
	Math 333	Probability and Statistics (3-0-3) ***or***
	Math 105	Elementary Probability and Statistics (3-0-3)
	IS 331	Database Design Management and Applications (3-0-3) ***or***
	CS 431	Database System Design and Management (3-0-3)

Core (7 courses)

Business Core (2 courses)

Take 2 of the following courses:

*	Acct 615	Management Accounting (3 credits)
*	Fin 600	Corporate Finance I (3 credits)
*	HRM 601	Organizational Behavior (3 credits)
	IS 677	Information System Principles (3 credits)

Information Systems Core (2 courses)

Take 2 of the following courses:

	IS 684	Business Process Innovation (3 credits)
	IS 685	Enterprise Architecture and Integration (3 credits)
	IS 678	IT Service Management (3 credits)

System Analysis Core (3 courses)

	IS 631	Enterprise Database Management (3 credits)
	IS 663	System Analysis and Design (3 credits)
	CS 651	Data Communications (3 credits)

*Students who have taken an undergraduate equivalent of one of these courses may substitute up to one business core course with an additional elective.

Electives: *(Choose 3 courses)*

Students may choose any 3 courses from those listed below. Students may optionally choose 2 or more courses from a single area, which will constitute a specialization.

Electives and Specialization Areas

Masters Project & Thesis (strongly encouraged)

We strongly encourage students to design and conduct a Masters Project Thesis with an Information Systems professor. If you are considering a Project or Thesis, please consult the professor early to determine the best electives to support your work. A Master Project (IS 700) can substitute for one elective and a Master Thesis (IS 701) for two electives, and be considered part of a specialization with the MS Advisor's permission.

Data Management

Recommended Electives

IS 634	Information Retrieval (3 credits)
IS 687	Transaction Mining and Fraud Detection (3 credits)
IS 688	Web Mining (3 credits)
IS 6XX	(Data Analytics for Information Systems*) (3-0-3)

Additional Electives

CS 602	Java Programming (3 credits)
CS 632	Advanced Database System Design (3 credits)
CS 634	Data Mining (3 credits)
CS 731	Applications of Database Systems (3 credits)
Mgmt 635	Data Mining and Analysis (3 credits)
CE 602	Geographic Information System (3 credits)
IS 700	Master's Project (3 credits)
IS 701	Master's Thesis (6 credits)

*Students considering a Master Project of Thesis with this specialization are encouraged to take IS 6XX (Data Analytics for Information Systems) as an elective.

Business Decision Making

Recommended Core Course or Elective

IS 684	Business Process Innovation (3 credits)

Additional Electives

IS 677	Information System Principles (3 credits)
IS 678	IT Service Management (3 credits)
IS 679	Information Systems Strategy (3 credits)
Acct 615	Management Accounting (3 credits)
Fin 600	Corporate Finance I (3 credits)
Fin 630	Applied Business Econometrics (3 credits)
HRM 601	Organizational Behavior (3 credits)
MIS 648	Decision Support Systems for Managers (3 credits)
MIS 680	Management Science (3 credits)
Mgmt 620	Management of Technology (3 credits)
Mgmt 630	Decision Analysis (3 credits)
Mgmt 650	Knowledge Management (3 credits)
Mgmt 685	Operations Research and Decision Making (3 credits)

		Mgmt 710	Forecasting Methods for Business Decisions (3 credits)
		Mrkt 620	Competing in Global Markets (3 credits)
		Mrkt 645	Internet Marketing Strategy (3 credits)

User Experience Design

Recommended Elective

		IS 6XX	(User Experience Design*) (3-0-3)

Additional Electives

		IS 658	Multimedia Systems (3 credits)
		IS 686	Pervasive Computing: An HCI Perspective (3 credits)
		IS 735	Social Media (3 credits)
		IS 6XX	(User Experience Research*) (3-0-3)
		IE 661	Man-Machine Systems (3 credits)
		IE 662	Cognitive Engineering (3 credits)
		IE 664	Advanced Ergonomics (3 credits)
		PTC 605	Elements of Visual Design (3 credits)
		PTC 606	Advanced Information Design (3 credits)
		PTC 629	Theory and Practice of Social Media (3 credits)
		PTC 650	ELearning Design for Mobile (3 credits)
		IS 700	Master's Project (3 credits)
		IS 701	Master's Thesis (6 credits)

*Students considering a Master or Thesis with this specialization are encouraged to take both IS 6XX (User Experience Design) and IS 6XX (User Experience Research) as electives.

Security and Network Management

		IS 680	Information Systems Auditing (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		IS 682	Forensic Auditing for Computing Security (3 credits)
		IS 687	Transaction Mining and Fraud Detection (3 credits)
		CS 608	Cryptography and Security (3-1-3)
		CS 645	Security and Privacy in Computer Systems (3-0-3)
		CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits)
		CS 656	Internet and Higher-Layer Protocols (3 credits)
		CS 696	Network Management and Security (3 credits)
		IT 620	Wireless Networks Security and Administration (3 credits)
		IT 640	Network Services Administration (3 credits)

Systems Analysis and Design

		IS 676	Requirements Engineering (3 credits)
		IS 683	Web Systems Web Development (3 credits)
		IS 684	Business Process Innovation (3 credits)
		IS 685	Enterprise Architecture and Integration (3 credits)
		IS 6XX	(User Experience Design) (3-0-3)
		CS 673	Software Design and Production Methodology (3 credits)

		CS 683	Software Project Management (3-0-3)
		CS 684	Software Testing and Quality Assurance (3-0-3)
		CS 685	Software Architecture (3-0-3)
		EM 636	Project Management (3 credits)
		EM 637	Project Control (3 credits)
		Mgmt 644	Communication in Technology Transfer and Innovation (3 credits)

Emergency Management

		IS 612	Emergency Management Informatics (3 credits)
		IS 613	Design of Emergency Management Information Systems (3 credits)
		IS 614	Command and Control Systems (3 credits)
		IS 616	Learning Methodologies and Training Technologies (3 credits)
		EvSc 603	Hazardous Waste Operations and Emergency Response (3 credits)
		EvSc 616	Toxicology for Engineers and Scientists (3 credits)
		MIP 674	Infrastructure and Architecture (3 credits)

Web Systems

		IS 634	Information Retrieval (3 credits)
		IS 658	Multimedia Systems (3 credits)
		IS 683	Web Systems Web Development (3 credits)
		IS 688	Web Mining (3 credits)
		IS 690	Web Services and Middleware (3 credits)
		PTC 628	Analyzing Social Networks (3 credits)
		PTC 632	Content Management and Information Architecture (3 credits)

Build Your Own Specialization

Students may propose a coherent set of courses that have a common thread related to an area that you are interested in. The MS IS advisor approves the proposed specialization.

Catalog and curricula information approved by the relevant academic department.

Chemical Engineering

Administered By: Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering

Administration

Chairman	Norman Loney
Director of Pharmaceutical Engineering Program	Piero M. Armenante

Faculty

Distinguished Professors	Piero M. Armenante, Kamalesh K. Sirkar, Rajesh N. Dave
Foundation Professor	Kamalesh K. Sirkar(Membrane Separations)
Professors	Basil C. Baltzis, Robert B. Barat, Boris Khusid, Edward L. Dreyzin, Teddy Greenstein, Deran Hanesian, Howard S. Kimmel, Norman Loney, Angelo Perna, Donald H. Sebastian, Reginald P. Tomkins, Marino Xanthos
Associate Professor	Laurent Simon
Assistant Professors	Ecevit A. Bilgili, Xianqin Wang
Distinguished Research Professors	Costas G. Gogos
Research Professors	Hyun J. Jun, Ming-wan Young
Joint Appointments	Joseph W. Bozzelli(Chemistry), Somenath Mitra(Chemistry)

Advisors

Undergraduate Advisor	Lisa M. Kardos
Co-Graduate Advisors	Norman Loney, Reginald P. Tomkins
Freshman Advisor	Lisa M. Kardos

Degrees Offered: Master of Science in Chemical Engineering; Master of Science in Pharmaceutical Engineering and 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 must 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 550 (pencil and paper) and 213 (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 (3 credits)
ChE 612	Kinetics of Reactions and Reactor Design (3 credits)
ChE 624	Transport Phenomena I (3 credits)
ChE 626	Mathematical Methods in Chemical Engineering (3 credits)

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. An oral presentation is also required. The MS thesis committee must be formed and submitted to the department for approval at least one semester before the expected graduation date. The department provides a form for the formation of the MS thesis committee.

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.

For students with a MS in Pharmaceutical Engineering from NJIT they are required to take four course from a list of six NJIT PhEn courses [PhEn 601, 603, 606, 612, 614 or 618) as equivalent ChE elective graduate courses. These students will be required to take an additional 12 credits of ChE core courses and 18 credits of equivalent courses which 12 credits must be at the 700 level.

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 (3 credits)
		ChE 612	Kinetics of Reactions and Reactor Design (3 credits)
		ChE 624	Transport Phenomena I (3 credits)
		ChE 626	Mathematical Methods in Chemical Engineering (3 credits)

6 credits from 600- or 700-level courses in 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 a 6-hour written examination. Students are expected to solve/answer 4 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, and 1 problem in Transport Phenomena. There are two problems in each of the required areas and students have to select one problem from each area. All problems are weighed equally and are graded on the 0-10 scale. A grade of at least 28 out of 40 points (i.e., at least 70%) is required to pass the exam. A grade of 60%, or less is a failing grade. Students receiving grades higher than 60% but less than 70% (i.e.. more than 24 but less than 28 out of 40) may pass, fail, or conditionally pass the exam based on the decision of the department committee on Graduate Studies.

Students are notified about an upcoming exam at least three months in advance and asked to respond in writing if they intend to take the exam.

Information 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.

Chemistry

Administered By: Department Chemistry and Environmental Science

Administration

Chair	Edgardo T. Farinas
Associate Chair	Edgardo T. Farinas
Director of Freshman Chemistry	Frank B. Ellis

Faculty

Distinguished Professors	Joseph W. Bozzelli, Carol A. Venanzi, Somenath Mitra
Professors	Tamara Gund, Lev N. Krasnoperov, Nancy L. Jackson
Associate Professors	Leonard Dauerman, Maurie Cohen, Edgardo T. Farinas, Zeyuan Qiu
Assistant Professors	Liping Wei, Haidong Huang
Research Professors	Zafar Iqbal
University Lecturers	William Skawinski, Michael P. Bonchonsky, Roumiana S. Petrova, Alexander D. Butherus, Bhavani Balasubramanian, Kathleen M. Gilbert
Director of Freshman Chemistry	Frank B. Ellis
Professor Emeritus	Barbara B. Kebbekus, Donald Getzin

Advisors

Chemistry Graduate Advisor	Carol A. Venanzi
Pharma Chem Graduate Advisor	Lev N. Krasnoperov
Undergraduate Advisor	Roumiana S. Petrova

Degrees Offered: Master of Science in Chemistry

Master of Science in Chemistry

An undergraduate degree in chemistry or chemical engineering is usually required. Students with baccalaureate degrees in other areas of science and engineering may be considered for admission and required to take an individually designed program that includes undergraduate courses before beginning the graduate program. These courses are not counted toward degree credit.

A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent, is typically required for admission. General GRE scores must be submitted by those seeking financial support and those whose last prior degree was from outside the United States. Subject GRE is not required. International students must achieve a minimum TOEFL score of 550 (paper and pencil) and 213 (computer based).

Off-Campus Programs: At the National Starch and Chemical Corporation, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see Extension Programs in this catalog. In addition, a distance-based, 12-credit graduate certificate in Applied Chemistry is available as a step toward this degree for employees of the corporation. For further information about extension programs and Graduate Certificates, call the Associate Vice President for Continuing and Distance Education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; e-mail: cpe@njit.edu.

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 (3 credits)
Chem 605	Advanced Organic Chemistry I: Structure (3 credits)

3 credits from:

Chem 661	Instrumental Analysis Laboratory (3 credits)
Chem 664	Advanced Analytical Chemistry (3 credits)

3 credits from:

Chem 610	Advanced Inorganic Chemistry (3 credits)
Chem 673	Biochemistry (3 credits)

3 credits from:

Chem 658	Advanced Physical Chemistry (3 credits)

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.

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 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. 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. The date, time and place of the defense must be posted thoughout campus and e-mailed to the department at least two weeks ahead of time.

Obtaining a Ph.D. is expected to entail more than just fulfilling formal requirements. There are skills which students will develop while completing the formal program. We call these skills "The Informal Requirements".

Master of Science in Pharmaceutical Chemistry (30 credits)

OPTIONS:

1. 30 credits of course work,

2. 27 credits of course work, 3 credits research project,

3. 24 credits of course work, 6 credits of master’s thesis

(Note: All courses are 3-credits each)

REQUIRED CORE COURSES (15 credits):

		Chem 605	Advanced Organic Chemistry I: Structure (3 credits)
		Chem 673	Biochemistry (3 credits)
		Chem 777	Principles of Medicinal Chemistry (3)

		Chem 714	Pharmaceutical Analysis (3 credits)
		PhEn 601	Principles of Pharmaceutical Engineering (3 credits)

ELECTIVE COURSES (15 credits):

		Chem 661	Instrumental Analysis Laboratory (3 credits)
		Chem 664	Advanced Analytical Chemistry (3 credits)
		Chem 737	Applications of Computational Chemistry and Molecular Modeling (3-1-3)
		Chem 610	Advanced Inorganic Chemistry (3 credits)
		Chem 736	Inorganic Biological Chemistry (3-0-3)
		Chem 658	Advanced Physical Chemistry (3 credits)
		Chem 748	Nanomaterials (3)
		EvSc 616	Toxicology for Engineers and Scientists (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		Math 664	Methods for Statistical Consulting (3 credits)
		PhEn 500	Pharmaceutical Engineering Fundamentals I (3 credits)
		PhEn 604	Validation and Regulatory Issues in the Pharmaceutical Industry (3 credits)
		PhEn 618	Principles of Pharmacokinetics and Drug Delivery (3 credits)
{		PHEN635	***or***
		ME 635	Computer-Aided Design (3 credits)
		R120:572	(Concepts in Pharmaceutical Drug Development (Rutgers))
		R120:584	(Enzyme Kinetics & Mechanism (Rutgers))
		R160:515	(Chemical Structure Determination (Rutgers))
		PathN5209	(Business of Science: From Molecules to Medicine (UMD))
		GsndN5310	(Clinical Trials Overview: Methodology & Practices (UMD))
		PhpyN5021	(Principles of Pharmacology (UMD))
		CHEM700B	
		CHEM701C	

Catalog and curricula information approved by the relevant academic department.

Civil Engineering

Administered By: Department of Civil and Environmental Engineering. Colton Hall, Room 200.

Administration

Chairperson	Taha F. Marhaba
Acting Associate Chairperson for Graduate Studies	Methi Wecharatana
Associate Chairperson for Undergraduate Studies	Walter Konon

Faculty

Distinguished Professor	Sunil Saigal
Professors	Lisa B. Axe, Sima Bagheri, Michel Boufadel, I J. Chien, Harold D. Deutschman, Robert Dresnack, Eugene B. Golub, Hsin-neng Hsieh, Ct T. Hsu, Raj P. Khera, Walter Konon, Taha F. Marhaba, Jay N. Meegoda, Priscilla Nelson, Dorairaja Raghu, John R. Schuring, Methi Wecharatana, Lazar Spasovic
Associate Professors	Thomas J. Olenik, Janice R. Daniel, Yuan Ding, Fadi A. Karaa, Rongfang Liu
Assistant Professors	Wen Zhang
Senior University Lecturer	Geraldine Milano, Stephanie R. Santos

Advisors

Freshman Advisor	Priscilla Nelson
Undergraduate Advisor	Walter Konon, Thomas J. Olenik
Graduate Advisor (PhD for Students)	Methi Wecharatana

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.

Other suitable electives may be taken subject to approval of program advisor.

A. CONSTRUCTION ENGINEERING AND MANAGEMENT

Bridge Program

		CE 210	Construction Materials and Procedures (3-0-3)
		CE 501	Introduction to Soil Behavior (3 credits)
		Mech 320	Statics and Strength of Materials (3-0-3)
		CS 101	Computer Programming and Problem Solving (3-0-3)
		Math 225	Survey of Probability and Statistics (1-0-1)
		Math 112	Calculus II (4-1-4)

Core Courses
6 credits as follows:

		CE 610	Construction Management (3 credits)
		CE 611	Project Planning and Control (3 credits)

Thesis

Required of those receiving departmental awards; elective for all others.

Specialty Electives

12-18 credits as follows:

		CE 614	Underground Construction (3 credits)
		CE 615	Infrastructure and Facilities Remediation (3 credits)

		CE 616	Construction Cost Estimating (3 credits)
		CE 617	Historic Preservation (3-0-3)
		CE 644	Geology in Engineering (3 credits)
		CE 700	Civil Engineering Project (3 credits)
		CE 671	Performance and Risk Analysis of Infrastructure Systems (3 credits)
		CE 701	Master's Thesis (6 credits)

General Electives

0 to 6 credits as follows:

See List of Department General Electives.

Management/Leadership Electives

3 to 6 credits as follows:

		CE 711	Methods Improvement in Construction (3 credits)
		EM 632	Legal Aspects in Construction (3 credits)
		HRM 601	Organizational Behavior (3 credits)

B. ENVIRONMENTAL ENGINEERING:

Bridge Program:

Bridge Courses for Water Quality Program

		CE 320	Fluid Mechanics (4-0-4)
		CE 321	Water Resources Engineering (3-0-3)
		Chem 126	General Chemistry II (3-0-3)

Bridge Courses for Integrated Site Remediation

		Chem 126	General Chemistry II (3-0-3)
		CE 321	Water Resources Engineering (3-0-3)
		CE 501	Introduction to Soil Behavior (3 credits)

Core Courses

6 credits as follows:

		EnE 663	Water Chemistry (3 credits)
{		EnE 661	Microbiology for Environmental Engineers (3 credits) ***or***
		EvSc 627	Environmental Microbiology (3 credits)

Thesis

Required of those receiving departmental awards; electives for all others.

Specialty Electives
12 to 18 credits as follows:

Water Quality, Treatment and Infrastructure

		EnE 620	Environmental Chemodynamics (3 credits)

		EnE 664	Physical and Chemical Treatment (3 credits)
		EnE 665	Biological Treatment (3 credits)
		EnE 672	Stormwater Management (3 credits)
		CE 671	Performance and Risk Analysis of Infrastructure Systems (3 credits)

Integrated Site Remediation

		EnE 660	Introduction to Solid and Hazardous Waste Problems (3 credits)
		EnE 662	Site Remediation (3 credits)
		EnE 671	Environmental Impact Analysis (3 credits)
		CE 602	Geographic Information System (3 credits)

Multidisciplinary

This offers the flexibility of a program. The curriculum is customized in consultation with the graduate advisor.

General Electives:

0 to 6 credits as follows:

See List of Department General Electives.

Management/Leadership Electives:

3 to 6 credits as follows:

		CE 610	Construction Management (3 credits)
		CE 711	Methods Improvement in Construction (3 credits)
		EM 631	Legal Aspects in Environmental Engineering (3 credits)
		HRM 601	Organizational Behavior (3 credits)

C. GEOTECHNICAL ENGINEERING:

Bridge Program:

		CE 320	Fluid Mechanics (4-0-4)
		CE 332	Structural Analysis (3-0-3)
		CE 333	Reinforced Concrete Design (3-0-3)
		CE 341	Soil Mechanics (3-0-3)
		CE 341A	Soil Mechanics Laboratory (0-3-1)
		CE 443	Foundation Design (3-0-3)
		CS 101	Computer Programming and Problem Solving (3-0-3)
		Math 222	Differential Equations (4-0-4)

Core Courses:
6 credits as follows:

		CE 641	Engineering Properties of Soils (3 credits)
		CE 642	Foundation Engineering (3 credits)

Thesis:
Required of those receiving departmental awards; elective for all others.

Specialty Electives:
12 to 18 credits as follows:

		CE 545	Rock Mechanics I (3 credits)
		CE 602	Geographic Information System (3 credits)
		CE 643	Advanced Foundation Engineering (3 credits)
		CE 644	Geology in Engineering (3 credits)
		CE 645	Rock Mechanics II (3 credits)
		CE 606	Geospatial Data Applications (3 credits)
		CE 647	Geotechnical Aspects of Solid Waste (3 credits)
		CE 648	Flow Through Soils (3 credits)
		CE 700	Civil Engineering Project (3 credits)
		CE 701	Master's Thesis (6 credits)
		CE 742	Geotechnology of Earthquake Engineering (3 credits)

General Electives:
0 to 6 credits as follows:

See List of Department General Electives.

Management/Leadership Electives
3 to 6 credits as follows:

		CE 610	Construction Management (3 credits)
		CE 711	Methods Improvement in Construction (3 credits)
		EM 632	Legal Aspects in Construction (3 credits)
		HRM 601	Organizational Behavior (3 credits)

Structural Engineering:
Bridge Program:

		CE 333	Reinforced Concrete Design (3-0-3)
		CE 341	Soil Mechanics (3-0-3)
		CE 341A	Soil Mechanics Laboratory (0-3-1)
		CE 432	Steel Design (3-0-3)
		CIS 101	Computer Programming and Problem Solving (2-1-2)
		Math 222	Differential Equations (4-0-4)
		Mech 236	Dynamics (2-0-2)

Core Courses:
6 credits as follows:

		CE 639	Applied Finite Element Methods (3 credits)
		CE 636	Stability of Structures (3 credits)

Thesis:
Required of those receiving departmental awards; elective for all others.

Specialty Electives:
15 to 18 credits as follows:

		CE 531	Design of Masonry and Timber Structures (3 credits)
		CE 631	Advanced Reinforced Concrete Design (3 credits)
		CE 632	Prestressed Concrete Design (3 credits)
		CE 634	Structural Dynamics (3 credits)
		CE 635	Fracture Mechanics of Engineering Materials (3 credits)
		CE 637	Short Span Bridge Design (3 credits)

		CE 638	Nondestructive Testing Methods in Civil Engineering (3 credits)
		CE 700	Civil Engineering Project (3 credits)
		CE 701	Master's Thesis (6 credits)
		CE 702	Special Topics in Civil Engineering (3 credits)
		CE 730	Plastic Analysis and Design (3 credits)
		CE 733	Design of Metal Structures (3 credits)
		CE 734	Design of Tall Buildings and Space Structures (3 credits)
		CE 736	Finite Element Methods in Structural and Continuum Mechanics (3 credits)
		CE 737	Earthquake Engineering (3 credits)
		CE 739	Structural Optimization (3 credits)
		Mech 630	Theory of Elasticity (3 credits)

General Electives
0 to 6 credits as follows:

See List of Department General Electives.

Management/Leadership Electives
3 to 6 credits as follows:

		CE 610	Construction Management (3 credits)
		CE 711	Methods Improvement in Construction (3 credits)
		EM 632	Legal Aspects in Construction (3 credits)
		HRM 601	Organizational Behavior (3 credits)

D. TRANSPORTATION ENGINEERING:

Bridge Program

		CE 350	Transportation Engineering (3-0-3)
		CS 101	Computer Programming and Problem Solving (3-0-3)
		Econ 265	Microeconomics (3-0-3)
		Math 105	Elementary Probability and Statistics (3-0-3)
		Math 309	Mathematical Analysis for Technology (3-0-3)

Core Courses
6 credits as follows:

tran650,tran615

Thesis
Required of those receiving departmental awards; elective for all others.

Specialty Electives
12 to 18 credits as follows:

		CE 659	Flexible and Rigid Pavements (3 credits)
		Tran 552	Geometric Design of Transportation Facilities (3 credits)
		Tran 603	Introduction to Urban Transportation Planning (3 credits)
		Tran 625	Public Transportation Operations and Technology (3 credits)
		Tran 653	Traffic Safety (3 credits)
		Tran 655	Land Use Planning (3 credits)
		Tran 700	Master's Project (3 credits)
		Tran 701	Master's Thesis (6 credits)

		Tran 752	Traffic Control (3 credits)

Civil Engineering

Administered By: Department of Civil and Environmental Engineering

Geotechnical Engineering:
Bridge Program:

		CE 320	Fluid Mechanics (4-0-4)
		CE 332	Structural Analysis (3-0-3)
		CE 333	Reinforced Concrete Design (3-0-3)
		CE 341	Soil Mechanics (3-0-3)
		CE 341A	Soil Mechanics Laboratory (0-3-1)
		CE 443	Foundation Design (3-0-3)
		CS 101	Computer Programming and Problem Solving (3-0-3)
		Math 222	Differential Equations (4-0-4)

Core Courses:
6 credits as follows:

		CE 641	Engineering Properties of Soils (3 credits)
		CE 642	Foundation Engineering (3 credits)

Thesis:
Required of those receiving departmental awards; elective for all others.

Specialty Electives:
12 to 18 credits as follows:

		CE 545	Rock Mechanics I (3 credits)
		CE 602	Geographic Information System (3 credits)
		CE 643	Advanced Foundation Engineering (3 credits)
		CE 644	Geology in Engineering (3 credits)
		CE 645	Rock Mechanics II (3 credits)
		CE 606	Geospatial Data Applications (3 credits)
		CE 647	Geotechnical Aspects of Solid Waste (3 credits)
		CE 648	Flow Through Soils (3 credits)
		CE 700	Civil Engineering Project (3 credits)
		CE 701	Master's Thesis (6 credits)
		CE 742	Geotechnology of Earthquake Engineering (3 credits)

General Electives:
0 to 6 credits as follows:

See List of Department General Electives.

Management/Leadership Electives
3 to 6 credits as follows:

		CE 610	Construction Management (3 credits)
		CE 711	Methods Improvement in Construction (3 credits)
		EM 632	Legal Aspects in Construction (3 credits)

HRM 601	Organizational Behavior (3 credits)

Structural Engineering:
Bridge Program:

CE 333	Reinforced Concrete Design (3-0-3)
CE 341	Soil Mechanics (3-0-3)
CE 341A	Soil Mechanics Laboratory (0-3-1)
CE 432	Steel Design (3-0-3)
CIS 101	Computer Programming and Problem Solving (2-1-2)
Math 222	Differential Equations (4-0-4)
Mech 236	Dynamics (2-0-2)

Core Courses:
6 credits as follows:

CE 639	Applied Finite Element Methods (3 credits)
CE 636	Stability of Structures (3 credits)

Thesis:
Required of those receiving departmental awards; elective for all others.

Specialty Electives:
15 to 18 credits as follows:

CE 531	Design of Masonry and Timber Structures (3 credits)
CE 631	Advanced Reinforced Concrete Design (3 credits)
CE 632	Prestressed Concrete Design (3 credits)
CE 634	Structural Dynamics (3 credits)
CE 635	Fracture Mechanics of Engineering Materials (3 credits)
CE 637	Short Span Bridge Design (3 credits)
CE 638	Nondestructive Testing Methods in Civil Engineering (3 credits)
CE 700	Civil Engineering Project (3 credits)
CE 701	Master's Thesis (6 credits)
CE 702	Special Topics in Civil Engineering (3 credits)
CE 730	Plastic Analysis and Design (3 credits)
CE 733	Design of Metal Structures (3 credits)
CE 734	Design of Tall Buildings and Space Structures (3 credits)
CE 736	Finite Element Methods in Structural and Continuum Mechanics (3 credits)
CE 737	Earthquake Engineering (3 credits)
CE 739	Structural Optimization (3 credits)
Mech 630	Theory of Elasticity (3 credits)

General Electives
0 to 6 credits as follows:

See List of Department General Electives.

Management/Leadership Electives
3 to 6 credits as follows:

CE 610	Construction Management (3 credits)
CE 711	Methods Improvement in Construction (3 credits)
EM 632	Legal Aspects in Construction (3 credits)
HRM 601	Organizational Behavior (3 credits)

Transportation Engineering:

Bridge Program

		CE 350	Transportation Engineering (3-0-3)
		CS 101	Computer Programming and Problem Solving (3-0-3)
		Econ 265	Microeconomics (3-0-3)
		Math 105	Elementary Probability and Statistics (3-0-3)
		Math 309	Mathematical Analysis for Technology (3-0-3)

Core Courses
6 credits as follows:

		Tran 650	Urban Systems Engineering (3 credits)
		Tran 615	Traffic Studies and Capacity (3 credits)

Thesis
Required of those receiving departmental awards; elective for all others.

Specialty Electives
12 to 18 credits as follows:

		CE 659	Flexible and Rigid Pavements (3 credits)
		Tran 552	Geometric Design of Transportation Facilities (3 credits)
		Tran 603	Introduction to Urban Transportation Planning (3 credits)
		Tran 625	Public Transportation Operations and Technology (3 credits)
		Tran 653	Traffic Safety (3 credits)
		Tran 655	Land Use Planning (3 credits)
		Tran 700	Master's Project (3 credits)
		Tran 701	Master's Thesis (6 credits)
		Tran 752	Traffic Control (3 credits)

Civil Engineering

Administered By: Department of Civil and Environmental Engineering

Civil Engineering - Online
Master of Science in Civil Engineering

Intended for engineering students who want broad technical competence in civil engineering.

Admission Requirements

Students are expected to have an undergraduate degree in engineering or its equivalent.

Bridge Program - Students who lack an appropriate background are asked to make up deficiencies by taking a program of course that is designed in consultation with the graduate advisor. These courses are not typically available online and taken in addition to the degree requirements. Please note that the prerequisites for bridge course must also be met.

		CS 101	Computer Programming and Problem Solving (3-0-3)
		Econ 265	Microeconomics (3-0-3)
		Math 112	Calculus II (4-1-4)
		Math 105	Elementary Probability and Statistics (3-0-3)
		Mech 320	Statics and Strength of Materials (3-0-3)

{	CE 200	Surveying (3-0-3) ***and***
	CE 200A	Surveying Laboratory (0-3-1)
	CE 210	Construction Materials and Procedures (3-0-3)
	CE 320	Fluid Mechanics (4-0-4)
	CE 321	Water Resources Engineering (3-0-3)
	CE 341	Soil Mechanics (3-0-3)
	CE 350	Transportation Engineering (3-0-3)

Degree Requirements

A minimum of 30 credits, not including any bridge courses, is required. Candidates must consult with the graduate advisor (not thesis advisor) in designing appropriate programs of study.

Students must attain a minimum GPA of 3.0 in the core courses listed bellow, and a minimum overall GPA of 3.0.

Core Courses
21 credits as follows:

CE 610	Construction Management (3 credits)
CE 611	Project Planning and Control (3 credits)
CE 616	Construction Cost Estimating (3 credits)
CE 620	Open Channel Flow (3 credits)
CE 621	Hydrology (3 credits)
Tran 603	Introduction to Urban Transportation Planning (3 credits)
Tran 752	Traffic Control (3 credits)

Students receiving financial aid at any point in their studies must complete 6 credits of CE 701 Master's Thesis.

Management/Leadership Electives

9 credits as follows:

EM 602	Management Science (3 credits)
HRM 601	Organizational Behavior (3 credits)
EM 631	Legal Aspects in Environmental Engineering (3 credits)

PhD in Civil Engineering

This is a program for superior students with master's degrees in civil engineering or allied fields who wish to do advanced research in an area of civil engineering. In exceptional circumstances, highly qualified students with bachelor's degrees in civil engineering may be accepted directly into the doctoral program.

Admission Requirements:
A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is normally required for admission. The GRE (general section) is required of all applicants. 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.

Catalog and curricula information approved by the relevant academic department.

Computational Biology

Administered By: Department of Mathematical Sciences

Administration

Chair	Jonathan H. Luke
Associate Chair, Administration	John K. Bechtold
Associate Chair, Undergraduate Studies	Zoi-heleni Michalopoulou
Director, Graduate Studies	Michael R. Booty
Director, Statistics Program	Aridaman K. Jain
Departmental Coordinator	Eileen M. Michie

Faculty

Distinguished Professors	Gregory A. Kriegsmann, Robert M. Miura*
Professors	Daljit S. Ahluwalia, Roman I. Andrushkiw, John K. Bechtold, Manish Bhattacharjee, Denis L. Blackmore, Michael R. Booty, Amitabha K. Bose, Wooyoung Choi, Fadi Deek** , Lou Kondic, Jonathan H. Luke, Zoi-heleni Michalopoulou**** , Petronije Milojevic, Farzan Nadim*** , Manuel Perez, Michael S. Siegel
Associate Professors	Bruce G. Bukiet, Hamilton A. Chase, Linda J. Cummings, Sunil K. Dhar, Rose Dios, Jorge P. Golowasch*** , Roy H. Goodman, David J. Horntrop, Shidong Jiang, Jay M. Kappraff, Martin Katzen, Murray I. Lieb, Victor V. Matveev, Richard O. Moore, Cyrill B. Muratov, Horacio G. Rotstein, Peter G. Petropoulos, Roy A. Plastock, Gareth J. Russell*** , Sundarraman Subramanian, Yuan-nan Young
Assistant Professors	Shahriar Afkhami zakerzadeh, Yassine Boubendir, Daniel E. Bunker*** , Peter Gordon, Wenge Guo, Ronald Sverdlove*****
Senior University Lecturers	Aridaman K. Jain, Karen D. Rappaport, Jeyakumaran Ratnaswamy
Lecturers	John Hunter, Rudy Kelly, Diana P. Klimek, Soroosh Mohebbi Forushani, Jonathan J. Porus, Joseph Zaleski
Post Doctoral Fellows	Gabriel D. Chaves, Christopher C. Fazioli, Arnaud B. Goullet, Jacek Wrobel

* Joint appointment with Department of Biomedical Engineering

** Joint appointment with the Department of Information Systems

*** Joint appointment with the Federated Department of Biological Sciences

**** Joint appointment with the Department of Electrical and Computer Engineering

***** Joint appointment with School of Mangement

Degrees Offered: Master of Science in Computational Biology

The Master of Science in Computational Biology seeks to train students at the interface of biology, computational science, and mathematical science. The program will train students to pose biological problems in mathematical terms using techniques of mathematical modeling. It will teach students how to use computational, numerical and analytic tools to aid in the analysis of mathematical models. Furthermore, it will show students how to interpret their mathematical results in biological terms. This program will be of interest to any student who is interested in a truly inter-disciplinary learning experience.

Master of Science in Computational Biology

Master of Science in Computational Biology

This masters program is designed to provide computational biology skills for students with a background in biology, mathematics, computer science, physical science, or engineering.

Admission Requirements:

1. B.S. in a natural science, mathematics, computer science, or an engineering discipline.
2. Math 222 and 337 or their equivalents.
3. One year of physics.
4. One semester of chemistry.
5. Biology – Foundations of Biology: Biol 205 & R120:201 or equivalent.
6. Computer Science - CS 113 or 115, or their equivalents.If the prerequisites are not fulfilled, completion of specific bridge courses will be required as a condition of admission.

Degree Requirements: A minimum of 30 credits is required for the degree, excluding bridge courses. The graduate curriculum consists of seven core courses and additional elective courses, with an optional thesis (six credits) or research project (three credits).

Required Courses (21 Credits):

Biol 630	Critical Thinking for the Life Sciences (3 credits)
Math 611	Numerical Methods for Computation (3 credits)
Math 630	Linear Algebra and Applications (3 credits)
Math 635	Analytical Computational Neuroscience (3 credits)
Math 663	Introduction to Biostatistics (3-0-3) ***or***
Math 615	Approaches to Quantitative Analysis in the Life Sciences (3 credits)
Biol 638	Computational Ecology (3-0-3)
BNFO 601	Foundations of Bioinformatics I (3 credits)

Electives: (Choose 3 courses from below; 9 credits)

Math 637	Foundations of Mathematical Biology (3 credits)
Math 644	Regression Analysis Methods (3 credits)
Math 699	Design and Analysis of Experiments (3 credits)
Chem 658	Advanced Physical Chemistry (3 credits)
R120:512	Mammalian Physiology (3 credits)
R120:530	Biophysical Membrane Physiology (4 credits)
Biol 601	Computational Biology I (3-0-3)
Biol 641	Systems Neuroscience (3 credits)
Math 636	Systems Computational Neuroscience (3 credits)
Biol 612	Comparative Animal Physiology (3 credits)
Math 573	Intermediate Differential Equations (3 credits)
Math 672	Biomathematics I: Biological Waves and Oscillations (3 credits)

***Masters Project/Thesis (Optional):**

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

* Other courses may be taken with advisor's approval

** Masters Project or a Master's Thesis is optional. (Advisor's permission is required).

Computer Engineering

Administered By: Department of Electrical and Computer Engineering

Administration

Chair	Leonid Tsybeskov
Associate Chair (Undergraduate)	Marek Sosnowski
Associate Chair (Graduate)	Durgamadhab Misra

Faculty

Distinguished Professors	Yeheskel Bar-Ness, Atam P. Dhawan, Bernard Friedland, Jacob Savir
Professors	Ali N. Akansu, Nirwan Ansari, John D. Carpinelli, Haim Grebel, Richard A. Haddad, Alexander M. Haimovich, Durgamadhab Misra, Edip Niver, Yun-qing Shi, Kenneth S. Sohn, Marek Sosnowski, Leonid Tsybeskov, Gerald Whitman, Mengchu Zhou, Sotirios G. Ziavras
Associate Professors	Ali Abdi, Hongya Ge, Sui-hoi E. Hou, Walid Hubbi, Roberto Rojas-Cessa, Osvaldo Simeone
Assistant Professors	Abdallah Khreishah
Senior University Lecturers	Stewart Personick
University Lecturers	Mohammed Feknous, Serhiy P. Levkov, Timothy W. Steele

Advisors

Undergraduate Advisor	Shivon S. Boodhoo
Undergraduate Advisor Upper Division and Transfers	Marek Sosnowski
MS Computer Engineering Advisor	Mengchu Zhou
PHD Computer Engineering Advisor	Durgamadhab Misra
MS Electrical Engineering Advisor	Durgamadhab Misra
PHD Electrical Engineering Advisor	Durgamadhab Misra
MS Telecommunications Advisor	Roberto Rojas-Cessa
MS Internet Engineering Advisor	Roberto Rojas-Cessa
MS Power and Enegery Systems Advisor	Mengchu Zhou

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. All applicants must submit GRE scores. International students must achieve a minimum TOEFL score of 550 (pencil and paper) and (213 computer-based).

Admission Requirements:
Applicants are expected to have an undergraduate education in engineering or computer science. Applicants with baccalaureate degrees in areas other than computer engineering may be admitted and required to complete a bridge program. Those with undergraduate degrees in other fields should consult the MSCOE Program Advisor for bridge requirements. Bridge courses do not count toward degree requirements.

Bridge Program: Students with undergraduate degrees in computer science take courses from:

		ECE 353	Computer Organization and Architecture (3-0-3)
		ECE 395	Microprocessor Laboratory (0-4-2)
		ECE 231	Circuits and Systems I (3-1-3)
		ECE 684	Advanced Microprocessor Systems (3 credits)

Students with undergraduate degrees in electrical engineering take courses from:

		CIS 505	Programming, Data Structures, and Algorithms (3 credits)
		ECE 353	Computer Organization and Architecture (3-0-3)
		ECE 395	Microprocessor Laboratory (0-4-2)
		ECE 684	Advanced Microprocessor Systems (3 credits)

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; 21 or more credits must be from ECE courses. They include two required computer engineering core courses, two more required courses for one of the five areas of specialization, and a master's project or thesis. As a requirement for graduation, students must achieve a 3.0 cumulative GPA, not including the master's thesis or project. The master's thesis or project grade must be B or higher.

All M.S. students are required to fulfill? two semesters of ECE 791 (Graduate Seminar).

Core:
Required for all specializations

6 credits:

		CS 610	Data Structures and Algorithms (3 credits)
		ECE 690	Computer Systems Architecture (3 credits)

Project or Thesis (required):

{		ECE 700	Master's Project (3 credits) ***or***
	*	ECE 701	Master's Thesis (3 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 (3 credits)
		ECE 692	Embedded Computing Systems (3)

Microprocessor-Based Systems:
Required:
6 credits:

		ECE 686	Instrumentation Systems and Microprocessors (3 credits)
		ECE 688	Microcontrollers in Instrumentation (3 credits)

Intelligent Systems:
Required:
6 credits:

		ECE 605	Discrete Event Dynamic Systems (3 credits)
		ECE 609	Artificial Neural Networks (3 credits)

VLSI System Design:
Required:
6 credits

		ECE 658	VLSI Design I (3 credits)
		ECE 758	VLSI Design II (3 credits)

Computer Networking:
Required:
6 credits:

		ECE 683	Computer Network Design and Analysis (3 credits)
		ECE 637	Internet and Higher-Layer Protocols (3 credits)

Doctor of Philosophy in Computer Engineering

This program is intended for superior students with a master's degree in computer engineering, computer science, electrical engineering, or other related fields, who wish to pursue advanced research in computer engineering. The program emphasizes the following areas: computer architecture and systems, computer networking, intelligent systems, microprocessor-based systems, and VLSI systems design.

Admission Requirements:
Applicants are expected to have a master's degree in computer engineering, computer science, electrical engineering, or other related fields. Students who lack an appropriate background may be admitted and required to take bridge courses that cannot be applied as degree credits.

Students must demonstrate superior academic background in engineering, mathematics, and physical science; skills in programming; and proficiency in major areas of computer engineering and science. A minimum master's GPA of 3.5 on a 4.0 scale, or equivalent, is required for admission. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (213 computer-based).

Superior undergraduate students may apply to be admitted directly into the Ph.D. program. Such an accelerated program requires a minimum entrance GPA of 3.5 and an interview with the Electrical and Computer Engineering Department Graduate Affairs Committee.

Degree Requirements:
A minimum of 60 degree credits beyond the master'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 for six semesters 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 Electrical and Computer Engineering department website.

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* ECE 701 (6 credits)

Catalog and curricula information approved by the relevant academic department.

Computer Science

Administered By: Department of Computer Science, Guttenberg Information Technologies Center, Room 4400.

Administration

Chairperson	James Geller
Associate Chairperson	Cristian M. Borcea
PhD Director	David Nassimi

Faculty

Distinguished Professor	Joseph Y. Leung
Professors	James M. Calvin, Narain Gehani, James Geller, James McHugh, Ali Mili, Marvin K. Nakayama, Yehoshua Perl, Frank Y. Shih, Boris S. Verkhovsky, Jason T. Wang
Associate Professors	Michael A. Baltrush, Cristian M. Borcea, Barry Cohen, Alexandros Gerbessiotis, Daochuan Hung, Chengjun Liu, Usman W. Roshan, Andrew Sohn, Dimitrios Theodoratos, Guiling Wang
Assistant Professors	Reza Curtmola, Zhi Wei
Senior Lecturers	George Blank, Osama Eljabiri, Jonathan J. Kapleau, Dionissios Karvelas, Morty D. Kwestel, Theodore L. Nicholson, Wallace Rutkowski
University Lecturers	George Blank, Jonathan J. Kapleau, Junilda Spirollari

Advisors

Undergraduate Advisor	Amanda D. Ackerman, Casey L. Hennessey, George W. Olsen
MSCS Advisor	Amanda D. Ackerman, Casey L. Hennessey
First Year PhD Advisor	David Nassimi

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 science department maintains and offers computing facilities for its students, faculty, and staff. The computing facilities include research laboratories housing research in areas of computer science such as: networking, real-time systems, hypermedia, parallel processing, and collaborative systems. Users have access to the state-of-the-art software and hardware including Oracle database, UNIX-based workstations and Microsoft Windows PCs supported by several file and compute servers.

Internet access, departmental intranets, and conferencing systems provide an integrated infrastructure for supporting teaching and research.

Master of Science in Computer Science

The Master of Science (MS) in Computer Science (CS) is intended for students who are interested in pursuing advanced studies in computer science.

Admission Requirements:

- GPA
  - 3.0 out of 4.0 required for students with a computer science background.
  - 3.0 out of 4.0 required for students without a computer science background who may be required to enroll in bridge courses.
- International students TOEFL score: the Institute requires a minimum score of 213 paper based or 79 online.
- International students: GRE required.
- Students with a US or Canadian degree in computer science or engineering: GRE recommended but not required.
- Students with a US or Canadian degree not in computer science or engineering: GRE required.

Students who lack a comprehensive computer science background may be required to take appropriate bridge courses and attain a minimum cumulative GPA of 3.0 in the bridge courses.

Students are expected to have good programming skills, and a grasp of the fundamentals of computer science (students should have acquired this knowledge in the undergraduate degree Bachelor of Science in Computer Science or equivalent degree). To ensure that students have the background to do well and succeed in doing the MS in Computer Science at NJIT, they will be required to take a short answer exam to demonstrate that they have good programming skills (in C++ or Java) and that they know the basic concepts of operating systems, networking, and databases. Students who do not do well in the exam are offered the opportunity to improve their skills via bridge courses.

Note that credits earned in the bridge program cannot count towards the MS program. However, grades of 500-level bridge courses contribute towards the graduate GPA. Students must maintain a cumulative graduate GPA of 3.0 or better.

If a student satisfies a bridge requirement before matriculation, the student can request a bridge course waiver which must be filed no later than the end of the first semester of studies and accompanied by all relevant documentation as required by University regulations. See Academic Policies and Procedures in the NJIT Graduate Catalog at catalog.njit.edu/graduate/frontmatter/AcademicPolicy.php.

PASS/FAIL courses, professional development courses, work experience, or a course with a grade less than B (or equivalent) cannot be used to satisfy a bridge course requirement. Grades in the bridge program (500-level courses or higher) contribute to the cumulative graduate GPA. However, these courses do not count toward the MS program credit requirements. The undergraduate catalog, catalog.njit.edu/courses/cs.php, contains descriptions of undergraduate courses included in the bridge program.

Application Processing:

The Computer Science Department reviews only completed applications submitted to the Office of Graduate Admissions. Applicants are advised to request status information on their application directly from the Graduate Admissions Office, not the Computer Science Department. Graduate Admissions can be reached at admissions@njit.edu or www.njit.edu/gadmission or by mail at NJIT, Graduate Admissions Office, University Heights, Newark NJ 07102.

Degree Requirements:

Students will meet with the graduate advisor to assist them in formulating a program of study and selecting a possible specialization.

The courses required are:

A) Four Core Courses:

- Either CS 610 Data Structures and Algorithms or CS 667 Design Techniques for Algorithms.
- Three of the following four course choices:
  - CS 631 Database Systems Design.
  - CS 630 Internet and Higher Layer Protocols.
  - CS 650 Computer Architecture.
  - CS 656 Operating Systems.

B) Six Elective Courses:

a. 6 courses from the Computer Science graduate catalog. Two of these six must be from an approved list of advanced courses

b. One (1) course either from the Computer Science graduate catalog or from another department's graduate catalog. Courses from outside the Computer Science Department must be relevant to the Computer Science program and require prior approval.

Total number of credits required for graduation is 30.

The 30 credit requirement may be satisfied in one of three ways:

1. 27 credits of course work (9 courses) plus 3 credits of masters project (1 course) (see below),
2. 24 credits of course work (8 courses) plus 6 credits of masters thesis (2 courses) (see below)
3. 30 credits of course work

Specializations:

Students can optionally specialize in a specific area (see below) by taking a minimum of three (3) courses listed in the specialization in accordance with requirements (b) and (c). Note that some specialization courses have prerequisites that must be fulfilled before enrolling in these courses.

Computer Networking and Security

Choose three (3) courses from the following table:

		CS 608	Cryptography and Security (3-1-3)
		CS 633	Distributed Systems (3 credits)
		CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits)
		CS 696	Network Management and Security (3 credits)
		IS 681	Computer Security Auditing (3 credits)

Databases and Data Mining

Choose three (3) courses from the following table:

		CS 632	Advanced Database System Design (3 credits)
		CS 731	Applications of Database Systems (3 credits)
		CS 634	Data Mining (3 credits)
		BNFO 644	Data Mining and Management in Bioinformatics (3 credits)
		CS 744	Data Mining and Management in Bioinformatics (3 credits)
		CS 700B	(Master's Project)

Note: Taking CS 700 level courses require permission of the graduate advisor.

Image Processing and Pattern Recognition

Choose three (3) courses from the following table:

		CS 659	Image Processing and Analysis (3 credits)
		CS 681	Computer Vision (3-0-3)
		CS 759	Advanced Image Processing and Analysis (3 credits)
		CS 780	Computer Vision (3 credits)
		CS 700B	(Master's Project)

Note: Taking CS 700 level courses require permission of the graduate advisor.

Computer Algorithms

Choose three (3) courses from the following table:

		CS 611	Introduction to Computability and Complexity (3 credits)
		CS 667	Design Techniques for Algorithms (3 credits)
		CS 700B	(Master's Project)

Bioinformatics

Choose three (3) courses from the following table:

		BNFO 601	Foundations of Bioinformatics I (3 credits)
		BNFO 602	Foundations of Bioinformatics II (3 credits)
		CS 744	Data Mining and Management in Bioinformatics (3 credits)
		Math 663	Introduction to Biostatistics (3-0-3)
		CS 700B	(Master's Project)

Note: Taking CS 700 level courses require permission of the graduate advisor.

Masters Project

Students must

- Enroll in the Masters Project course CS 700B.

In the semester prior to enrolling in CS 700B, the student must prepare and submit a project proposal to the Department no later than the last weekday class day of the 8th week of the

- Fall semester for a spring project, or
- Spring semester for a summer or fall project.

The student must have an advisor in the Computer Science Department who is a tenure- track faculty member or who holds a joint appointment in the department.

Project Requirements

- Before a student pursues a Master's Project, the following requirements must be fully satisfied:

  - All bridge courses must be completed - In the semester prior to the project, a student prepares and submits a project proposal to the Department no later than the last weekday class day of the 8th week of the Fall semester for a spring project and no later than the last weekday class day of the 8th week of the Spring semester for a summer or fall project. The preparatory work for the proposal may be accomplished within the framework of a required course or an independent study course offered by the prospective advisor. Therefore, such a course must be taken in the semester prior to the project.

- A CS Department tenure-track faculty member or a faculty member who
  holds a joint appointment in the computer science department can advise an MS project.

- Proposal preparation must adhere to the existing departmental guidelines; the information and templates are available online.

Thesis Option (30 credits)

Students must

- select a specialization, and
- enroll in the Thesis CS 701 course for two (2) semesters (Thesis must match specialization).

A student can enroll in CS 701 during the second semester of full time study.Normally the student enrolls for two semesters of CS 701 to prepare the thesis proposal, perform the research, and prepare the thesis. The thesis must be orally defended and follow the style set forth by the Graduate School at NJIT. The thesis committee is composed of a Computer Science tenure-track committee chair and two other tenure-track members of the Computer Science Department or Faculty holding a joint appointment to the department.**Thesis Requirements**

- Before a student pursues a Master's Thesis, the following requirements must be fully satisfied:
  - All bridge courses must be completed.
  - In the semester prior to the thesis, a student prepares and submits a thesis proposal to the department no later than week 8 of the Fall semester for a spring thesis and week 8 of the Spring semester for a summer of fall thesis. The preparatory work for the proposal may be accomplished within the framework of a required course or an independent study course offered by the prospective advisor. Therefore, such a course must be taken in the semester prior to the thesis.
- A CS department tenure-track faculty member or a faculty member who holds a joint appointment in the Computer Science Department can advise an MS thesis.
- A thesis must adhere to the style requirements set forth by the Graduate School: www.njit.edu/v2/Directory/Admin/Graduate_Studies/thesis.php.
- An oral defense is required. The defense must take place between one week prior to the Reading Day of the semester and the last day of the Examination period. A committee of at least three tenure-track faculty members from the CS Department, including the thesis advisor, collectively determines the grade for CS 701 at the conclusion of the oral defense.

Other Policies

- **Transfer:** Transfer of computer science courses from other US/Canada institutions is allowed as per university regulations provided that these courses are related to the program. Graduate Advisor and Graduate Studies Office approvals are required.
- **MS/MS Program:** Under the University MS/MS program, up to six credits of courses taken in other departments can be used for graduate credits toward the degree as long as these courses are related to computer science. Graduate advisor and Graduate Studies Office approvals are required.
- **Co-op Program:** Before a student applies for CS 590/591/592 registration, the successful completion of the bridge program, all ESL requirements, and at least four graduate courses is required.
- The same course cannot satisfy two or more requirements.

CS Advanced Courses

CS 611	Introduction to Computability and Complexity (3 credits)
CS 632	Advanced Database System Design (3 credits)
CS 659	Image Processing and Analysis (3 credits)
CS 661	Systems Simulation (3 credits)
CS 665	Algorithmic Graph Theory (3 credits)
CS 667	Design Techniques for Algorithms (3 credits)
CS 668	Parallel Algorithms (3 credits)
CS 670	Artificial Intelligence (3 credits)
CS 673	Software Design and Production Methodology (3 credits)
CS 680	Linux Kernel Programming (3)
CS 681	Computer Vision (3-0-3)

		CS 696	Network Management and Security (3 credits)
		CS 704	Sequencing and Scheduling (3-0-3)
		CS 730	Seminar in Database Management Topics (3 credits)
		CS 731	Applications of Database Systems (3 credits)
		CS 734	Data Mining (3 credits)
		CS 744	Data Mining and Management in Bioinformatics (3 credits)
		CS 750	High Performance Computing (3 credits)
		CS 752	Communication Protocol Synthesis and Analysis (3 credits)
		CS 759	Advanced Image Processing and Analysis (3 credits)
		CS 775	Seminar in Software Engineering (3 credits)
		CS 780	Computer Vision (3 credits)
		CS 782	Pattern Recognition and Applications (3 credits)
		CS 700B	(Master's Project)

Bridge Courses

Students who intend to pursue an MS degree in Computer Science are expected to have a certain background in Computer Science and Mathematics. A student who does not have this background may need to enroll bridge courses before taking graduate level Computer Science courses. This will help ensure success in the MS program. These students will be notified in their acceptance letter that bridge courses are a condition of their acceptance into the Master's Program. If a student's acceptance letter indicates bridge courses are required, they must contact the Graduate Advisor. If the acceptance letter does not indicate bridge courses, none are required and the student may immediately begin taking graduate courses. A student must maintain a cumulative GPA of 3.0 in bridge courses. Bridge courses do not count towards MS degree requirements; however, they count toward the cumulative graduate GPA

		CS 252	Computer Organization and Architecture (3-0-3)
		CS 332	Principles of Operating Systems (3-0-3)
		CS 505	Programming, Data Structures, and Algorithms (3 credits)
		CS 506	Foundations of Computer Science (3 credits)
		Math 111	Calculus I (4-1-4)
		Math 112	Calculus II (4-1-4)
		Math 211	Calculus III A (3-0-3)
		Math 333	Probability and Statistics (3-0-3)

Note: CS 505 requires prior knowledge of higher level programming language. For students with no prior programming experiences, CS 113 and CS 114 are recommended for replacement.

PhD 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.

		CS 251	Computer Organization (3-0-3)
		CS 332	Principles of Operating Systems (3-0-3)
		CS 333	Introduction to UNIX Operating Systems (3-0-3)
		CS 505	Programming, Data Structures, and Algorithms (3 credits)
		CS 510	Assembly Language Programming and Principles (3 credits)
		Math 111	Calculus I (4-1-4)

Math 112	Calculus II (4-1-4)
Math 211	Calculus III A (3-0-3)
Math 226	Discrete Analysis (4-0-4)
Math 333	Probability and Statistics (3-0-3)

Core Requirements:
All PhD students are required to take qualifying examinations in the following areas:

CS 610	Data Structures and Algorithms (3 credits)
CS 611	Introduction to Computability and Complexity (3 credits)
CS 665	Algorithmic Graph Theory (3 credits)

Concentration Areas:

A PhD. student within the program is required to pick an area of concentration. While the areas of concentrations change according to faculty research interests, here are examples of possible concentrations with possible courses taken within those concentrations..

CS 631	Data Management System Design (3 credits)
CS 632	Advanced Database System Design (3 credits)
IS 634	Information Retrieval (3 credits)
CS 665	Algorithmic Graph Theory (3 credits)
CS 667	Design Techniques for Algorithms (3 credits)
CS 670	Artificial Intelligence (3 credits)
CS 734	Data Mining (3 credits)
BIOL601	

Computer Algorithms and Theory of Computing:

CS 610	Data Structures and Algorithms (3 credits)
CS 611	Introduction to Computability and Complexity (3 credits)
CS 665	Algorithmic Graph Theory (3 credits)
CS 667	Design Techniques for Algorithms (3 credits)
CS 668	Parallel Algorithms (3 credits)
CS 669	Computational Geometry (3 credits)
IE 704	Sequencing and Scheduling (3 credits)

Computer Systems, and Parallel and Distributed Processing:

CS 630	Operating System Design (3 credits)
CS 633	Distributed Systems (3 credits)
CS 636	Compiling System Design (3 credits)
CS 637	Real-Time Systems (3 credits)
CS 650	Computer Architecture (3 credits)
CS 668	Parallel Algorithms (3 credits)
CS 750	High Performance Computing (3 credits)
ECE 658	VLSI Design I (3 credits)
ECE 758	VLSI Design II (3 credits)
ECE 689	Digital System Design for Machine Arithmetic (3 credits)
ECE 785	Parallel Processing Systems (3 credits)

Databases, Data Mining, and Knowledge-Based Engineering:

CS 630	Operating System Design (3 credits)
CS 631	Data Management System Design (3 credits)
CS 632	Advanced Database System Design (3 credits)
IS 634	Information Retrieval (3 credits)
IS 658	Multimedia Systems (3 credits)

CS 665	Algorithmic Graph Theory (3 credits)
CS 667	Design Techniques for Algorithms (3 credits)
CS 670	Artificial Intelligence (3 credits)
CS 671	Knowledge-Based Systems (3 credits)
CS 731	Applications of Database Systems (3 credits)
CS 734	Data Mining (3 credits)

Image Processing and Computer Graphics:

CS 630	Operating System Design (3 credits)
CS 632	Advanced Database System Design (3 credits)
CS 657	Principles of Interactive Computer Graphics (3 credits)
CS 659	Image Processing and Analysis (3 credits)
CS 665	Algorithmic Graph Theory (3 credits)
CS 667	Design Techniques for Algorithms (3 credits)
CS 682	Geometric Modeling (3 credits)
CS 759	Advanced Image Processing and Analysis (3 credits)
CS 780	Computer Vision (3 credits)
CS 782	Pattern Recognition and Applications (3 credits)
ECE 601	Linear Systems (3 credits)
ECE 643	Digital Image Processing I (3 credits)
ME 635	Computer-Aided Design (3 credits)

Other 600/700-level courses as approved by advisor.

Networking and Security:

CS 604	Client/Server Computing (3 credits)
CS 630	Operating System Design (3 credits)
CS 651	Data Communications (3 credits)
CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits)
CS 654	Telecommunication Networks Performance Analysis (3 credits)
CS 656	Internet and Higher Layer Protocols (3 credits)
CS 696	Network Management and Security (3 credits)
CS 697	Principles of Broadband ISDN and ATM (3 credits)
CS 741	Communication Network Design (3 credits)
CS 752	Communication Protocol Synthesis and Analysis (3 credits)

Software Engineering:

CS 601	Object-Oriented Programming (3 credits)
CS 610	Data Structures and Algorithms (3 credits)
CS 611	Introduction to Computability and Complexity (3 credits)
CS 630	Operating System Design (3 credits)
CS 635	Computer Programming Languages (3 credits)
CS 636	Compiling System Design (3 credits)
CS 641	Formal Languages and Automata (3 credits)
CS 667	Design Techniques for Algorithms (3 credits)
CS 673	Software Design and Production Methodology (3 credits)
IS 676	Requirements Engineering (3 credits)
IS 683	Object-Oriented Software Development (3 credits)
CS 688	Programming for Interactive Environments (3 credits)

Systems Analysis, Simulation and Modeling:

CS 605	Discrete Event Dynamic Systems (3 credits)
CS 621	Numerical Analysis I (3 credits)

		CS 622	Numerical Analysis II (3 credits)
		CS 630	Operating System Design (3 credits)
		CS 631	Data Management System Design (3 credits)
		CS 637	Real-Time Systems (3 credits)
		CS 651	Data Communications (3 credits)
		CS 654	Telecommunication Networks Performance Analysis (3 credits)
		CS 661	Systems Simulation (3 credits)
		CS 662	Model Analysis and Simulation (3 credits)
		CS 741	Communication Network Design (3 credits)

Computing and Business

Administered By: College of Computing Sciences

Administration

Chairperson	Michael A. Baltrush
Associate Chairperson	James M. Calvin
PhD Director	David Nassimi

Faculty

Distinguished Professor	Joseph Y. Leung
Professors	Narain Gehani, James Geller, James McHugh, Ali Mili, Yehoshua Perl, Frank Y. Shih, Boris S. Verkhovsky, Jason T. Wang
Associate Professors	Michael A. Baltrush, James M. Calvin, Alexandros Gerbessiotis, Daochuan Hung, Marvin K. Nakayama, Chengjun Liu, John W. Ryon, Andrew Sohn, Dimitrios Theodoratos
Assistant Professors	Cristian M. Borcea, Barry Cohen, Usman W. Roshan, Guiling Wang
Special Lecturers	George Blank, Osama Eljabiri, Jonathan J. Kapleau, Dionissios Karvelas, Morty D. Kwestel, Theodore L. Nicholson, Wallace Rutkowski

Advisors

Undergraduate Advisor	Amanda D. Ackerman, Casey L. Hennessey, George W. Olsen
MSCS Advisor	Amanda D. Ackerman, Casey L. Hennessey
1st Year PhD Advisor	David Nassimi

Technology and Science are dramatically changing our economy and our society. This is creating new business opportunities and needs, with an increasing push for computing employees to be more involved in business aspects of a company. Computing employees must have a solid understanding of business fundamentals to succeed. Specifically designed to address theses issues, the Master of Science (MS) in Computing and Business degree is primarily for people who want to develop, use, and manage software applications and systems in a business environment.

Offered by the College of Computing Sciences, the MS in Computing and Business contains a mix of courses in computer science and business. With one of the most computing intensive campuses in the world, NJIT has pioneered in the applications of new technologies as learning tools. The College of Computing Sciences educates one of the largest groups of information technology students in the nation.

M. S. in Computing and Business (33 credits)

Core: 24 credits

Business Core:

		Acct 615	Management Accounting (3 credits)
		Fin 600	Corporate Finance I (3 credits)
		HRM 601	Organizational Behavior (3 credits)
		Mrkt 620	Competing in Global Markets (3 credits)

Computer Science Core

		CS 610	Data Structures and Algorithms (3 credits)
		CS 631	Data Management System Design (3 credits)
		CS 634	Data Mining (3 credits)
		CS 696	Network Management and Security (3 credits)

Electives: Choose 9 credits (ONLY one from SOM)

		CS 632	Advanced Database System Design (3 credits)
		CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits)
		CS 656	Internet and Higher-Layer Protocols (3 credits)
		CS 661	Systems Simulation (3 credits)
		ECE 644	Wireless Communication (3 credits)
		Fin 624	Corporate Finance II (3 credits)
		Fin 626	Financial Investment Institutions (3 credits)
		Fin 634	Mergers, Acquisitions, and Restructuring (3 credits)
		Fin 641	Derivatives Markets (3 credits)
		Fin 650	Investment Analysis and Portfolio Theory (3 credits)
		IS 634	Information Retrieval (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		Mgmt 630	Decision Analysis (3 credits)
		Mgmt 635	Data Mining and Analysis (3 credits)
		Mgmt 650	Knowledge Management (3 credits)
		MIS 625	Management Strategies for E-Commerce (3 credits)

Computing & Business Bridge Courses

		CS 252	Computer Organization and Architecture (3-0-3)
		CS 332	Principles of Operating Systems (3-0-3)
		CS 505	Programming, Data Structures, and Algorithms (3 credits)
		CS 506	Foundations of Computer Science (3 credits)
		Math 111	Calculus I (4-1-4)
		Math 112	Calculus II (4-1-4)
		Math 211	Calculus III A (3-0-3)
		Math 333	Probability and Statistics (3-0-3)

Catalog and curricula information approved by the relevant academic department.

Critical Infrastructure Systems

Administered By: Department of Civil and Environmental Engineering

Administration

Chair	Taha F. Marhaba
Associate Chair	Janice R. Daniel
Associate Chair	Walter Konon

Faculty

Professors	Priscilla Nelson
Associate Professors	Fadi A. Karaa

Advisor

Graduate Advisor	Hsin-neng Hsieh

Admission Requirements

Students are expected to have an undergraduate degree in engineering or its equivalent.

Bridge program-Students who lack an appropriate background are asked to make up deficiencies by taking a program of courses that is designed in consultation with the graduate advisor. These courses are taken in addition to the degree requirements, and typically center around upgrading their background in statistics and mathematics. If this background is not sufficient, the minimal bridge course consists of EM 503-Methods and Applications of Industrial Statistics and Probability.

Degree Requirements

A minimum of 30 degree credits, not including any bridge courses, is required. Candidates must consult with the graduate advisor (not thesis advisor) in designing appropriate programs of study.

Students must attain a minimum GPA of 3.0 in the core courses listed below, and a minimum overall GPA of 3.0.

Master of Science in Critical Infrastructure Systems

Core Courses

6 credits as follows:

CE 671	Performance and Risk Analysis of Infrastructure Systems (3 credits)
CE 672	Security Management of Critical Infrastructure (3 credits)
EM 602	Management Science (3 credits)
Arch 675	Elements of Infrastructure Planning (3 credits)

Students receiving financial aid at any point in their studies must complete 6 credits of CE 701 Master's Thesis.

Electives

12 to 18 credits as follows:

Critical Infrastructure Life-Cycle Management (CILC)

Planning and Facilities Management

		CE 602	Geographic Information System (3 credits)
		CE 615	Infrastructure and Facilities Remediation (3 credits)

Engineered Systems

		Tran 705	Mass Transportation Systems (3 credits)
		CE 650	Urban Systems Engineering (3 credits)
		ECE 610	Power System Steady-State Analysis (3 credits)
		ECE 637	Internet and Higher-Layer Protocols (3 credits)
		ECE 683	Computer Network Design and Analysis (3 credits)
		ECE 673	Random Signal Analysis I (3 credits)
		ECE 642	Communication Systems I (3 credits)

Program/Impact Management

		CE 610	Construction Management (3 credits)
		CE 611	Project Planning and Control (3 credits)
		CE 616	Construction Cost Estimating (3 credits)
		IE 651	Industrial Simulation (3 credits)
		IE 605	Engineering Reliability (3 credits)
		IE 614	Safety Engineering Methods (3 credits)
		EnE 610	Hazardous Site Operations (3 credits)
		EnE 662	Site Remediation (3 credits)
		EnE 663	Water Chemistry (3 credits)
		EnE 671	Environmental Impact Analysis (3 credits)
		HRM 601	Organizational Behavior (3 credits)

Critical Infrastructure Security and Emergency Management (CISE)

Emergency and Preparedness Management (Joint UMDNJ)

		Mgmt 612	Principles of Emergency Management (3 credits)
		IS 613	Design of Emergency Management Information Systems (3 credits)
		IS 614	Command and Control Systems (3 credits)

Enabling Systems and Technologies

		MIS 648	Decision Support Systems for Managers (3 credits)
		Tran 615	Traffic Studies and Capacity (3 credits)
		Tran 752	Traffic Control (3 credits)
		Tran 755	Intelligent Transportation Systems (3 credits)
		EM 771	Operations Cost and Management Control (3 credits)
		Mgmt 635	Data Mining and Analysis (3 credits)
		Mgmt 650	Knowledge Management (3 credits)
		CS 631	Data Management System Design (3 credits)
		CS 632	Advanced Database System Design (3 credits)
		CS 782	Pattern Recognition and Applications (3 credits)
		IE 706	A Queueing Approach to Performance Analysis (3 credits)
		IE 621	Systems Analysis and Simulation (3 credits)

Public Health Systems and Emergency Preparedness

		PHCO 0502	(Principles and Methods of Epidemiology)
		PHCO 0503	(Introduction to Environmental Health)
		ENOH 0697	(Public Health Preparedness I:Agents of Mass Injury or Destruction)
		ENOH 0695	(Public Health Preparedness II:Emergency Management and Response)
		HEBS 0679	(Health/Risk Communications)

Other suitable electives may be taken subject to approval of program advisor, particularly in the area of Public Health Systems and Emergency Preparedness.

FACULTY PROFILES

Fadi A. Karaa
Ph.D., Massachusetts Institute of Technology

Professor Karaa�s research and consulting activities are focused on construction project management and control, and infrastructure asset management systems. He has developed copyrighted decision support systems for capital improvement planning and maintenance management of water and wastewater infrastructure used by the Army Corps of Engineers and water agencies and municipalities. He has performed lifecycle cost analysis and project control implementations for large Boston-area infrastructure projects. Dr. Karaa was the Director of the Construction Management Graduate Program at Northeastern University. He has also taught courses at MIT and Tufts University in design and construction project Management. At Oracle, he led a National Data Warehousing practice for the Industrial Sector. His current interests are in the design and development of sustainable resilient large-scale infrastructure systems integrating lifecycle and security management systems. Such systems include oil and gas energy supply chain infrastructure, urban underground infrastructure and dam breakage detection and response models for early warning and evacuation planning.

PRISCILLA P. NELSON
Ph.D., Cornell University
Professor Nelson works in diverse areas of civil engineering, including geotechnical and geological engineering, rock mechanics, underground construction, and design of underground facilities.? She has also been involved in engineering for extreme events and natural disaster mitigation. ?Her recent activities also extend into risk-based performance assessment and critical infrastructure systems.?

Cyber Security and Privacy

Administered By: Department of Computer Science, Guttenberg Information Technologies Center, Room 4400. For more details see the CS Web page at http://cs.njit.edu

Administration

Chairperson	James Geller
Associate Chairperson	Cristian M. Borcea
PhD Director	David Nassimi

Faculty

Distinguished Professor	Joseph Y. Leung
Professors	James M. Calvin, Narain Gehani, James Geller, James McHugh, Ali Mili, Marvin K. Nakayama, Yehoshua Perl, Frank Y. Shih, Boris S. Verkhovsky, Jason T. Wang
calvin,gehani,geller,mchugh,mili,marvin,perl,shih,verb,wangj	Michael A. Baltrush, Cristian M. Borcea, Barry Cohen, Alexandros Gerbessiotis, Daochuan Hung, Chengjun Liu, Usman W. Roshan, Andrew Sohn, Dimitrios Theodoratos, Guiling Wang
Assistant Professors	Reza Curtmola, Zhi Wei
Senior Lecturers	George Blank, Osama Eljabiri, Jonathan J. Kapleau, Dionissios Karvelas, Morty D. Kwestel, Theodore L. Nicholson, Wallace Rutkowski
University Lecturers	George Blank, Jonathan J. Kapleau, Junilda Spirollari

Advisors

Advisors	Amanda D. Ackerman, Casey L. Hennessey
First Year PhD Advisor	David Nassimi

Degrees Offered: Master of Science in Cyber Security and Privacy

Admission requirements: To be eligible for admission, a student must have completed an undergraduate degree, preferably in Computer Science, Computer Engineering, Information Systems, Information Technology, or a related field, with a minimum GPA of 3.0 on a 4.0 scale. Students not satisfying these criteria will be considered for conditional admission on a case-by-case basis. This includes students whose bachelor's degree is in a non-computing field but have professional experience in computing or systems administration. Any such student who is admitted will be required to complete the following bridge courses with a GPA of 3.0 or higher: CS 505 Programming, Data Structures and Algorithms, CS 506 Foundations of Computer Science. The bridge courses will not be counted toward the MS degree.

Application Processing: The Computer Science Department reviews only completed applications submitted to the Office of Graduate Admissions. Applicants are advised to request status information on their application directly from the Graduate Admissions Office, not the Computer Science Department. Graduate Admissions can be reached at admissions@njit.edu or www.njit.edu/gadmission or by mail at NJIT, Graduate Admissions Office, University Heights, Newark NJ 07102.

Master of Science in Cyber Security and Privacy

Degree Requirements

An MSCSP course program must satisfy the following distribution requirement:- 30 credits are required, which can be satisfied as either one of the following options:

- Courses (30 credits)
- Courses (27 credits) + MS Project (3 credits)
- Courses (24 credits) + MS Thesis (6 credits)

- All Core courses are required.- At most two courses can be Foundational courses.- At most two courses can be chosen from outside the Department of Computer Science.If a student chooses the MS project or MS thesis option, the project or thesis must be related to cyber security.

Core Courses

CS 608	Cryptography and Security (3-1-3)
CS 656	Internet and Higher-Layer Protocols (3 credits) ***or***
ECE 637	Internet and Higher-Layer Protocols (3 credits)
CS 698	(Security and Privacy in computer systems) (3-0-3)
CS 698	(Network Protocols Security) (3-0-3)
CS 698	(Counter-Hacking Techniques) (3-0-3)
CS 696	Network Management and Security (3 credits) ***or***
ECE 638	Network Management and Security (3 credits)

Elective Courses

CS 633	Distributed Systems (3 credits)
CS 660	Digital Watermarking (3)
CS 673	Software Design and Production Methodology (3 credits)
CS 680	Linux Kernel Programming (3)
CS 708	Advanced Data Security and Privacy (3 credits)
CS 734	Data Mining (3 credits)
CS 755	Security and Privacy in Wireless Networks (3 credits) ***or***
ECE 782	Advanced Data Security and Privacy (3 credits)
IS 680	Information Systems Auditing (3 credits)
IS 681	Computer Security Auditing (3 credits)
IS 682	Forensic Auditing for Computing Security (3 credits)
IS 687	Transaction Mining and Fraud Detection (3 credits)
IT 620	Wireless Networks Security and Administration (3 credits)
IT 640	Network Services Administration (3 credits)
ECE 636	Computer Networking Laboratory (3 credits)
Mgmt 688	Information Technology, Business and the Law (3 credits)
Mgmt 691	Legal and Ethical Issues (3 credits)

Foundational Courses

CS 610	Data Structures and Algorithms (3 credits)
CS 630	Operating System Design (3 credits)

		CS 631	Data Management System Design (3 credits)

Electrical Engineering

Administered By: Department of Electrical and Computer Engineering

Administration

Chair	Leonid Tsybeskov
Associate Chair (Undergraduate)	Marek Sosnowski
Associate Chair (Graduate)	Durgamadhab Misra

Faculty

Distinguished Professors	Yeheskel Bar-Ness, Atam P. Dhawan, Bernard Friedland, Jacob Savir
Professors	Ali N. Akansu, Nirwan Ansari, John D. Carpinelli, Haim Grebel, Richard A. Haddad, Alexander M. Haimovich, Durgamadhab Misra, Edip Niver, Yun-qing Shi, Kenneth S. Sohn, Marek Sosnowski, Leonid Tsybeskov, Gerald Whitman, Mengchu Zhou, Sotirios G. Ziavras
Associate Professors	Ali Abdi, Hongya Ge, Sui-hoi E. Hou, Walid Hubbi, Roberto Rojas-Cessa, Osvaldo Simeone
Assistant Professors	Abdallah Khreishah
University Lecturers	Mohammed Feknous, Serhiy P. Levkov, Timothy W. Steele

Advisors

Undergraduate Advisor	Shivon S. Boodhoo
Undergraduate Advisor Upper Division and Transfers	Marek Sosnowski
MS Electrical Engineering Advisor	Durgamadhab Misra
PHD Electrical Engineering Advisor	Durgamadhab Misra
MS Computer Engineering Advisor	Mengchu Zhou
PHD Computer Engineering Advisor	Durgamadhab Misra
MS Telecommunications Advisor	Roberto Rojas-Cessa
MS Internet Engineering Advisor	Roberto Rojas-Cessa
MS Power and Energy Systems Advisor	Mengchu Zhou

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 programs offer students with backgrounds in electrical engineering or related areas unusual opportunities to specialize in advanced phases of electrical engineering. In addition to more than 30 full-time faculty members devoted to teaching and research, students are taught by adjunct professors from industry who offer specialty courses in their area of expertise and serve on thesis and dissertation committees.

The master's degree programs provide state-of-the-art training at advanced levels in areas of technical specialization, including faculty-supervised research. Students in the doctoral program conduct significant original research in areas of interest to department members. Students also have opportunities to conduct thesis research at industrial sites, hospitals, biomedical engineering facilities, and university centers and departments.

Master of Science in Electrical Engineering

A program for students with an undergraduate degree in engineering who wish either to specialize in an advanced phase of electrical engineering or prepare for a more advanced degree.

Admission Requirements:
Applicants are expected to have undergraduate backgrounds in physics, mathematics (through differential equations and vector analysis), electrical networks and devices, electronics, analysis and design methods, transients, electromagnetic fields, and appropriate laboratory work in some of these areas. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (213 computer-based). For further information, see the Admissions section in this catalog.

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 (3-0-3)
		ECE 232	Circuits and Systems II (3-1-3)
		ECE 333	Signals and Systems (3-0-3)
		ECE 361	Electromagnetic Fields I (3-0-3)
		ECE 362	Electromagnetic Fields II (3-0-3)
		ECE 372	Electronic Circuits II (3-0-3)
		ECE 373	Electronic Circuits III (3-0-3)

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 the MSEE Program Advisor. The master's program consists of 30 credits. Students who enter the program but who do not receive departmental or research-based awards have three program options: 24 course credits and 6 credits of master's thesis; or 27 course credits and 3 credits of master's project; or 30 course credits not to include either a master's project or thesis. Students should consult with the Program Advisor or designee before registering for courses to make sure they are meeting department requirements. As a requirement for graduation, students must achieve a 3.0 cumulative GPA in graduate-level courses, not including the master's thesis or project. The project grade must be B or better.

ECE courses at the 500 level are not acceptable for credit toward a graduate degree in electrical engineering. Only one 500 level course outside the department may be applied for credit toward a graduate degree in electrical engineering.

All students are required to fulfill two semesters of 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 (3 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 MSEE Program Advisor or designee. Two non-ECE graduate courses may be chosen. Students should contact the MSEE Program Advisor for guidance.

Electrical Engineering Core:
Applies to all areas of specialization in Electrical Engineering

6 credits:

ECE 601	Linear Systems (3 credits)
ECE 673	Random Signal Analysis I (3 credits) ***or***
ECE 620	Electromagnetic Field Theory (3 credits)

Focus Area: Communications, Signal Processing and Microwave:

Area requirements (Choose at least two)

ECE 640	Digital Signal Processing (3 credits)
ECE 642	Communication Systems I (3 credits)
ECE 742	Communication Systems II (3 credits)
ECE 740	Advanced Digital Signal Processing (3 credits)
ECE 630	Microwave Engineering (3 credits)
ECE 632	Antenna Theory (3 credits)

Suggested Electrical Engineering Electives:

ECE 609	Artificial Neural Networks (3 credits)
ECE 622	Wave Propagation (3 credits)
ECE 623	Fourier Optics (3 credits)
ECE 625	Fiber and Integrated Optics (3 credits)
ECE 626	Optoelectronics (3 credits)
ECE 642	Communication Systems I (3 credits)
ECE 644	Wireless Communication (3 credits)
ECE 684	Advanced Microprocessor Systems (3 credits)
ECE 746	Adaptive Array Processing and Interference Cancellation (3 credits)
ECE 747	Signal Decomposition Techniques: Transforms, Sub-bands, and Wavelets (3 credits)
ECE 755	Advanced Topics in Digital Communications (3 credits)
ECE 757	Advanced Wireless Communications (3 credits)
ECE 776	Information Theory (3 credits)
ECE 777	Statistical Decision Theory in Communications (3 credits)
ECE 778	Algebraic Coding for Information Transmission (3 credits)

Focus Area : Computer Netwoking:

Area requirements

ECE 683	Computer Network Design and Analysis (3 credits)
ECE 783	Computer Communication Networks (3 credits)

Suggested Electrical Engineering Electives:

ECE 605	Discrete Event Dynamic Systems (3 credits)
ECE 637	Internet and Higher-Layer Protocols (3 credits)
ECE 638	Network Management and Security (3 credits)
ECE 639	Principles of Broadband Networks (3 credits)
ECE 642	Communication Systems I (3 credits)
ECE 644	Wireless Communication (3 credits)
ECE 645	Wireless Networks (3 credits)
ECE 658	VLSI Design I (3 credits)
ECE 677	Optimization Techniques (3 credits)
ECE 681	High Performance Routers and Switches (3 credits)
ECE 690	Computer Systems Architecture (3 credits)

		ECE 742	Communication Systems II (3 credits)
		ECE 745	Advanced Wireless Networks (3 credits)
		ECE 785	Parallel Processing Systems (3 credits)
		ECE 685	Network Interface Design (3 credits)
		CS 610	Data Structures and Algorithms (3 credits)
		CS 665	Algorithmic Graph Theory (3 credits)
		Math 661	Applied Statistics (3 credits)
		Mgmt 685	Operations Research and Decision Making (3 credits)

Area requirements

		ECE 689	Computer Arithmetic Algorithms (3 credits)
		ECE 690	Computer Systems Architecture (3 credits)

Suggested Electrical Engineering Electives:

		ECE 605	Discrete Event Dynamic Systems (3 credits)
		ECE 612	Computer Methods Applied to Power Systems (3 credits)
		ECE 640	Digital Signal Processing (3 credits)
		ECE 643	Digital Image Processing I (3 credits)
		ECE 650	Electronic Circuits (3 credits)
		ECE 660	Control Systems I (3 credits)
		ECE 664	Real-time Computer Control Systems (3 credits)
		ECE 684	Advanced Microprocessor Systems (3 credits)
		ECE 686	Instrumentation Systems and Microprocessors (3 credits)
		ECE 687	Design of Medical Instrumentation (3 credits)
		ECE 688	Microcontrollers in Instrumentation (3 credits)
		ECE 785	Parallel Processing Systems (3 credits)

Focus Area : Solid State, VLSI and Electro-optics Systems:

Area requirements (Choose at least two)

		ECE 622	Wave Propagation (3 credits)
		ECE 626	Optoelectronics (3 credits)
		ECE 650	Electronic Circuits (3 credits)
		ECE 657	Semiconductor Devices (3 credits)
		ECE 658	VLSI Design I (3 credits)
		ECE 758	VLSI Design II (3 credits)

Suggested Electrical Engineering Electives:

		ECE 605	Discrete Event Dynamic Systems (3 credits)
		ECE 623	Fourier Optics (3 credits)
		ECE 624	Optical Engineering (3 credits)
		ECE 625	Fiber and Integrated Optics (3 credits)
		ECE 630	Microwave Engineering (3 credits)
		ECE 648	Digital Microelectronics (3 credits)
		ECE 659	Fabrication Principles of Electronic and Optoelectronic Devices (3 credits)
		ECE 660	Control Systems I (3 credits)
		ECE 677	Optimization Techniques (3 credits)
		ECE 684	Advanced Microprocessor Systems (3 credits)
		ECE 690	Computer Systems Architecture (3 credits)
		ECE 730	Theory of Guided Waves (3 credits)
		ECE 739	Laser Systems (3 credits)
		ECE 756	Advanced Topics in Semiconductor Devices (3 credits)

		ECE 785	Parallel Processing Systems (3 credits)
		ECE 789	Selected Topics in Electrical and Computer Engineering II (3 credits)
		ECE 677	Optimization Techniques (3 credits)
		ECE 768	Optimal Control Theory (3 credits)
		MtSE 702	Characterization of Solids (3 credits)
		MtSE 650	Physical Metallurgy (3 credits)
		MtSE 765	Science and Technology of Thin Films (3 credits)

Focus Area : Intelligent Systems:

Area requirements (choose at least two)

		ECE 605	Discrete Event Dynamic Systems (3 credits)
		ECE 609	Artificial Neural Networks (3 credits)
		ECE 610	Power System Steady-State Analysis (3 credits)
		ECE 660	Control Systems I (3 credits)

Suggested Electrical Engineering Eectives:

		ECE 611	Transients in Power Systems (3 credits)
		ECE 612	Computer Methods Applied to Power Systems (3 credits)
		ECE 613	Protection of Power Systems (3 credits)
		ECE 614	Dynamics of Electromechanical Energy Conversion (3 credits)
		ECE 615	Advanced Electromechanical Energy Conversion I (3 credits)
		ECE 616	Power Electronics (3 credits)
		ECE 640	Digital Signal Processing (3 credits)
		ECE 664	Real-time Computer Control Systems (3 credits)
		ECE 666	Control Systems II (3 credits)
		ECE 661	Control System Components (3 credits)
		ECE 677	Optimization Techniques (3 credits)
		ECE 684	Advanced Microprocessor Systems (3 credits)
		ECE 766	Stability Theory of Nonlinear Systems (3 credits)
		ECE 768	Optimal Control Theory (3 credits)
		ECE 769	Stochastic Estimation and Control (3 credits)

Doctor of Philosophy in Electrical Engineering

This is a program for superior students with master's degrees in electrical engineering or allied fields who wish to conduct advanced research in an area of electrical engineering.

Exceptional Candidates with a Bachelor of Science in Electrical Engineering

Highly qualified students with bachelor's degrees in electrical engineering may be accepted directly into the doctoral program. Contact the doctoral program coordinator for further information.

Admission Requirements:
Applicants are expected to have a broad background in engineering, mathematics, physics, and computer science. At least half of undergraduate course work should have been in the physical sciences or similar fields. Doctoral students should have majored in electrical engineering or related field, with course work at the master's level in mathematics, physics and/or computer science. In addition, students are expected to be proficient in computer programming. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (213 computer-based).

Students who lack an appropriate background will be required to take additional courses that cannot be applied as degree credits.

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.

Registrations for six semesters of ECE 791Graduate Seminar are required of all doctoral students.

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.

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* ECE 701 (6 credits)

Emergency Management and Business Continuity

Administered By: Department of Information Systems, College of Computing Sciences, http://is.njit.edu

Administration

Interim Dean, College of Computing Sciences	James Geller
Associate Dean, College of Computing Sciences	Barry Cohen
Assistant to the Dean, College of Computing Sciences	Serena Branson
Chair, Information Systems Department	Yi-fang Wu
Assistant to the Chair, Information Systems	Michelle D. Craddock-Bouler
Director of Undergraduate HCI Program	Quentin Jones
Director of Undergraduate IS Programs	Lin Lin
Director of Master's Programs	Michael P. Bieber
Director of Emergency Management & Business Continuity	Michael J. Chumer
Director of PhD Program	Michael P. Bieber
Secretary	Patricia B. Lundberg

Faculty

Professors Emeriti	S R. Hiltz, Marilyn Tremaine, Murray Turoff
Professors	Michael P. Bieber, Fadi Deek
Associate Professors	Quentin Jones, Michael L. Recce, Julian M. Scher, Yi-fang Wu
Assistant Professors	Lian Duan, Songhua Xu
Senior University Lecturers	Richard W. Egan, Lin Lin, Keith A. Williams

Advisors

Advisor B.A./ B.S.	Amanda D. Ackerman, George W. Olsen, Casey L. Hennessey
Advisor M.S.	George W. Olsen
Advisor Ph.D.	Michael P. Bieber

The M.S. in Emergency Management and Business Continuity is designed to enhance critical skills and knowledge among corporate and public sector professionals working in the area of emergency management and business continuity.

The M.S. in Emergency Management and Business Continuity is managed and directed as an interdisciplinary program by NJIT's Department of Information Systems. A university-wide program committee will keep the structure, guidance and direction to courses, course development, and specialty area development on the leading edge.

Goals of the Program

This program is intended to:

- Allow students from most undergraduate degrees to enter a Master's level program in the field of Emergency Management and Business Continuity.
- Encourage those with undergraduate degrees in the Physical, Biological, Social Sciences, Engineering, Management,

Public Administration, and Communications to enter this evolving field.
- Encourage outstanding students to consider an academic path to a Ph.D. and to conduct research in their original (undergraduate degree) field that is relevant to areas of Emergency Management and Business Continuity. For students going on to a participating Ph.D. program, all 30 credits will be counted toward the 90 graduate credit Ph.D. requirements.
- Provide a part time path to the degree based entirely on courses offered online through the Web, using appropriate group communications technology that allows for active participation with other course and degree students (Virtual Classroom (TM) and Asynchronous Learning Network approaches).
- Meet the new policy of the International Association of Emergency Managers (IAEM), which will require, beginning in 2010, an academic degree rather than just the current four years of experience requirement.
- Bring about the integration of the endeavors of Emergency Management and Business Continuity into one academic program, given that crises and disasters are impartial about their impact on both public and private sector segments of society.
- Increase the professionalism of this field, which is evolving in importance and societal needs, by increasing its presence in academic, research, and development professional communities.

THE PROGRAM IS OFFERED BOTH ONLINE AND ON CAMPUS

M. S. in Emergency Management and Business Continuity (30 credits)

For further details, see http://is.njit.edu/academics/

Summary

Fundamental Courses	12 Credits
Elective Courses	6 Credits
Specialty Area Courses	12 Credits
Total	**30 Credits**

Fundamental/Core Courses (12 credits):

Students may choose core courses in any order but we recommend students take IS 612 in the first semester.

IS 613	Design of Emergency Management Information Systems (3 credits)
IS 614	Command and Control Systems (3 credits)
Mgmt 612	Principles of Emergency Management (3 credits) ***or***
IS 612	Emergency Management Informatics (3 credits)
Mgmt 616	Learning Methodologies and Training Technologies (3 credits) ***or***
IS 616	Learning Methodologies and Training Technologies (3 credits)

Electives (6 credits):

Choose two of the following courses, or one course plus a master's project or masters thesis. Students who have not worked in this area are advised to consider doing a project or thesis.

HRM 601	Organizational Behavior (3 credits)
CE 602	Geographic Information System (3 credits)
IS 615	Improvisation in Emergency Management (3 credits)
EvSc 625	Social Dimensions of Risk (3 credits) ***or***
IS 617	Social Dimensions of Risk (3 credits)
Proj/Thesis	(Master's Project, 3 credits, or Thesis, 6 credits)

Specialty/Application Area (12 credits):

Students may take a coherent set of four additional courses in another field that is related to Emergency Management. Usually this would be in their current professional area as specified by their undergraduate or other graduate degrees. Such courses may be applied to a second masters or a Ph.D. program in accordance with NJIT policies and program structure. Students can take all four courses in one specialty area or across several specialties as appropriate to their interests.

There is an advisor for each specialty area that may be contacted for questions on that specialty area and for advice on choosing courses. The specialty areas currently include:

Critical Infrastructure:

Critical Infrastructure focuses on planning issues, maintainability and safety engineering, vulnerability analysis, hazard/crisis impact analysis and mitigation, infrastructure inter-dependencies, rehabilitation technologies, condition assessment, problem detection, diagnosis and process propagation, and program management. Students with an undergraduate degree in civil engineering and related engineering disciplines would be encouraged to consider this specialty area.

		CE 671	Performance and Risk Analysis of Infrastructure Systems (3 credits)
		CE 672	Security Management of Critical Infrastructure (3 credits)
		EM 602	Management Science (3 credits)
		Arch 675	Elements of Infrastructure Planning (3 credits)

Computer Engineering:

The design and assurance of communication infrastructure is critical to all aspects of emergency management. Being able to evaluate and insure the mitigation of vulnerabilities for such systems is an important contribution to the infrastructure survivability of such systems. Students with an undergraduate degree in Computer Engineering are encouraged to consider this specialty area.

		ECE 644	Wireless Communication (3 credits)
		ECE 645	Wireless Networks (3 credits)
		ECE 683	Computer Network Design and Analysis (3 credits)
		ECE 637	Internet and Higher-Layer Protocols (3 credits)
		ECE 639	Principles of Broadband Networks (3 credits)
		ECE 789	Selected Topics in Electrical and Computer Engineering II (3 credits)

Environmental Science:

With the increasing complexity of our society comes severe risk of the accidental and deliberate release of a wide range of hazardous materials, both chemical and biological. Those trained to be able to make a meaningful contribution to the understanding of the associated risks, how to detect and track the implications of their occurrence, and how to respond meaningfully to their mitigation represent an important professional talent that needs to be available in the Emergency Management and Business Continuity Area. All organizations dealing with hazardous materials should have this sort of talent in their Emergency Management team.

		EvSc 603	Hazardous Waste Operations and Emergency Response (3 credits)
		EvSc 610	Environmental Chemical Science (3 credits)
		EvSc 611	Hazardous Waste Management (3 credits)
		EvSc 612	Environmental Analysis (3 credits)
		EvSc 613	Environmental Problem Solving (3 credits)
		EvSc 614	Quantitative Environmental Risk Assessment (3 credits)
		EvSc 616	Toxicology for Engineers and Scientists (3 credits)
		EM 631	Legal Aspects in Environmental Engineering (3 credits)

Information Systems:

The application of computing information and communication in the Emergency Management and Business Continuity field represents the potential use of technology to integrate all the functions that must take place before, during, and after the disaster, as well as among the different organizations and units of organizations that must be involved in the preparedness, response, and recovery. Information systems are the glue that puts together planning, mitigation, detection, training, command and control, response, and recovery into one unified process that provides the necessary infrastructure for the overall responsibilities. As such, they must be designed and developed with the evolving needs of the users and the organizations integrated into the development process.

		IS 615	Improvisation in Emergency Management (3 credits)
		IS 631	Enterprise Database Management (3 credits)
		IS 634	Information Retrieval (3 credits)
		IS 658	Multimedia Systems (3 credits)
		IS 677	Information System Principles (3 credits)
		IS 679	Information Systems Strategy (3 credits)
		IS 680	Information Systems Auditing (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		IS 687	Transaction Mining and Fraud Detection (3 credits)
		IS 764	Research Methods for Human-Centered Computing and Design (3 credits)

Management:

The professionals in Emergency Management must be able to integrate the development of plans for response processes (within their organization and across necessary external organizations). They must also ensure that everyone will receive adequate training and that in times of disaster those involved can work as well motivated and coordinated teams, no matter what degree of heterogeneity of expertise and level of experience exists among respondents. The emergency manager or business continuity professional must be able to be an entrepreneur or champion of emergency preparedness, and to prove and present people the best possible justifications for investing in an organizational function that may not be viewed as absolutely necessary by all those concerned, especially in times of restricted budgets. He or she must be able to stimulate planning, communication, and coordination among all parts of the organization or organizational units necessary to bring about effective crisis planning and response.

		Acct 615	Management Accounting (3 credits)
		EM 636	Project Management (3 credits)
		Fin 600	Corporate Finance I (3 credits)
		HRM 630	Managing Technological and Organizational Change (3 credits)
{		MIS 645	Information Systems Principles (3 credits) ***or***
		IS 677	Information System Principles (3 credits)
		MIS 648	Decision Support Systems for Managers (3 credits)
		Mgmt 630	Decision Analysis (3 credits)
		Mgmt 650	Knowledge Management (3 credits)
		Mgmt 635	Data Mining and Analysis (3 credits)

Catalog and curricula information approved by the relevant academic department.

Engineering Management

Administered By: Department of Mechanical and Industrial Engineering

Administration

Chairperson	Rajpal S. Sodhi
Associate Chairperson	Athanassios Bladikas
Program Director	Athanassios Bladikas

Faculty

Professors	Layek Abdel-Malek, Reggie J. Caudill, Sanchoy K. Das, Paul G. Ranky, Stephen J. Tricamo
Associate Professors	George Abdou, Golgen Bengu, Athanassios Bladikas, Kevin J. Mcdermott*

* Joint appointment with Department of Engineering Technology.

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 courses in the areas of statistics, cost analysis and engineering economics.

Graduate Certificate Program: A 12-credit graduate certificate in Construction Management, Operations Productivity, Pharmaceutical Management or Project Management is available as a step toward this degree. Please see Graduate Certificates in this catalog for further information. For more information about continuing and distance education, please contact the Division of Continuing Professional Education, 1-800-624-9850 or 973-596-3060; email: cpe@njit.edu.

Off-Campus Programs: At extension and corporate sites, NJIT offers sufficient courses to fulfill all degree requirements. NJIT faculty teach all courses. For locations, see Extension Programs in this catalog. The university's distance learning arm, ACCESS/NJIT, offers this program (as well as part of the bridge program described above) to qualified students who have access to the Internet and a VCR. In addition, distance-based, 12-credit graduate certificates in **Construction Management, Operations Productivity, Pharmaceutical Management or Project Management**, are available as a step toward this degree. See Graduate Certificates in this catalog. For further information about extension programs, ACCESS/NJIT programs, and graduate certificates, call the associate vice president of continuing and distance education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; email cpe@njit.edu.

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 (IE 700) or a 6-credit thesis (IE 701) are optional electives. In some cases, students may select courses to enhance their technical competency. In other cases, individuals may select courses to prepare for a change in responsibilities or job function. At least half of the elective courses must be selected from those having an IE or EM prefix.

Core:
18 credits:

Acct 615	Management Accounting (3 credits)
EM 602	Management Science (3 credits)
EM 636	Project Management (3 credits)
HRM 601	Organizational Behavior (3 credits)
IE 673	Total Quality Management (3 credits)
MIS 645	Information Systems Principles (3 credits)

Electives:

12 credits of electives may be chosen from the following list of courses:

EM 634	Legal, Ethical and Intellectual Property Issues for Engineering Managers (3 credits)
EM 637	Project Control (3 credits)
EM 691	Cost Estimating for Capital Projects (3 credits)
IE 651	Industrial Simulation (3 credits)
IE 659	Supply Chain Engineering (3 credits)
EM 632	Legal Aspects in Construction (3 credits)
IE 618	Engineering Cost and Production Economics (3 credits)
IE 621	Systems Analysis and Simulation (3 credits)
EM 640	Distribution Logistics (3 credits)
EM 641	Engineering Procurement and Materials Management (3 credits)
MnE 655	Concurrent Engineering (3 credits)
EM 674	Benchmarking and Quality Function Deployment (3 credits)
IE 605	Engineering Reliability (3 credits)
IE 672	Industrial Quality Control (3 credits)
MnE 654	Design for Manufacturability (3 credits)
EM 632	Legal Aspects in Construction (3 credits)
IE 653	Facility Maintenance (3 credits)
MnE 601	Computerized Manufacturing Systems (3 credits)
MnE 602	Flexible and Computer Integrated Manufacturing (3 credits)
MnE 655	Concurrent Engineering (3 credits)
EM 655	Management Aspects of Information Systems (3 credits)
IE 661	Man-Machine Systems (3 credits)
EM 635	Management of Engineering Research and Development (3 credits)

* School of Management courses with a FIN, MRKT, MIS, HRM or MGMT prefix may be taken as electives

** Students may also have graduate courses in their undergraduate engineering degree or other technical descipline.

Engineering Science

Administered By: Office of the Dean, Newark College of Engineering

Administration

Program Director	Yuan Ding

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

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 (4-0-4)
CE 321	Water Resources Engineering (3-0-3)
CE 322	Hydraulic Engineering (3-0-3)
CE 501	Introduction to Soil Behavior (3 credits)
Chem 126	General Chemistry II (3-0-3)
CIS 101	Computer Programming and Problem Solving (2-1-2)
Math 222	Differential Equations (4-0-4)
Mech 234	Engineering Mechanics (2-0-2)
Mech 236	Dynamics (2-0-2)

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 (3 credits)
		EnE 660	Introduction to Solid and Hazardous Waste Problems (3 credits)
		EnE 661	Microbiology for Environmental Engineers (3 credits)
		Math	(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 (3 credits)
		CE 602	Geographic Information System (3 credits)
		CE 604	Environmental Modeling in Remote Sensing (3 credits)
		CE 605	Research Methods in Remote Sensing (3 credits)
		CE 618	Applied Hydrogeology (3 credits)
		CE 620	Open Channel Flow (3 credits)
		CE 621	Hydrology (3 credits)
		CE 623	Groundwater Hydrology (3 credits)
		CE 647	Geotechnical Aspects of Solid Waste (3 credits)
		CE 702	Special Topics in Civil Engineering (3 credits)
		EnE 610	Hazardous Site Operations (3 credits)
		EnE 662	Site Remediation (3 credits)
		EnE 664	Physical and Chemical Treatment (3 credits)
		EnE 665	Biological Treatment (3 credits)
		EnE 666	Analysis of Receiving Waters (3 credits)
		EnE 668	Air Pollution Control (3 credits)
		EnE 669	Water and Wastewater Analysis (3 credits)
		EnE 670	Advanced Processes in Water Pollution Control (3 credits)
		EnE 671	Environmental Impact Analysis (3 credits)
		EnE 672	Stormwater Management (3 credits)
		EnE 700	Environmental Engineering Project (3 credits)
		EnE 702	Special Topics in Environmental Engineering (3 credits)
		EnE 720	Environmental Chemodynamics (3)
		EnE 760	Applied Environmental Soil Chemistry (3 credits)

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 (pencil and paper) and 213 (computer-based).

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: Department of Chemistry and Environmental Science

Administration

Program Director	Maurie Cohen

Faculty

Professor	Nancy L. Jackson
Associate Professors	Maurie Cohen, Zeyuan Qiu
Lecturer	Michael P. Bonchonsky
Affiliated Faculty	Joseph W. Bozzelli, Somenath Mitra

Degrees Offered: Master of Science in Environmental Policy Studies, Ph.D. in Environmental Science (Policy Concentration)

The Graduate Program 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 a series of foundation courses (Tier One) in environmental social science, environmental science, research methods, and economics. Advanced courses (Tier Two) build on this initial framework and provide extensions in specific applications in environmental law, energy policy, and a selection of advanced topics.

The faculty is multidisciplinary with strengths in environmental social science, economics, geography, and law. Graduates of the program have secured employment in both the public and private sectors including with the United States Environmental Protection Agency, the New Jersey Department of Environmental Protection, regional planning commissions, local community development programs, and engineering and planning firms. Graduates have also entered doctoral- level programs in environmental science, policy, and law.

The Ph.D. in Environmental Science (Policy Concentration) is offered by the Department of Chemistry and Environmental Science of which the Graduate Program in Environmental Policy is a constituent part. Successful environmental policies must rest on the development of reliable models for assessing change to the biophysical environment in the presence of human action. The Department offers a research-oriented doctoral degree in Environmental Science with a concentration in Environmental Policy. The program emphasis is on the integration of environmental and social sciences to develop more effective responses to contemporary problems of resource management. For more information about degree requirements, please visit the website of the Department of Chemistry and Environmental Science.

Master of Science in Environmental Policy Studies

The Master of Science in Environmental Policy Studies is designed to provide students with the opportunity to acquire skills in the methods and tools used in environmental problem solving and policy analysis. The Program may be completed on a part-time or full-time basis. Courses are offered both online and on a face-to-face basis.

Admission Requirements:
The following criteria are applied when considering an applicant for admission to the program:

- An undergraduate degree in earth sciences (e.g. physical geography, geology, meteorology, ecology), social sciences (e.g.

human geography, economics, sociology), engineering (e.g. environmental, civil, chemical) or another related discipline.

- An undergraduate GPA of at least 3.0 and at least 3.5 in major field (on a scale of 4.0).
- A minimum of one semester of statistics at the undergraduate level; an advanced statistics course at the undergraduate level is highly desirable.
- A combined GRE score (verbal and quantitative) of at least 1100

The following materials must be submitted to be considered for admission:

- Application for Admission to Graduate Study form
- MS-EPS Supplemental Materials form
- Official transcripts of all prior work and certificate of graduation
- Personal statement (two to three pages)
- Three letters of recommendation
- Graduate Record Examination (GRE) scores
- International students are required to pass the TOEFL at 550 (pencil and paper), 213 (computer based) or above.

Degree Requirements
Students are required to complete a total of 30 graduate course credits: 18 credits of required core courses and 12 credits of elective application courses.

		EPS 601	Research Methods for Environment & Sustainability Policy (3 credits)
		EPS 612	Introduction to Environmental Policy Studies (3 credits)
		EPS 614	Environmental Economics & Management (3 credits)
		EPS 622	Sustainable Politics & Policy (3 credits)
		EPS 638	Physical Geography (3)
		EM 631	Legal Aspects in Environmental Engineering (3 credits)

ELECTIVE APPLICATION COURSES (12 credits)

The Graduate Program in Environmental Policy Studies offers a regular series of special topics courses and students may also enroll in courses offered by other departments. The website Green@NJIT offers a comprehensive list of options. The selection of elective application courses is made in consultation with the Program Director.

Students may select to write a 6-credit thesis in lieu of two elective application courses and this work is normally completed over two sequential semesters. Preparation of the thesis is conducted under the supervision of an advisor and presented to a three-member committee. Subject to approval by the Program Director, students also have the option to substitute up to two sections (6 credits) of independent study under faculty direction in place of elective application courses.

Various - Four Electives (12 Credits)

		EPS 701	Master's Thesis (6 credits)
		EPS 725	Independent Study I (3 credits)
		EPS 726	Independent Study II (3 credits)

Catalog and curricula information approved by the relevant academic department.

Environmental Science

Administered By: Department of Chemistry and Environmental Science

Adminstration

Chairperson	Somenath Mitra
Associate Chairperson	Edgardo Farinas

Faculty

Distinguished Professors	Carol A. Venanzi, Joseph W. Bozzelli, Somenath Mitra
Professors	Tamara Gund, Lev N. Krasnoperov, Nancy L. Jackson
Associate Professor	Zeyuan Qiu, Maurie Cohen
Assistant Professors	Liping Wei, Haidong Huang
Special Lecturer	William Skawinski
Research Professor	Zafar Iqbal

Advisors

Undergraduate Advisors	Roumiana S. Petrova
Graduate Advisor	Somenath Mitra

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, Environmental Engineering and Environmental Policy at NJIT, the Federated Department of Biological Sciences, and the Rutgers-Newark Department of Earth & Environmental Sciences. The strong research program is supported by major grants from federal and state agencies, and industry. Environmental science plays a major role in several NJIT research centers, including the Otto York center for Environmental Engineering and Science.

Master of Science in Environmental Science

This is an interdisciplinary program intended for individuals with backgrounds in science or engineering who want advanced education in the identification, management, treatment and effects of hazardous and toxic materials in the environment. It may be taken on a part-time or full-time basis.

Admission Requirements:
Applicants should have undergraduate degrees in chemistry, biology, chemical engineering, environmental engineering, environmental science, or related fields who have taken a minimum of one year of college chemistry and mathematics through calculus. Students who lack an appropriate background may be considered for admission and required to take a program of courses that is designed in consultation with the graduate advisor. These may include undergraduate courses which are not counted toward degree credit.

A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent, is typically required for admission. Those applying for financial support and those whose last prior degree was from outside the United States must submit GRE scores. International students must achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based).

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 (3 credits)
EvSc 610	Environmental Chemical Science (3 credits)
EvSc 612	Environmental Analysis (3 credits)
EvSc 616	Toxicology for Engineers and Scientists (3 credits)
EvSc 627	Environmental Microbiology (3 credits)

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 (3 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:

EvSc 602	Special Topics in Environmental Science I (3 credits)
EvSc 611	Hazardous Waste Management (3 credits)
EvSc 613	Environmental Problem Solving (3 credits)
EvSc 614	Quantitative Environmental Risk Assessment (3 credits)
EvSc 615	Global Environmental Problems (3 credits)
EvSc 700	Master's Project (3 credits)
EvSc 702	Special Topics in Environmental Science II (3 credits)
EvSc 711	Advanced Environmental Analysis (3 credits)
EvSc 725	Independent Study I (3 credits)
EvSc 726	Independent Study II (3 credits)
EnE 673	Sustainability and Life Cycle Analysis (3-0-3)
EnE 672	Stormwater Management (3 credits)
EnE 660	Introduction to Solid and Hazardous Waste Problems (3 credits)
EnE 662	Site Remediation (3 credits)
EnE 664	Physical and Chemical Treatment (3 credits)
EnE 665	Biological Treatment (3 credits)
EnE 620	Environmental Chemodynamics (3 credits)
ChE 685	Industrial Waste Control I (3 credits)
ChE 686	Industrial Waste Control II (3 credits)
ChE 687	Industrial Gas Cleaning (3 credits)
ChE 740	Biological Treatment of Hazardous Chemical Wastes (3 credits)

		CE 602	Geographic Information System (3 credits)
		Chem 664	Advanced Analytical Chemistry (3 credits)
		R120:551	Biology of Pollution (3 credits)
		R120:522	
		R120:534	
		R120:523	Biogeography (3 credits)
		IE 615	Industrial Hygiene and Occupational Health (3 credits)
		EPS 612	Introduction to Environmental Policy Studies (3 credits)
		EPS 622	Sustainable Politics & Policy (3 credits)
		EPS 614	Environmental Economics & Management (3 credits)
		EPS 638	Physical Geography (3)

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 R120:604), 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 R120:604), and a minimum overall GPA of 3.0.

Required:
51 credits as follows:

		R120:604	Microbiology: Principles and Applications (3 credits)
		EM 631	Legal Aspects in Environmental Engineering (3 credits)
		EvSc 610	Environmental Chemical Science (3 credits)
		EvSc 612	Environmental Analysis (3 credits)
		EvSc 616	Toxicology for Engineers and Scientists (3 credits)

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.

Healthcare Systems Management

Administered By: Department of Mechanical & Industrial Engineering

Program Director:	Sanchoy K. Das

The MS in Healthcare Systems Management will train and educate graduates in the application of systems analysis and quantitative methods in managing the various components of the healthcare delivery system. The program provides graduates with contemporary knowledge and the needed technical expertise for the efficient design, management and operation of healthcare facilities, including hospitals, nursing facilities, clinics, and pharmacies. This expertise will span the subjects of systems engineering, operations management, and advanced information technologies and will present concepts and tools for both reducing healthcare system costs and increasing the quality of healthcare services. Healthcare Systems are defined as the network of physical facilities, equipment, informational technologies, and patient flow processes that are associated with providing and delivering healthcare services. Graduates would find jobs in hospitals and healthcare organizations, serving in progressively more responsible positions in the quality improvement, decision support, information technology, patient accounting, facilities planning, or operations management departments.

DEGREE REQUIREMENTS: A minimum of 30 credits beyond a baccalaureate degree is required. A master's thesis or independent research is optional.

ADMISSION REQUIREMENTS: A BS degree in a technical discipline (e.g., Engineering, Computer Science, Informational Technology, Physics etc.). A bridge program is also available for suitable candidates from other degree majors. Individuals who have been working in a healthcare related organization for two or more years, and are now looking for additional skills to further progress their careers in the healthcare industry would be ideal candidates.

Master of Science in Healthcare Systems Management

CORE COURSES:

IE 699	Special Topics in Industrial Engineering (3 credits)
IE 699	Special Topics in Industrial Engineering (3 credits)
EM 602	Management Science (3 credits)
EM 636	Project Management (3 credits)
HRM 601	Organizational Behavior (3 credits)
IE 604	Advanced Engineering Statistics (3 credits)

ELECTIVES: (Select 4)

IE 699	Special Topics in Industrial Engineering (3 credits)
EM 637	Project Control (3 credits)
IE 682	Industrial Safety and Health Evaluation (3 credits)
IE 672	Industrial Quality Control (3 credits)
IE 650	Advanced Topics in Operations Research (3 credits)
IE 621	Systems Analysis and Simulation (3 credits)
IE 673	Total Quality Management (3 credits)
MIS 648	Decision Support Systems for Managers (3 credits)
Mgmt 620	Management of Technology (3 credits)

History

Administered By: Federated History Department of Rutgers-Newark and NJIT

Administration

NJIT Chairperson	Richard B. Sher
Rutgers-Newark acting Chair	Karen Caplan
Director, Graduate Programs	Karen Caplan
NJIT Graduate Coordinator	Neil M. Maher
Rutgers-Newark Undergraduate Advisor	Eva Giloi

Faculty

Distingushed Professors	Richard B. Sher
History Advisor	Richard B. Sher, Maureen O'Rourke
Professors	Karl W. Schweizer
Associate Professor	Neil M. Maher, Norman Tobias
Assistant Professors	Alison Lefkovitz
Senior University Lecturer	Lisa Nocks
University Lecturer	Kyle Riismandel
Adjunct Faculty	Scott L. Kent, Joyce Mullan, Mary Catherine Moran
Emeritus Faculty	John E. O'Connor, Doris H. Sher

Rutgers-Newark Faculty

Board of Governors Distinguished Service Professor	Clement Price
Professors	Susan L. Carruthers, Steven J. Diner, James Goodman, Jan Ellen Lewis, Said S. Samatar, Beryl E. Satter, Marc S. Weiner, Odoric Y. K. Wou
Associate Professors	Karen Kaplan, Jon Cowans, Gary D. Farney, Ruth Feldstein, Eva Giloi
Assistant Professors	Kornel Chang, Mark Krasovic, Amita Satyal, Timothy Stewart-Winter, Whitney Strub, Nukhet Varlik
Adjunct Faculty	Elizabeth Aaron, Danielle Bradley, Andrew Daily, Courtney Doucette, Leigh-Anne Francis, Matthew Friedman, Stuart Gold, Jose Gomez-Rivera, Susan Helft, Lacey Hunter, Benjamin Hutchins, Rebecca Lubot, Thomas McCabe, Abigail Mellen, Christopher Mitchell, Raymond Ojserkis, Sonia Robles
Emeritus Faculty	Norma Basch, Norman Dain, Peter B. Golden, David H. Hosford, Taras Hunczak, Warren F. Kimball, Jonathan Lurie, Irwin L. Merker, John W. Osborne, Elliot Rosen, Frederick H. Russell, Gabor P. Vermes, Olga J. Wagenheim, Odoric Y. Wou

Degrees Offered: Master of Arts in History, Master of Arts in Teaching (History). Both degrees are offered jointly by NJIT and 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 technology and medicine; the history of communication, cultural and intellectual history; diplomatic history; history of women; pre-Civil War and contemporary America; African and African-American history; legal history; and global and comparative history.

Master of Arts in History

The M.A. in History furnishes a broad yet rigorous training in history in preparation for a wide variety of careers in education, law, business, medicine, and administration.

Admission Requirements:
Applicants must have an undergraduate degree from an accredited institution and favorable letters of recommendation from professors familiar with their work. An undergraduate GPA of at least 3.0 is normally required. Students must provide GRE scores.

Application:
Students interested in the program should contact the graduate programs director and apply to Rutgers-Newark.

Degree Requirements
A minimum of 30 credits is required, including 18 in a major field and 6 in a minor field chosen in consultation with a faculty advisor. The remaining 6 credits may be completed through a Master's Thesis or a combination of a Master's Essay and an additional course.

Major Fields:

American History See the Federated History Department website for more information.

World History See the Federated History Department website for more information.

History of Technology, Environment, and Medicine/Health
Based at NJIT, this concentration is a unique integration of three relatively new and increasingly important historical sub-disciplines. Students concentrating in the History of Technology, Environment, and Medicine/Health explore not only the interrelationships between environmental transformations, technology in society, and health and medicine, but also their social meanings, their cultural relations, their political, social, and gender histories, and their local, national, and global contexts. NJIT has a distinguished concentration of faculty in these areas, with particular strengths in American environmental and urban environmental history; the social and cultural history of medicine; and the history of technology and communication.

Students interested in pursuing this major field of concentration should contact the NJIT graduate coordinator for more information.

The following is a sample curriculum for a student completing a major field of study (18 credits) in the History of Technology, Environment and Medicine/Health.

		Hist 622	Culture and Science in the History of American Medicine (3 credits)
		Hist 628	Gender, Science and Technology in the Modern World (3 credits)
		Hist 632	Technology, Culture and History (3 credits)
		Hist 634	Environmental History of North America (3 credits)
		Hist 635	History of Technology, Environment and Medicine: Theory and Method (3 credits)
		Hist 638	Social History of Communication (3 credits)
		Hist 656	Topics in the History of Health (3 credits)

Minor Field:

Five upper division courses, at least four in history, one may be HSS 404 or HSS 404h offered by the History Department.

Faculty Coordinator: Richard Sher
Cullimore Hall, Room 329
E-mail: sher@njit.edu Phone (973) 596-3377

Interested Persons may also contact the Academic Coordinator Maureen O'Rourke

E-mail: history@njit.edu

Master's Thesis/Master's Essay:

Students must complete either (1) a Master's Thesis (6 credits) or (2) a Master's Essay (3 credits) and an additional 3 credits of course work. For additional information on the Master's Thesis and Master's Essay, see the Federated History Department website.

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.

Catalog and curricula information approved by the relevant academic department.

Industrial Engineering

Administered By: Department of Mechanical and Industrial Engineering

Administration

Chairperson	Reggie J. Caudill
Associate Chairperson	Athanassios Bladikas
Program Director	Athanassios Bladikas

Faculty

Professors	Layek Abdel-Malek, Reggie J. Caudill, Sanchoy K. Das, Paul G. Ranky, Stephen J. Tricamo
Associate Professors	George Abdou, Golgen Bengu, Athanassios Bladikas, Kevin J. Mcdermott, Arijit Sengupta* , Jian Yang

Advisors

Graduate Advisor	Sanchoy K. Das

* Joint appointment with Department of Engineering Technology

Degrees Offered: Master of Science in Industrial Engineering; Doctor of Philosophy in Industrial Engineering

Industrial Engineering (IE) is a field of study intended for professionals who are interested in managing and analyzing complex systems. IEs typically formulate mathematical and/or digital simulation models of these systems with the intention of improving system and economic performance. Unique and in contrast to other traditional disciplines in engineering IEs focus on information driven human decision making and a broad based systems perspective. IEs consider themselves to be virtually any setting where outcomes are influenced by key decisions.

Master of Science in Industrial Engineering:

Individuals with a diversity of technical background have completed the MSIE degree. These individuals are attracted by the historically strong role played by IEs in modeling and analysis within traditional production and distribution settings, that now extend to healthcare, transportation, and a wide range of service industries. Program provides advanced training in operations research, supply chain, and process modeling and analysis. All courses are offered primarily in evening and weekend sessions at our Newark campus, and ideal for working professionals. Many courses are also offered online in an E-learning mode.

Master of Science in Industrial Engineering

A program for individuals who seek professional advancement in the industrial engineering field.

Admission Requirements:

A B.S. degree in an engineering, information technology, information technology, operations management, science, or related technical discipline. A bridge program is also available for suitable candidates.

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 (3 credits)
		EM 602	Management Science (3 credits)
		IE 501	Fundamentals of Industrial Engineering (3 credits)

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 (3 credits)
		IE 618	Engineering Cost and Production Economics (3 credits)
		IE 621	Systems Analysis and Simulation (3 credits)
		IE 650	Advanced Topics in Operations Research (3 credits)

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:
Students may choose to specialize in any one of the following areas. Completion of all three courses in a specialization will qualify the student for a specialization certificate to be issued by the department. This will be awarded in conjunction with successful completion of the MS degree.

Quality Systems Engineering:

		IE 672	Industrial Quality Control (3 credits)
		IE 673	Total Quality Management (3 credits)
		MnE 654	Design for Manufacturability (3 credits)

Operations Research:

		IE 651	Industrial Simulation (3 credits)
		IE 704	Sequencing and Scheduling (3 credits)
		IE 650	Advanced Topics in Operations Research (3 credits)

Information Systems Design:

		CIS 610	Data Structures and Algorithms (3 credits)
		CIS 631	Data Management System Design (3 credits)
		EM 655	Management Aspects of Information Systems (3 credits)

Supply Chain & Logistics:

		IE 642	Network Flows and Applications (3 credits)
		IE 699	Special Topics in Industrial Engineering (3 credits)
		EM707	

Service Systems Engineering:

		IE 651	Industrial Simulation (3 credits)

		IE636	
		MIS 648	Decision Support Systems for Managers (3 credits)

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 (3 credits)
		IE 651	Industrial Simulation (3 credits)
		IE 706	A Queueing Approach to Performance Analysis (3 credits)
		IE 659	Supply Chain Engineering (3 credits)

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, CS, and Math.

Human Factors and Occupational Safety:
Core:
12 credits:

		IE 604	Advanced Engineering Statistics (3 credits)
		IE 760	Quantitative Methods in Human Factors (3 credits)
		IE 761	Advanced Studies in Human Factors (3 credits)
		IE 762	Psychophysical Methods in Human Factors (3 credits)

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, CS, and Math.

Information Systems

Administered By: Department of Information Systems, College of Computing Sciences, http://is.njit.edu

Administration

Interim Dean, College of Computing Sciences	James Geller
Associate Dean, College of Computing Sciences	Barry Cohen
Assistant to the Dean, College of Computing Sciences	Serena Branson
Chair, Information Systems Department	Yi-fang Wu
Assistant to the Chair, Information Systems	Michelle D. Craddock-Bouler
Director of Undergraduate HCI Program	Quentin Jones
Director of Undergraduate IS Programs	Lin Lin
Director of Master's Programs	Michael P. Bieber
Director of Emergency Management & Business Continuity	Michael J. Chumer
Director of PhD Program	Michael P. Bieber
Secretary	Patricia B. Lundberg

Faculty

Professors Emeriti	S R. Hiltz, Marilyn Tremaine, Murray Turoff
Professors	Michael P. Bieber, Fadi Deek
Associate Professors	Quentin Jones, Michael L. Recce, Julian M. Scher, Yi-fang Wu
Assistant Professors	Lian Duan, Songhua Xu
Senior University Lecturers	Richard W. Egan, Lin Lin, Keith A. Williams

Advisors

Advisor B.A./ B.S.	Amanda D. Ackerman, George W. Olsen, Casey L. Hennessey
Advisor M.S.	George W. Olsen
Advisor Ph.D.	Michael P. Bieber

Degrees Offered:

- Master of Science in Information Systems
- Doctor of Philosophy in Information Systems

Information systems are computer systems that support the operations, management, and decision-making in organizations. Information systems are now an integral part of the work environment of every organization and play a critical role in the running of organizations. They are the heart of our Internet-based economy. Information systems enable people to access the information they need, collaborate, make decisions, and perform their jobs and personal activities effectively.

The field of Information Systems (IS) aims to bridge the fields of computer science and business. It resides at the interaction of these two fields. IS professionals serve as the critical link between the technical areas and other areas of an organization.

NJIT's IS professors are experts in the field and are very student focused. NJIT’s IS graduates place among the highest-paying and most plentiful jobs nationally. NJIT's very active Career Services Division promotes many co-op and internship opportunities with major local companies. This is fostered by our location within Northern New Jersey's high concentration of business and industry, and NJIT is just ½ hour from midtown Manhattan by train. We welcome both part-time and full-time students, and offer relatively low tuition rates for the region.

Master of Science in Information Systems

Masters in Information Systems (MSIS)

The MSIS prepares to become business and systems analysts, data scientists, systems and application designers, and designers of user interfaces and user experience. The curriculum core focuses on business mining and analytics, systems design that both extracts and utilizes this business data, and the techniques that assure the effectiveness of the user interface for such systems. Four electives provide broad flexibility to one expertise in related analytics, design, business and computing areas of interest to the student.

Bridge Program

CS 100	Roadmap to Computing (3-0-3) ***or***
CS 113	Introduction to Computer Science (3-0-3) ***or***
CS 505	Programming, Data Structures, and Algorithms (3 credits)
Math 111	Calculus I (4-1-4) ***or***
Math 138	General Calculus I (3-0-3)
Math 333	Probability and Statistics (3-0-3) ***or***
IS 331	Database Design Management and Applications (3-0-3) ***or***
CS 431	Database System Design and Management (3-0-3)
Math 333	Probability and Statistics (3-0-3) ***or***
IS 331	Database Design Management and Applications (3-0-3) ***or***
CS 431	Database System Design and Management (3-0-3)

IS Core Courses (6 courses)

IS 6XX	(User Experience Design) (3-0-3)
IS 663	System Analysis and Design (3 credits)
IS 631	Enterprise Database Management (3 credits)
IS 6XX	(Data Analytics for Information Systems) (3-0-3)
IS 684	Business Process Innovation (3 credits)

And one of the following courses:

IS 634	Information Retrieval (3 credits)
IS 687	Transaction Mining and Fraud Detection (3 credits)
IS 688	Web Mining (3 credits)

Electives (4 courses)

Students may choose any 4 courses from those listed below. Students may optionally choose 2 or more courses from a single area, which will constitute a specialization.

Electives and Specialization Areas

Masters Project & Thesis (strongly encouraged)

We strongly encourage students to design and conduct a Master Project or Master Thesis with an Information Systems professor. If you are considering a Project or Thesis, please consult the professor early to determine the best electives to support your work. A Master Project (IS 700) can substitute for one elective and a Master Thesis (IS 701) for two electives, and be considered part of a specialization with the MS Advisor's permission.

Data Management

		IS 634	Information Retrieval (3 credits)
		IS 687	Transaction Mining and Fraud Detection (3 credits)
		IS 688	Web Mining (3 credits)
		CS 602	Java Programming (3 credits)
		CS 632	Advanced Database System Design (3 credits)
		CS 634	Data Mining (3 credits)
		CS 731	Applications of Database Systems (3 credits)
		Mgmt 635	Data Mining and Analysis (3 credits)
		CE 602	Geographic Information System (3 credits)
		IS 700	Master's Project (3 credits)
		IS 701	Master's Thesis (6 credits)

Business Decision Making

		IS 677	Information System Principles (3 credits)
		IS 678	IT Service Management (3 credits)
		IS 679	Information Systems Strategy (3 credits)
		Acct 615	Management Accounting (3 credits)
		Fin 600	Corporate Finance I (3 credits)
		Fin 630	Applied Business Econometrics (3 credits)
		HRM 601	Organizational Behavior (3 credits)
		MIS 648	Decision Support Systems for Managers (3 credits)
		MIS 680	Management Science (3 credits)
		Mgmt 620	Management of Technology (3 credits)
		Mgmt 630	Decision Analysis (3 credits)
		Mgmt 650	Knowledge Management (3 credits)
		Mgmt 685	Operations Research and Decision Making (3 credits)
		Mgmt 710	Forecasting Methods for Business Decisions (3 credits)
		Mrkt 620	Competing in Global Markets (3 credits)
		Mrkt 645	Internet Marketing Strategy (3 credits)

User Experience Design

		IS 658	Multimedia Systems (3 credits)
		IS 686	Pervasive Computing: An HCI Perspective (3 credits)
		IS 735	Social Media (3 credits)
		IS 6XX	(User Experience Research*) (3-0-3)
		IE 661	Man-Machine Systems (3 credits)
		IE 662	Cognitive Engineering (3 credits)
		IE 664	Advanced Ergonomics (3 credits)
		PTC 605	Elements of Visual Design (3 credits)
		PTC 606	Advanced Information Design (3 credits)
		PTC 629	Theory and Practice of Social Media (3 credits)
		PTC 650	ELearning Design for Mobile (3 credits)

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

*Students considering a Masters Project or Thesis with this specialization are encouraged to take IS 6XX as an elective

Security and Network Management

		IS 680	Information Systems Auditing (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		IS 682	Forensic Auditing for Computing Security (3 credits)
		IS 687	Transaction Mining and Fraud Detection (3 credits)
		CS 608	Cryptography and Security (3-1-3)
		CS 645	Security and Privacy in Computer Systems (3-0-3)
		CS 651	Data Communications (3 credits)
		CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits)
		CS 656	Internet and Higher-Layer Protocols (3 credits)
		CS 696	Network Management and Security (3 credits)
		IT 620	Wireless Networks Security and Administration (3 credits)
		IT 640	Network Services Administration (3 credits)

Systems Analysis and Design

		IS 676	Requirements Engineering (3 credits)
		IS 683	Web Systems Web Development (3 credits)
		IS 684	Business Process Innovation (3 credits)
		IS 685	Enterprise Architecture and Integration (3 credits)
		IS 6XX	(User Experience Design) (3-0-3)
		CS 673	Software Design and Production Methodology (3 credits)
		CS 683	Software Project Management (3-0-3)
		CS 684	Software Testing and Quality Assurance (3-0-3)
		CS 685	Software Architecture (3-0-3)
		EM 636	Project Management (3 credits)
		EM 637	Project Control (3 credits)
		Mgmt 644	Communication in Technology Transfer and Innovation (3 credits)

Emergency Management

		IS 612	Emergency Management Informatics (3 credits)
		IS 613	Design of Emergency Management Information Systems (3 credits)
		IS 614	Command and Control Systems (3 credits)
		IS 616	Learning Methodologies and Training Technologies (3 credits)
		EvSc 603	Hazardous Waste Operations and Emergency Response (3 credits)
		EvSc 616	Toxicology for Engineers and Scientists (3 credits)
		MIP 674	Infrastructure and Architecture (3 credits)

Web Systems

		IS 634	Information Retrieval (3 credits)
		IS 658	Multimedia Systems (3 credits)
		IS 683	Web Systems Web Development (3 credits)

		IS 688	Web Mining (3 credits)
		IS 690	Web Services and Middleware (3 credits)
		PTC 628	Analyzing Social Networks (3 credits)
		PTC 632	Content Management and Information Architecture (3 credits)

Build Your Own Specialization

Students may propose a coherent set of courses that have a common thread related to an area that you are interested in. The MS IS advisor approves the proposed specialization.

Ph.D. in Information Systems

Administered By: Department of Information Systems, College of Computing Sciences, http://is.njit.edu

Ph.D. in Information Systems

PhD in Information Systems (IS)
24 course credits (8 courses) + 36 dissertation credits

The Information Systems (IS) PhD program is designed to produce scholars with a commanding knowledge of both theory and practice of IS for complex applications and environments. The program encourages an interdisciplinary approach to the exploration of information systems, and the evaluation of its effectiveness and consequences.

IS PhD dissertations must make a substantial scientific contribution to their particular area of research. PhD students can do research in two research tacks: Information Integration and Informatics (III), i.e., information science and data intensive research, and Human-Centered Computing (HCC).Entrance Requirements

- Applicants from varying academic backgrounds may apply. Applicants without sufficient computing or mathematics/statistics background, however, will be assigned additional foundation coursework.
- Typically applicants are required to have a Master's degree with a demonstrated record of academic achievement and show promise of being able to excel in the program, but we make exceptions for outstanding students with a Bachelor's degree.
- GPA should be 3.5 or better on a 4.0 scale.
- To ensure that each student finds a dissertation advisor and committee with proper expertise, after receiving an application, the PhD director will inform those who pass the first round of screening to contact and secure a faculty advocate with the proper expertise to assess and foster their research interests. Applicants should explore faculty web sites (is.njit.edu, look for those listed among our core faculty—assistant professors, associate professors and professors) and may consult with the PhD director regarding research interests and contacting faculty.

Application Materials

The IS PhD application requires several items in addition those listed at the NJIT Admissions Office web site (njit.edu/admissions). For complete details see is.njit.edu/academics.

Financial Support and Application Deadlines

Application deadlines are as follows:

- For Fall semester:
  - For those seeking financial support: February 15
  - For those not seeking financial support: March 15
- For Spring semester:
  - For those seeking financial support: September 1

- For those not seeking financial support: October 1

Part-Time Students

The IS PhD program welcomes part-time students, under the following conditions. Part-time students should arrange their work schedules to participate in research group meetings, seminars and other research activities as often as possible. These activities often take place during the day. Part-time students are required to obtain a leave from work obligations for at least one year in order to focus on their research proposition and dissertation research on a full-time basis.

Distance Students

The IS PhD is an on-campus program; we cannot accommodate distance learning students.

Overall Course Requirements

Students must maintain a grade average of 3.5 (B+) or better in core courses. No course with a grade less than B will count. Up to 2 courses may be independent study. At least 5 courses must be at the 700 level.

PhD Program Overview and Credits

The PhD program has 4 stages. Full-time students entering with an IS Master's degree are expected to complete within 4 years. Those entering with only a BS or a non-IS background are expected to complete within 5 years. Per NJIT policy, the maximum duration for the entire doctoral study is 7 years for both full-time and part-time students. The following table shows the expected and maximum time allowed for each stage.

		Math 661	Applied Statistics (3 credits)
		IS 764	Research Methods for Human-Centered Computing and Design (3 credits)
		IS 765	Quantitative Methods in Information Systems Research (3 credits)
		IS 766	Philosophy of Information Science (3-0-3)

Participation in Research Activities

IS research group meetings present an important opportunity for faculty and PhD students to immerse themselves in IS research paradigms, learn about research interests, present ideas, and find collaborators.

Full-time funded students must register for:

		IS 791	Graduate Seminar (Non-credit)

and attend research group meetings and research talks every semester. Part-time and distance students also must register for the seminar and actively participate (in person or remotely) for at least 2 semesters, and are strongly encouraged to attend as often as they can. Exit requirements for IS 791 include presentations in research group meetings.

Qualifying Exam

The qualifying exam is given each year in May. The exam has 3 sections:

- Quantitative research methods.
- Qualitative research methods.
- Reviewing articles .

A student failing two or more sections the first time or any part twice will be dismissed from the program. If a student fails only one section, a second opportunity to retake that section will be offered in the following May. No other options besides retaking the exam will be considered.

Stage 3: Research & Teaching Apprenticeship

This stage includes:

- finding a dissertation advisor,

- completing coursework,
- regular publishing,
- regular reviewing,
- teaching, and
- developing a research proposition.

Dissertation Advisor

Students must select a dissertation advisor by the end of the first year of entering Stage 3. This presumably was the students faculty advocate during the admissions process, though this is a period for students to explore one or more areas of research as part of finding an exciting dissertation topic.

Coursework

Students must complete their coursework by the end of this stage. Courses fall into 2 categories:

. *Specific Knowledge for Research and Dissertation:* Students and their advisors are responsible for choosing courses that will provide appropriate knowledge to complete the student's dissertation, and to be considered knowledgeable in the student's chosen field. The advisor can recommend courses in excess of the official number of credits required for graduation if the additional knowledge is critical.

. *General Knowledge for Teaching:* If necessary, students and their advisors are responsible for choosing additional courses providing enough knowledge to teach general undergraduate courses in Information Systems and/or in the students chosen specialty.

Research Proposition

Once a student has sufficient knowledge in a research area, the student will prepare a research proposition. The research proposition proposes a research project following an established grant proposal format. The research proposition is meant to demonstrate research readiness in preparation for dissertation work. The topic does not have to become the student's dissertation, but the ideal case will and also would yield an actual grant proposal that gains funding for the student's research. Propositions will be reviewed by faculty and peers in a fashion similar to the National Science

Foundation review process. Students not passing will be given a second chance the following semester.

Regular Publishing

Students must submit one conference or journal paper every year. Students are strongly encouraged to co-author papers with faculty and other doctoral students.

Regular Reviewing

Students must review at least 5 papers, grant proposals or research propositions during this stage. These can include internal papers by faculty or students prior to submissions, or external papers by request of journal editors or conference program chairs. They also must participate in reviewing their peers' research propositions.

Teaching Apprenticeship and Practicum

Students apprentice with a faculty member for a semester in preparation for a teaching practicum. During the apprenticeship, students typically will serve as a teaching assistant or grader. During the practicum, the student will teach at least one section of that course under the course coordinators direct supervision. Students must receive a satisfactory evaluation to pass this requirement.

Stage 4: Dissertation Process

This stage includes:

- writing and defending a dissertation proposal,
- conducting the main study,
- writing and defending the full dissertation thesis, and
- submitting publications based both on the proposal and final thesis

Dissertation Proposal

The dissertation proposal is a binding contract between the dissertation committee and the student. If a student successfully defends a proposal, the research plan in the dissertation proposal is to be followed.

A dissertation proposal must show motivation, appropriate coverage of literature, a sound research framework, a prototype system (where appropriate), a pilot study (where appropriate), data analysis, and the detailed steps for completing the full dissertation.

Publishing

Before defending the dissertation proposal, a student must submit a paper based upon some aspect of it. Before defending the final dissertation, a student must submit a paper based on the results from its formal study (not just the pilot study from the proposal).

Teaching Practicum

During the practicum, after passing the dissertation proposal defense, a degree candidate will teach at least one previously apprenticed course under the course coordinator’s direct supervision. Students must receive a satisfactory evaluation to pass this requirement.

Catalog and curricula information approved by the relevant academic department.

Catalog and curricula information approved by the relevant academic department.

Information Technology Administration and Security

Administered By: Information Technology Program & the College of Computing Sciences

Administration

Director	Michael H. Halper

Faculty

Professors	Michael H. Halper, James McHugh
Senior University Lecturers	Maura A. Deek, Joan M. Kettering, Stanley J. Senesy, Robert Statica
University Lecturers	Marc T. Sequeira, Lori L. Watrous-deversterre

Advisor

Advisor	Amanda D. Ackerman, Casey L. Hennessey

Website

Website	it.njit.edu

DEGREE

The *MS in IT Administration and Security* degree teaches students how to administer IT systems and networks while ensuring their security. Students gain extensive hands-on experience administering an IT environment. MS ITAS graduates are well prepared for jobs as database, network, security and web services administrators. They are also prepared for successful leadership roles in various IT functions, such as enterprise application administrator, IT administration manager, computer security specialist, and IT department manager.

Admission Requirements

Applicants are expected to have completed an undergraduate degree, preferably in information technology, computer science, computer engineering, information systems, or a related field. Students not satisfying these criteria will be considered for conditional admission on a case-by-case basis and may be required to complete a bridge program outlined in their acceptance letter. Bridge courses are a condition for admission; they do not count towards the 30 credits needed for degree completion.

MS in Information Technology Administration and Security (MS ITAS) (30 credits)

Curriculum

Required Courses (six)

		IT 610	System Administration (3 credits)
		IT 620	Wireless Networks Security and Administration (3 credits)
		IT 635	Database Administration (3 credits)

		IT 640	Network Services Administration (3 credits)
{		CS 656	Internet and Higher-Layer Protocols (3 credits) ***or***
		ECE 637	Internet and Higher-Layer Protocols (3 credits)
		CS 696	Network Management and Security (3 credits)

Elective Courses

(select any four)

		CS 631	Data Management System Design (3 credits)
		CS 632	Advanced Database System Design (3 credits)
		CS 633	Distributed Systems (3 credits)
{		CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits) ***or***
		ECE 683	Computer Network Design and Analysis (3 credits)
		IS 631	Enterprise Database Management (3 credits)
		IS 677	Information System Principles (3 credits)
		IS 679	Information Systems Strategy (3 credits)
		IS 680	Information Systems Auditing (3 credits)
		IS 681	Computer Security Auditing (3 credits)
		IS 682	Forensic Auditing for Computing Security (3 credits)
		ECE 645	Wireless Networks (3 credits)
		ECE 639	Principles of Broadband Networks (3 credits)
		HRM 601	Organizational Behavior (3 credits)

Bridge Courses:

		IT 102	Advanced Programming for Information Technology (3-0-3)
		IT 230	Computer and Network Security (3-0-3)
		IT 420	Computer Systems and Networks (3-0-3)
		CS 332	Principles of Operating Systems (3-0-3)
		CS 505	Programming, Data Structures, and Algorithms (3 credits)

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* ECE course substitution for CS 652 and CS 656 is only for students with ECE background and upon approval of the graduate advisor.

Catalog and curricula information approved by the relevant academic department.

Infrastructure Planning

Administered By: College of Architecture and Design

Administration

Program Director	Darius T. Sollohub
Associate Program Director	Georgeen Theodore
Graduate Program and Admissions Coordinator	Frederick A. Little

Faculty

Distinguished Professor	G M. Mostoller, Zeynep Celik
Professors	Sima Bagheri, Robert Dresnack, Karen A. Franck, Urs P. Gauchat, Glenn Goldman, David L. Hawk, Peter C. Papademetriou, Antonio P. De Sousa Santos, Lazar Spasovic
Associate Professors	Janice R. Daniel, David H. Elwell, Joshua S. Greenfeld, Anthony W. Schuman, Donald R. Wall
Assistant Professors	Maurie Cohen, Gabrielle Esperdy, Richard J. Garber, Wassim Jabi, Darius T. Sollohub, Georgeen Theodore
Research Professors	Ervin Bales, Richard V. Olsen

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 of 550 (pencil and paper) and 213 (computer-based) in the case of international students.

Bridge Program: Students not sufficiently experienced in design will be required to take an intensive bridge course in design prior to entering the program. This course does not count toward degree credit.

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 credits)
		MIP 612	Introduction to Environmental Policy Studies (3 credits)
		MIP 615	Introduction to Transportation Studies (3 credits)
		MIP 631	History and Theory of Infrastructure (3 credits)
		MIP 675	Elements of Infrastructure Planning (3 credits)

Semester 2:

		MIP 602	Interdisciplinary Infrastructure Studio II (6 credits)
	*	MIP 618	Public and Private Financing of Urban Areas (3 credits)
		MIP 652	Geographic Information Systems (3 credits)
	*	MIP 655	Land Use Planning (3 credits)
{		MIP 673	Infrastructure Planning in Practice (3 credits) ***or***
		MIP 674	Infrastructure and Architecture (3 credits)

* Or substitute selected with the approval of Graduate Advisor.

Catalog and curricula information approved by the relevant academic department.

Master of Science in International Business

Administered By: School of Management

Administration

Dean	Pius J. Egbelu
Associate Dean	Lisa B. Axe
Sponsored Chairs	Katia Passerini(Hurlburt Professor)* , William V. Rapp(Henry J. Leir Chair in International Business)
Director, Executive Program	Delores E. Frazier

Advisors

Undergraduate Advisor	Michael T. Sweeney
Graduate Advisor	Lilia A. Lozarito

Faculty

Distinguished Professors	Pius J. Egbelu
Professors	Asokan Anandarajan, Jerry L. Fjermestad* , Shanthi Gopalakrishnan, Kenneth D. Lawrence, Rajiv Mehta, Hindy L. Schachter, Mark Somers, Cheickna Sylla
Associate Professors	Theologos H. Bonitsis, Katia Passerini* , Marguerite A. Schneider, Stephan P. Kudyba, Yi Chen
Assistant Professors	Michael A. Ehrlich, Wei Xu, Zhipeng Yan, Ronald Sverdlove, Ellen Thomas, James E. Cicon, Cesar Bandera
Special Lecturer	Jose C. Casal, Porchiung B. Chou, Diana Walsh, Karen P. Schoenebeck

* Joint appointee with the Department of Computer and Information Science

** Joint appointee with the School of Architecture

Master of Science in International Business (30 credits)

Please note that as of Fall 2013 this program is no longer admitting any new students. If you are interested in pursuing graduate studies in international Business, please consider the MS in Management program.

The Master of Science in International Business is designed for students to gain an understanding of the activities in international business providing a framework for understanding them from the perspective of a company manager. The MSIB is a 30 credit program (which is 10 courses)

Admission Requirements:

Applicants to the MSIB must submit complete transcripts of all undergraduate work and scores on the Graduate Management Admissions Test (GMAT). The GMAT is required of all applicants except those holding a master's or doctoral degree from an accredited U.S. university. Up to nine credits of graduate work may be transferred from another school, provided that they are not counted towards a terminal degree at that school.

MSIB Pre-Qualifying Requirements: Students are expected to demonstrate competency in the area of accounting, finance, quantitative methods, information systems, and economics. Depending on the applicant's undergraduate degree program all or part of the pre-qualifier requirements can be met with prior undergraduate course work. Applicants who do not meet pre-qualifying requirements will be required to complete up to 6 credits of course work.

Degree Requirements:

Bridge Course: (3 credits)

Necessary if candidate has no academic background in finance and accounting.

	Mgmt 501	Management Foundations (3-0-3)

Module I: Core Courses: All required no substitutions (9 credits)

	Acct 615	Management Accounting (3 credits) ***or***
	Fin 600	Corporate Finance I (3 credits)
	HRM 601	Organizational Behavior (3 credits)
*	Mgmt 692	Strategic Management (3 credits) ***or***
*	Mgmt 680	Entrepreneurial Strategy (3 credits)

Module II: One Free elective course (3 credits)

Any graduate level course; may be taken outside School of Management.

Module III: Specialization Courses, choose any 6 courses (18 Credits)

Fin 627	International Finance (3 credits)
EM 636	Project Management (3 credits)
Mgmt 650	Knowledge Management (3 credits)
Mgmt 670	International Business (3 credits)
Mgmt 675	Legal Environment of International Business (3 credits)
Mrkt 620	Competing in Global Markets (3 credits)
Mrkt 631	Market Planning and Analysis (3 credits)
Mrkt 642	International Marketing Management (3 credits)

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* Should be taken only in the final semester

Catalog and curricula information approved by the relevant academic department.

Internet Engineering

Administered By: Department of Electrical and Computer Engineering (ECE).

Administration

Interim Chair	Leonid Tsybeskov
Associate Chair (Undergraduate)	Marek Sosnowski
Associate Chair (Graduate)	Nirwan Ansari

Faculty

Distinguished Professors	Yeheskel Bar-Ness, Timothy N. Chang, Bernard Friedland, Jacob Savir
Professors	Ali N. Akansu, Nirwan Ansari, John D. Carpinelli, Roy H. Cornely, Haim Grebel, Richard A. Haddad, Alexander M. Haimovich, Jacob Klapper, Durgamadhab Misra, Edip Niver, Yun-qing Shi, Kenneth S. Sohn, Marek Sosnowski, Leonid Tsybeskov, Gerald Whitman, Mengchu Zhou, Sotirios G. Ziavras
Associate Professors	Ali Abdi, Hongya Ge, Sui-hoi E. Hou, Walid Hubbi, Roberto Rojas-Cessa
Assistant Professors	Jie Hu, Raquel Perez-castillejos, Osvaldo Simeone
Special Lecturer	Arthur B. Glaser

Advisors

Undergraduate Advisor	Shivon S. Boodhoo
Undergraduate Advisor	Marek Sosnowski
MS Computer Engineering Advisor	Durgamadhab Misra
PHD Computer Engineering Advisor	Nirwan Ansari
MS in Electrical Engineering Advisor	Sui-hoi E. Hou
PHD in Electrical Engineering Advisor	Nirwan Ansari
MS telecommunications Advisor	Roberto Rojas-Cessa
MS Internet Engineering Advisor	Roberto Rojas-Cessa
MS Bioelectronics Advisor	Marek Sosnowski
MS Power and Energy Systems Advisor	Nirwan Ansari

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. International students must also achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based). Applicants with undergraduate degrees in computer science, computer engineering or electrical engineering from an accredited institution are expected to have a GPA of at least 3.0 on a 4.0 scale. These students should have taken ECE 321 (Random Signal and Noise), or another equivalent course; ECE 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 (ECE 333), basic communication systems (ECE 481), programming (CS 112 or C++ programming), data structures and algorithms (CS 505), and computer organization (ECE 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; or 21 credits must be from ECE courses.

The required courses provide the basics of Internet Engineering. Electives are to be chosen from the available course pool to tailor the program to the student's professional needs and interests. This program utilizes graduate courses in Electrical and Computer Engineering, Computer and Information Science, Management Information Systems, and Management Programs at NJIT. They provide the necessary blend of education required for appropriate strength in Internet Engineering. All MS students are required to fulfill two semesters of ECE 791 (Graduate Seminar).

Core Courses (9 Credits):

ECE 637	Internet and Higher-Layer Protocols (3 credits)
ECE 683	Computer Network Design and Analysis (3 credits)
CS 602	Java Programming (3 credits)

******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 I (3 credits)
ECE 681	High Performance Routers and Switches (3 credits)
ECE 685	Network Interface Design (3 credits)
ECE 638	Network Management and Security (3 credits)
ECE 639	Principles of Broadband Networks (3 credits)
ECE 649	Compression in Multimedia Engineering (3 credits)
ECE 645	Wireless Networks (3 credits)
ECE 636	Computer Networking Laboratory (3 credits)
CS 604	Client/Server Computing (3 credits)
Mgmt 620	Management of Technology (3 credits)
MIS 625	Management Strategies for E-Commerce (3 credits)
MIS 636	Telecommunications: Policies and Regulations
ECE 783	Computer Communication Networks (3 credits)
ECE 745	Advanced Wireless Networks (3 credits)
ECE 788	Selected Topics in Electrical and Computer Engineering (3 credits) ***or***
ECE 789	Selected Topics in Electrical and Computer Engineering II (3 credits)

Project, Thesis (optional):

ECE 700	Master's Project (3 credits)
ECE 701	Master's Thesis (3 credits)

*** Other (new) courses related to Internet Engineering may be selected as electives with approval from the Graduate Advisor

Catalog and curricula information approved by the relevant academic department.

Manufacturing Systems Engineering

Administered By: Department of Mechanical & Industrial Engineering

Administrator

Chairperson	Rajpal S. Sodhi
Associate Chairperson	Athanassios Bladikas
Program Director	Sanchoy K. Das

Faculty

Professors	Layek Abdel-Malek, Reggie J. Caudill, Sanchoy K. Das, Paul G. Ranky, Donald H. Sebastian, Stephen J. Tricamo
Associate Professors	George Abdou, Golgen Bengu, Athanassios Bladikas, Kevin J. Mcdermott, Jian Yang

Advisors

Graduate Advisors	Sanchoy K. Das

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.

Master of Science in Manufacturing Systems Engineering

This is an interdisciplinary program of advanced study for individuals with backgrounds in engineering, focusing on efficient production in technology-intensive manufacturing industries.

Admission Requirements:
Applicants should be graduates of an accredited undergraduate engineering program. Students with degrees in science may also be considered.

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	Computerized Manufacturing Systems (3 credits)
		MnE 602	Flexible and Computer Integrated Manufacturing (3 credits)
		IE 659	Supply Chain Engineering (3 credits)
		MnE 654	Design for Manufacturability (3 credits)

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)

Area of Specialization: (9 credits)

Students may choose to specialize in any one of the following areas:

PROCESS AUTOMATION:

		IE 621	Systems Analysis and Simulation (3 credits)
		MnE 655	Concurrent Engineering (3 credits)
		ECE 601	Linear Systems (3 credits)

DESIGN FOR MANUFACTURING:

		ME 635	Computer-Aided Design (3 credits)
		IE 618	Engineering Cost and Production Economics (3 credits)
		IE 665	Applied Industrial Ergonomics (3 credits)

SIX SIGMA QUALITY:

		IE 672	Industrial Quality Control (3 credits)
		IE 673	Total Quality Management (3 credits)
		IE 604	Advanced Engineering Statistics (3 credits)

Material Science and Engineering

Administered By: Committee for the Interdisciplinary Program in Materials Science and Engineering

Administration

Academic Director	N M. Ravindra

Degrees Offered: Master of Science in Materials Science and Engineering; Doctor of Philosophy in Materials Science and Engineering

This intercollegiate (CSLA and NCE), interdepartmental, and interdisciplinary degree program is intended for individuals with a strong background in science and/or engineering.

Master of Science in Materials Science and Engineering

Admissions Requirement
Applicants are expected to have an undergraduate degree from an accredited institution. A minimum undergraduate GPA of 3.0 on a 4.0 scale, or equivalent is normally required for admission. An undergraduate major in physics, chemistry, materials science, or a related engineering discipline is preferred. GRE quantitative scores of 700 or higher are highly desirable. Students from countries where English is not the native language should demonstrate TOEFL scores higher than 550 (pencil and paper) and 213 (computer-based).

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 18 credits of required materials science courses and 12 credits in an area of specialization, which are selected in consultation with the program director or graduate advisor.

Seminar
In addition to the minimum 30 degree credits required, all students who receive program or research-based awards must enroll each semester in MtSE 791 Graduate Seminar.

Required:

		MtSE 601	Fundamentals of Engineering Materials (3 credits)
		MtSE 602	Thermodynamics of Materials (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)

9 credits from the following:

		MtSE 610	Mechanical Properties of Materials (3 credits)
		MtSE 648	NanoMaterials (3 credits)
		MtSE 655	Diffusion and Solid State Kinetics (3 credits)

		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		BME 672	Biomaterials (3 credits)
{		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
{		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		ChE 602	Selected Topics in Chemical Engineering I (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ECE 657	Semiconductor Devices (3 credits)
		PHYS682	
		Phys 687	Physics of Materials (3 credits)

PROJECT OR THESIS:
Required of all students receiving program or research-based awards, optional for all others.

		MtSE 700	Master's Project (3 credits)
		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

		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 723	Defects in Solids (3 credits)
		MtSE 724	Transport of Electrons and Phonons in Solids (3 credits)
		MtSE 725	Crystallography and Diffraction (3 credits)
		PHYS661	
		PHYS682	
		Phys 687	Physics of Materials (3 credits)
		PHYS762	
		PHYS763	
		PHYS771	
		PHYS781	
		Phys 789	Physics of Advanced Semiconductor Device Processing (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ChE 702	Selected Topics in Chemical Engineering II (3 credits)
		Chem 611	Solid-State Inorganic Chemistry (3 credits)
		Chem 626	Chemistry of Contemporary Materials (3 credits)
		ECE 623	Fourier Optics (3 credits)
		ECE 625	Fiber and Integrated Optics (3 credits)
		ECE 626	Optoelectronics (3 credits)
		ECE 657	Semiconductor Devices (3 credits)

		ECE 658	VLSI Design I (3 credits)
		ECE 659	Fabrication Principles of Electronic and Optoelectronic Devices (3 credits)
		ECE 739	Laser Systems (3 credits)
		ECE 760	Solid-State Image Sensors (3 credits)

Polymer and Biomaterials

		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 655	Diffusion and Solid State Kinetics (3 credits)
		BME 669	Engineering Physiology (3 credits)
		BME 672	Biomaterials (3 credits)
		BME 667	Bio-Control Systems (3 credits)
		BME 698	Selected Topics (3 credits)
{		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
{		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		ChE 627	Introduction to Biomedical Engineering (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ChE 702	Selected Topics in Chemical Engineering II (3 credits)
		Chem 640	Polymer Chemistry (3 credits)
		Chem 643	Polymer Laboratory I (3 credits)
		Chem 645	Polymer Laboratory II (3 credits)
		Chem 661	Instrumental Analysis Laboratory (3 credits)
		Chem 673	Biochemistry (3 credits)
		Math 661	Applied Statistics (3 credits)
		ME 670	Introduction to Biomechanical Engineering (3 credits)
		ME 671	Biomechanics of Human Structure and Motion (3 credits)
		ME 675	Mechanics of Fiber Composites (3 credits)
		ME 676	Applied Plasticity (3 credits)
		ME 678	Engineering Design of Plastic Products (3 credits)
		ME 679	Polymer Processing Techniques (3 credits)
		ME 680	Polymer Processing Equipment (3 credits)

Courses in metallic biomaaterials and polymeric biomaterials offered at the University of Medicine and Dentistry of New Jersey may be taken as electives. See the program director/graduate advisor for information on how to register for them.

Particulate and Nano Materials

		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)

		MtSE 655	Diffusion and Solid State Kinetics (3 credits)
		BME 669	Engineering Physiology (3 credits)
		BME 672	Biomaterials (3 credits)
{		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
{		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		ChE 627	Introduction to Biomedical Engineering (3 credits)
		PHYS661	
		PHYS682	
		Phys 687	Physics of Materials (3 credits)
		ME 675	Mechanics of Fiber Composites (3 credits)
		ME 676	Applied Plasticity (3 credits)
		ME 678	Engineering Design of Plastic Products (3 credits)

Other Fields of Materials Science and Engineering

		MtSE 655	Diffusion and Solid State Kinetics (3 credits)
		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 723	Defects in Solids (3 credits)
		MtSE 724	Transport of Electrons and Phonons in Solids (3 credits)
		MtSE 725	Crystallography and Diffraction (3 credits)
		PHYS661	
{		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
{		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		BME 672	Biomaterials (3 credits)
		BME 667	Bio-Control Systems (3 credits)
		BME 698	Selected Topics (3 credits)
		ChE 627	Introduction to Biomedical Engineering (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ChE 702	Selected Topics in Chemical Engineering II (3 credits)
		Chem 640	Polymer Chemistry (3 credits)
		Chem 643	Polymer Laboratory I (3 credits)
		Chem 645	Polymer Laboratory II (3 credits)
		Chem 661	Instrumental Analysis Laboratory (3 credits)
		Chem 673	Biochemistry (3 credits)
		Math 661	Applied Statistics (3 credits)
		ME 670	Introduction to Biomechanical Engineering (3 credits)
		ME 671	Biomechanics of Human Structure and Motion (3 credits)
		ME 675	Mechanics of Fiber Composites (3 credits)
		ME 676	Applied Plasticity (3 credits)

ME 678	Engineering Design of Plastic Products (3 credits)
ME 679	Polymer Processing Techniques (3 credits)
ME 680	Polymer Processing Equipment (3 credits)
PHYS682	
Phys 687	Physics of Materials (3 credits)

Doctor of Philosophy in Materials Science and Engineering

This is an intercollegiate (CSLA and NCE), interdepartmental, and interdisciplinary degree program for superior students who wish to do advanced research in an area of materials science and engineering. Current areas of research include electronic and photonic materials, nano and particulate materials, polymer and biomaterials, and other areas of materials science and engineering.

Admission Requirements:
Applicants are expected to have an appropriate master's degree in materials science or related field, physics, chemistry, or engineering from an accredited institution. Students entering with a master's degree must have at least a 3.5 GPA on a 4.0 scale in previous graduate study. Highly qualified students with bachelor's degrees may be accepted directly into the doctoral program. These students must have at least a 3.5 GPA in undergraduate work.

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 9 are materials science and engineering (MTSE) 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 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 and 36 credits of MtSE 790 Doctoral Dissertation and every semester of MtSE 791 Graduate Seminar.

For those entering with a bachelor's degree:

42 credits of course work and 36 credits of MtSE 790 Doctoral Dissertation and every semester of MtSE 791 Graduate Seminar. Among the course work, the following 18 credits are mandatory.

MTSE 601	
MTSE 602	
MtSE 619	Nano-scale Characterization of Materials (3 credits)

9 credits from the following:

MtSE 610	Mechanical Properties of Materials (3 credits)
MtSE 648	NanoMaterials (3 credits)
MtSE 681	Composite Materials (3 credits)
MtSE 682	Introduction to Ceramics (3 credits)
MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
BME 672	Biomaterials (3 credits)
BME 667	Bio-Control Systems (3 credits)
BME 698	Selected Topics (3 credits)
ChE 681	Polymerization-Principles and Practice (3 credits) ***or***

		CHEM681	
		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		Chem 640	Polymer Chemistry (3 credits)
		ChE 602	Selected Topics in Chemical Engineering I (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ECE 657	Semiconductor Devices (3 credits)
		PHYS682	
		Phys 687	Physics of Materials (3 credits)

Qualifying Examination

The student must pass a written and an oral qualifying examination. The written qualifying exam given every summer is administered to test general academic preparation and competence in the research of materials science and engineering. Within one year after passing the written qualifying exam, the student is required to pass the oral qualifying exam to achieve Ph.D. candidacy, in which the potential Ph.D. candidate presents a preliminary research proposal for approval by the dissertation committee. The student will be allowed two attempts to pass the written or oral qualifying exam.

The 4 topics of written qualifying exam are:

		MtSE 601	Fundamentals of Engineering Materials (3 credits)
		MtSE 602	Thermodynamics of Materials (3 credits)
		MtSE 619	Nano-scale Characterization of Materials (3 credits)

One of the following:

		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 648	NanoMaterials (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
		BME 672	Biomaterials (3 credits)

Formation of Dissertation Committee:

Within one year of passing the written qualifying examination, doctoral students must form a five-member dissertation committee that meets the approval of the graduate program director for materials science and engineering. The committee must include the dissertation advisor, three additional faculty members from the program, and at least one member from outside the program or NJIT.

Dissertation and Defense:

An oral presentation and public defense of the doctoral dissertation is required.

Areas of Specializations

The range of possible specializations is broad. Students should consult the graduate advisor in designing the area of specializations and related degree requirements. Three focused areas and suggested courses are listed below.

Electronic and Photonic Materials

		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)

		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 723	Defects in Solids (3 credits)
		MtSE 724	Transport of Electrons and Phonons in Solids (3 credits)
		MtSE 725	Crystallography and Diffraction (3 credits)
		PHYS661	
		PHYS682	
		Phys 687	Physics of Materials (3 credits)
		PHYS762	
		PHYS763	
		PHYS771	
		PHYS781	
		Phys 789	Physics of Advanced Semiconductor Device Processing (3 credits)
		PHYS661	
		ChE 627	Introduction to Biomedical Engineering (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ChE 702	Selected Topics in Chemical Engineering II (3 credits)
		Chem 611	Solid-State Inorganic Chemistry (3 credits)
		Chem 626	Chemistry of Contemporary Materials (3 credits)
		ECE 623	Fourier Optics (3 credits)
		ECE 625	Fiber and Integrated Optics (3 credits)
		ECE 626	Optoelectronics (3 credits)
		ECE 657	Semiconductor Devices (3 credits)
		ECE 658	VLSI Design I (3 credits)
		ECE 659	Fabrication Principles of Electronic and Optoelectronic Devices (3 credits)
		ECE 739	Laser Systems (3 credits)
		ECE 760	Solid-State Image Sensors (3 credits)

Particulate and Nano 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:

		MtSE 681	Composite Materials (3 credits)
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 725	Crystallography and Diffraction (3 credits)
		MtSE 648	NanoMaterials (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		Chem 640	Polymer Chemistry (3 credits)
		BME 672	Biomaterials (3 credits)
{		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
{		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		BME 669	Engineering Physiology (3 credits)

		BME 672	Biomaterials (3 credits)
		ChE 627	Introduction to Biomedical Engineering (3 credits)
		PHYS661	
		PHYS682	
		Phys 687	Physics of Materials (3 credits)
		ME 675	Mechanics of Fiber Composites (3 credits)
		ME 676	Applied Plasticity (3 credits)
		ME 678	Engineering Design of Plastic Products (3 credits)

Polymers 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:

		MTSE 681	
		MtSE 682	Introduction to Ceramics (3 credits)
		MtSE 687	Glass Science and Engineering (3 credits)
		MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
		MtSE 719	Physical Principles of Characterization of Solids (3 credits)
		MtSE 722	Science and Technology of Thin Films (3 credits)
		MtSE 725	Crystallography and Diffraction (3 credits)
		BME 672	Biomaterials (3 credits)
		BME 667	Bio-Control Systems (3 credits)
		BME 698	Selected Topics (3 credits)
{		ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
		CHEM681	
{		ChE 682	Polymer Structures and Properties (3 credits) ***or***
		CHEM682	
		BME 669	Engineering Physiology (3 credits)
		ChE 627	Introduction to Biomedical Engineering (3 credits)
		ChE 664	Experiments and Simulations in Particle Technology (3 credits)
		ChE 702	Selected Topics in Chemical Engineering II (3 credits)
		Chem 640	Polymer Chemistry (3 credits)
		Chem 643	Polymer Laboratory I (3 credits)
		Chem 645	Polymer Laboratory II (3 credits)
		Chem 661	Instrumental Analysis Laboratory (3 credits)
		Chem 673	Biochemistry (3 credits)
		Math 661	Applied Statistics (3 credits)
		ME 670	Introduction to Biomechanical Engineering (3 credits)
		ME 671	Biomechanics of Human Structure and Motion (3 credits)
		ME 675	Mechanics of Fiber Composites (3 credits)
		ME 676	Applied Plasticity (3 credits)
		ME 678	Engineering Design of Plastic Products (3 credits)
		ME 679	Polymer Processing Techniques (3 credits)
		ME 680	Polymer Processing Equipment (3 credits)

Courses in metallic biomaterials and polymeric biomaterials offered at the University of Medicine and Dentistry of New Jersey may be taken as electives. See the graduate advisor for information on how to register for them.

Other Fields of Materials Science and Engineering

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:

	MTSE 681	
	MtSE 682	Introduction to Ceramics (3 credits)
	MtSE 687	Glass Science and Engineering (3 credits)
	MtSE 688	Mathematical and Statistical Methods in Materials Science (3 credits)
	MtSE 719	Physical Principles of Characterization of Solids (3 credits)
	MtSE 722	Science and Technology of Thin Films (3 credits)
	MtSE 723	Defects in Solids (3 credits)
	MtSE 724	Transport of Electrons and Phonons in Solids (3 credits)
	MtSE 725	Crystallography and Diffraction (3 credits)
	PHYS661	
	BME 672	Biomaterials (3 credits)
	BME 667	Bio-Control Systems (3 credits)
	BME 698	Selected Topics (3 credits)
{	ChE 681	Polymerization-Principles and Practice (3 credits) ***or***
	CHEM681	
{	ChE 682	Polymer Structures and Properties (3 credits) ***or***
	CHEM682	
	ChE 627	Introduction to Biomedical Engineering (3 credits)
	ChE 664	Experiments and Simulations in Particle Technology (3 credits)
	ChE 702	Selected Topics in Chemical Engineering II (3 credits)
	Chem 640	Polymer Chemistry (3 credits)
	Chem 643	Polymer Laboratory I (3 credits)
	Chem 645	Polymer Laboratory II (3 credits)
	Chem 661	Instrumental Analysis Laboratory (3 credits)
	Chem 673	Biochemistry (3 credits)
	Math 661	Applied Statistics (3 credits)
	ME 670	Introduction to Biomechanical Engineering (3 credits)
	ME 671	Biomechanics of Human Structure and Motion (3 credits)
	ME 675	Mechanics of Fiber Composites (3 credits)
	ME 676	Applied Plasticity (3 credits)
	ME 678	Engineering Design of Plastic Products (3 credits)
	ME 679	Polymer Processing Techniques (3 credits)
	ME 680	Polymer Processing Equipment (3 credits)
	PHYS682	
	Phys 687	Physics of Materials (3 credits)

Catalog and curricula information approved by the relevant academic department.

Mechanical Engineering

Administered By: Department of Mechanical and Industrial Engineering

Administration

Chairperson	Reggie J. Caudill
Associate Chair.	Kwabena A. Narh
Graduate Advisor	Zhiming Ji

Faculty

Professors	Rong-yaw Chen, Ian S. Fischer, Avraham Harnoy, Bernard Koplik, Kwabena A. Narh, Anthony D. Rosato, Pushpendra Singh, Rajpal S. Sodhi, Chao Zhu, I J. Rao
Associate Professors	Pasquale J. Florio, Zhiming Ji
Assistant Professors	Shawn A. Chester, Eon soo Lee
University Lecturers	Balraj S. Mani, Harry V. Kountouras, Herli Surjanhata, Veljko Samardzic

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, Energetic Materials, Machine Vision and Motion Analysis, Waterjet Machining, Robotics and Intelligent Manufacturing, Bearing Lubrication, and Plastic Processing and Analysis.

Master of Science in Mechanical Engineering

A program for engineering graduates who want advanced professional preparation and further graduate study in mechanical engineering.

Admission Requirements:
Applicants are expected to have an undergraduate degree in mechanical engineering or a related field. General admissions requirements for master's programs as described in this catalog apply to applicants to the M.S. in Mechanical Engineering. Sufficient preparation in science and mathematics to complete the course of study is also necessary.

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 Master of Science in Mechanical Engineering program offers three areas of specialization.

CAD/CAM, Mechanisms & Control - computer aided engineering, mechanisms, biomechanical & medical devices, robotics and controls.

Mechanics & Material Processing - tissues & biomechanics, continuum mechanics, plastics, micro/nano materials, particle technology.

Thermo-Fluid Systems & Energy - biofluids, computational & multiphase fluid dynamics, granular science, HVAC, energy.

The student consults the graduate advisor to plan and develop an individualized and cohesive sequence of courses that meet program requirements of at least 30 degree credits.

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:
A 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)

Required Courses: *(12 credits)*

{		ME 616	Matrix Methods in Mechanical Engineering (3 credits) ***or***
		Math 651	Methods of Applied Mathematics I (3 credits)

and select **9 credits** from:

		ME 610	Applied Heat Transfer (3 credits)
		ME 611	Dynamics of Incompressible Fluids (3 credits)
		ME 614	Continuum Mechanics (3 credits)
		ME 620	Stress Methods in Mechanical Design (3 credits)
		ME 632	Mechanical Engineering Measurements (3 credits)
		ME 635	Computer-Aided Design (3 credits)

Elective ME Graduate Courses: *(9 or more credits)*

		ME 607	Advanced Thermodynamics (3 credits)
		ME 621	Energy Methods in Mechanical Design (3 credits)
		ME 622	Finite Element Methods in Mechanical Engineering (3 credits)
		ME 624	Microlevel Modeling in Particle Technology (3 credits)
		ME 625	Introduction to Robotics (3 credits)
		ME 630	Analytical Methods in Machine Design (3 credits)
		ME 636	Mechanism Design: Analysis and Synthesis (3 credits)
		ME 637	Kinematics of Spatial Mechanisms (3 credits)
		ME 655	Introduction to Modern Control Methods (3 credits)
		ME 670	Introduction to Biomechanical Engineering (3 credits)
		ME 678	Engineering Design of Plastic Products (3 credits)
		ME 679	Polymer Processing Techniques (3 credits)

The following PhD level courses are also available:

		ME 712	Mechanics of Viscous Fluids (3 credits)
		ME 713	Non-Newtonian Fluid Dynamics (3 credits)
		ME 714	Principles of Particulate Multiphase Flows (3 credits)
		ME 717	Selected Topics in Mechanical Engineering I (3 credits)
		ME 718	(Selected Topics in Mechanical Engineering II) (3 credits)
		ME 720	(Selected Topics in Mechanical Engineering IV) (3 credits)
		ME 735	Advanced Topics in Robotics (3 credits)

		ME 736	Advanced Mechanism Design (3 credits)

General Elective Courses: *(9 or less credits)*
Graduate courses from other departments or programs.

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.

Qualifying Examination: Once admitted to the program, candidates are expected to pass a qualifying examination. Qualifying in Subject Area will be based on students passing a minimum of 4 Mechanical Engineering graduate courses, one of which must be ME 616, with a cumulative grade point average of not less than 3.6/4.0. Qualifying in Examination of Research Potential will be based on the student's formal research prospectus submitted in written form and an oral examination concerned with student's research ability and general knowledge of mechanical engineering.

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* Note: Before registering for courses, all students must submit a Graduate Registration Form and all new students must obtain approval from the graduate advisor.

Occupational Safety and Health Engineering

Administered By: Department of Industrial and Manufacturing Engineering

Administration

Chairperson	Athanassios Bladikas
Associate Chairperson	George Abdou
Program Director	Arijit Sengupta

Faculty

Professors	Layek Abdel-Malek, Reggie J. Caudill, Sanchoy K. Das, Paul G. Ranky, Stephen J. Tricamo, Carl Wolf
Associate Professors	George Abdou, Golgen Bengu, Athanassios Bladikas, Kevin J. Mcdermott, Arijit Sengupta, Jian Yang

* Joint appointment with the Department of Engineering Technology

Degrees Offered: Master of Science in Occupational Safety and Health Engineering

The curriculum has been designed in accordance with the National Institute for Occupational Safety and Health (NIOSH), which sponsors the program. Through course work and research, individuals are exposed to all of the principal areas of concern to the entry-level safety professional, including how technology and hazardous materials affect the safety of the workplace.

NJIT's program is just one of a handful offered in the United States and the only master's-level program in New Jersey. NIOSH offers a limited number of stipends and tuition remission grants to qualified students.

Master of Science in Occupational Safety and Health Engineering

This program educates engineers in the specialty of occupational safety and health. Upon graduation, students are able to assume both the technical and managerial responsibilities of safety professionals.

Admission Requirements:
An accredited bachelor's degree in an engineering or scientific field is normally required.

Bridge Program: Students who lack an appropriate background may be admitted and required to make up deficiencies by taking a program of courses that is 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 36 credits is required.

Seminar: In addition to the minimum 36 degree credits required, all students who receive departmental or research-based awards must enroll each semester in IE 791 Graduate Seminar.

Required:
18 credits:

		EM 633	Legal Aspects of Health and Safety (3 credits)
		IE 604	Advanced Engineering Statistics (3 credits)
		IE 614	Safety Engineering Methods (3 credits)
		IE 615	Industrial Hygiene and Occupational Health (3 credits)
		IE 665	Applied Industrial Ergonomics (3 credits)
		IE 685	Systems Safety (3 credits)

Thesis:
Required for NIOSH; trainees; optional for all others.

		IE 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.

		BME 670	Introduction to Biomechanical Engineering (3 credits)
		BME 671	Biomechanics of Human Structure and Motion (3 credits)
		EvSc 603	Hazardous Waste Operations and Emergency Response (3 credits)
		EvSc 614	Quantitative Environmental Risk Assessment (3 credits)
		EvSc 616	Toxicology for Engineers and Scientists (3 credits)
		IE 608	Product Liability Control (3 credits)
		IE 661	Man-Machine Systems (3 credits)
		IE 662	Cognitive Engineering (3 credits)
		IE 664	Advanced Ergonomics (3 credits)
		IE 669	Human Design Factors in Engineering (3 credits)
		IE 675	Safety in Facility and Product Design (3 credits)
		IE 681	Interdisciplinary Seminar in Occupational Safety and Health (1 credit)
		IE 682	Industrial Safety and Health Evaluation (3 credits)
		IE700	
		IE 725	Independent Research (3 credits)
		ME 660	Noise Control (3 credits)

Accounting: Offered by the School of Management. See Management course list for faculty.

UNDERGRADUATE COURSES:

Acct 115 - Fundamentals of Financial Accounting (3-0-3)
This is an introductory-level financial accounting course designed to develop fundamentals of financial accounting. This course will help students develop skills in applying financial accounting principles to record basic economic transactions, summarize and present such transactions in financial statements as well as to analyze reported accounting information from a user's perspective to make informed financial decisions. Students will also learn to appreciate accounting as a dynamic, changing discipline rather than an inflexible set of rules. **Effective From: Fall 2010**

Acct 116 - Principles of Accounting II (3-0-3)
Prerequisite: Acct 115. A continuation of Acct 115. Valuation, depreciation, costing methods, overhead accumulations, and distribution. Emphasis given to standard costs, cost estimating and budgets. **Effective Until: Spring 2010**

Acct 117 - Survey of Accounting (3-0-3)
This is an introductory course designed to develop fundamentals of financial accounting-a process of identifying, recording, and communicating economic events of an organization. This course will provide students with an opportunity to develop skills in applying financial accounting principles to record basic economic transactions, summarize and present such transactions in financial statements as well as analyze reported accounting information by using ratios. **Effective From: Spring 2011**

Acct 215 - Managerial Accounting I (3-0-3)
Prerequisites: Acct 115 or Acct 117. This course introduces fundamentals of cost and managerial accounting, including an introduction to job orders and process costing systems, cost allocation, cost behavior, managerial decision models, cost and budgetary planning and control, standard costing, analysis of variance, and responsibility accounting. The course is designed to develop the fundamentals of managerial accounting and provide students with a working knowledge of how accounting data are used by management in planning, decision-making and operational control. **Effective From: Fall 2010**

Acct 315 - Accounting for Managerial Decision Making (3-0-3)
This course wil concentrate on management decisions and the contribution of accounting toward making these decisions. Emphasis is upon using accounting information to solve business problems.

Acct 317 - Managerial Accounting (3-0-3)
Prerequisites: Acct 115, Acct 116. The techniques of evaluating labor, material and overhead costs. Rate of return, variance analysis, and break-even analysis. **Effective Until: Spring 2010**

Acct 325 - Intermediate Accounting I (3-0-3)
Prerequisites: Acct 115 or 117 This course provides an in-depth study of generally accepted accounting principles in the classification, presentation and disclosure of assets required by external users of financial statements. Students will learn to complete accounting cycle activities; prepare and evaluate financial statements with data from an accounting information system; apply financial accounting functions and theory to recognize and measure different types of assets; calculate earnings per share; carry out income tax accounting; and understand the nature and effect of accounting errors. **Effective From: Fall 2010**

Acct 335 - Managerial Accounting II (3-0-3)
Acct 335, Managerial Accounting II Prereq: Acct 215 A study of the concepts and techniques used by cost accountants to assist decision-makers within the organization. In-depth, real-world scenarios will be discussed including process accounting, job-order accounting, measuring quality costs, activity-based costing, and evaluating performance. Students will be introduced to methods currently being used by American businesses, including service firms, as well as manufacturers. **Effective From: Fall 2010**

Acct 415 - Auditing (3-0-3)
An examination of current auditing theory and procedures employed in carrying out the audit. The course will cover the life cycle of the audit from accepting an audit, gathering evidence to giving an opinion on a company's financial reports. **Effective From:**

Spring 2010

Acct 425 - Tax Accounting I (3-0-3)
Prerequisite: Acct 115 or Acct 117. This course is the first part of the two tax accounting courses, with a focus on federal individual income taxation. It is designed to give the students a comprehensive understanding of personal income tax laws and to able him to prepare personal income tax returns of considerable complexity. Topics covered in this course will include gross income, property transactions, capital gains/losses, itemized deductions employee expenses, depreciation, accounting methods and tax credits, among others. **Effective From: Fall 2010**

Acct 435 - Intermediate Accounting II (3-0-3)
Prerequisite: Acct 325. This is the second part of the two intermediate level financial accounting courses designed to review the basic financial required statements and provide accounting students with in-depth study of accounting principles advanced by responsible professional organizations. Topics covered include the classification, presentation and disclosure of assets, liabilities and stockholders' equity for external users of financial information. **Effective From: Fall 2010**

GRADUATE COURSES:

Acct 515 - ManagerialAccounting (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 - Management Accounting (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 College of Architecture and Design

UNDERGRADUATE COURSES:

Arch 155 - Modes of Design Communication I (2-3-3)
Techniques of graphic presentation introduced as a basic language of architecture. Students work with a broad range of graphic presentation methods. Skills developed in drawing and architectural delineation. Fundamentals of perspective drawing, rendering techniques and format layout examined through an array of projects.

Arch 156 - Modes of Design Communication II (2-4-3)
Prerequisite: Arch 155. This course deals with advanced knowledge and skill acquisition of the diverse categories of information delivery required by the design professionals. **Effective From: Spring 2007**

Arch 163 - Introduction to Design I (1-12-5)
Introduction to an array of basic principles and elements of design. Emphasis on design methods, sensitivity to context, manipulation of form and space, and representation skills. General design fundamentals presented in the lecture hour.

Arch 164 - Introduction to Design II (1-12-5)
Prerequisite: Arch 163. A continuation of Arch 163.

Arch 223 - Construction I (3-0-3)
This course is an introduction to construction processes, focusing on wood, steel, masonry, concrete materials and their related assemblies. **Effective From: Fall 2011**

Arch 225 - Building Systems I (0-3-3)
This course is an introductory survey of the general principles and application of Sustainable Design, Site Systems, Structural Systems, Environmental Systems, Envelope Systems, Materials and Assembly Systems. This course will primarily focus on low-rise wood and steel structures. **Effective From: Fall 2007 Until: Spring 2013**

Arch 227 - Environmental Control Systems I (3-0-3)
This course introduces passive environmental design emphasizing sun, wind, daylight, heat flow, insulation/mass, visual comfort, thermal comfort, shading, climate, natural ventilation. The course uses ecotect software for thermal analysis. **Effective From: Spring 2012**

Arch 229 - Structures I (3-0-3)
This course begins with the history of building structures, continues by introducing structural behavior, forces and responses in structural systems, and concludes with an introduction to static structural analysis. **Effective From: Spring 2012**

Arch 251 - History of Architecture I (3-0-3)
Prerequisite: Hum 101. Introduces architectural history, theory and design, providing a conceptual framework for looking at the built environment. This course introduces key architectural concepts beginning with the earliest examples of human occupation, the shaping of space, and the transformation of natural landscape. Its geographic scope is global and its chronological scope ranges from prehistory to the middle ages. **Effective From: Fall 2011**

Arch 252 - History of Architecture II (3-0-3)
Prerequisite: Arch 251. This survey of the social, political, technological, functional, and aesthetic concerns of architectue, urban forms, and built and natural landscapes is a continuation of Arch 251. It covers the period from the 15th century to 1900 in Europe, the Americas, the Middle East, and Asia. Among its emphases are the impact and significance of absolutism, colonialism, nationalism, humanism, the enlightenment, industrialization and modernity. **Effective From: Spring 2012**

Arch 263 - Architecture Studio I (1-12-5)
Prerequisite: Arch 164. Utilizing knowledge and skills gained in Introduction to Design I and II, students learn about architectural

design. Examination of the technological, social and environmental issues as they relate to architectural design. Lecture hour used to explore in-depth aspects of architecture.

Arch 264 - Architecture Studio II (1-12-5)
Prerequisite: Arch 263. A continuation of Arch 263. Lecture hour used to explore in-depth aspects of architectural design.

Arch 282 - Structural Principles (3-0-3)
Introduces structural statics through timber and steel design. Influences of materials and structural system choice analyzed relative to their impact on building design. Responsibilities of the architect during the structural design phase are introduced. **Effective From: Fall 2013**

Arch 283 - Special Topics (3)
Investigation of problem of special interest in architecture.

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

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

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

Arch 316 - Computer Applications to Architecture (2-3-3)
Prerequisite: CIS 104. Introduces both philosophical and technical approaches to the use of the computer in architectural design and analysis. Explores the use of existing computer programs for spatial allocation, energy analysis, life cycle costing, problem analysis, and computer simulation. Projects include development of computer programs applicable to architecture.

Arch 317 - Advanced Architectural Graphics (2-3-3)
Prerequisite: Arch 155, Arch 264. Gives students advanced techniques for architectural expression, including Chinese ink wash and air brush techniques. Emphasis on how drawing may be used to reveal the inner qualities of design. A basic knowledge of drawing methods, media, materials, and projection techniques is assumed.

Arch 318 - New York City Lab (1-6-3)
Prerequisite: Arch 364. Explores the architectural and environmental development of New York City during the past 200 years in an organized series of field trips. Each week's trip encompasses a section and/or representative aspect of the city's evolution.

Arch 323 - Construction II (3-0-3)
Prerequisite: Arch 223. This course surveys enclosure joints and assemblies, including roofing, insulation, doors, windows, glass and hybrid systems. It also focuses on interior and exterior finishes and their construction methodology and documentation, including Building Information Modeling (BIM). **Effective From: Fall 2012**

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

Arch 328 - Urban Values (2-3-3)

Prerequisites: Arch 363. A survey of urban planning practice and historical, contemporary, and theoretical urban design approaches. Considers the physical environment as a response to human values, and explores how nature, the city, and the user influence the form and content. Case studies include cities, towns, and specialized recreation and retirement communities. Laboratory work includes field trips, demonstration exercises, and analysis of case studies.

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

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

Arch 332 - Architecture: Image and Word I (2-3-3)
This course will present films on Architecture in which architects are speaking about and showing their own work. What we think is true about architecture is often wrong. Single images tend to abstract and greatly simplify why and how great architecture is created. Rarely are buildings seen in their content. Rarely are climatic, cultural and technical issues of design illustrated. As a result, we often speculate about architecture based upon superficial or incomplete information. **Effective From: Fall 2007**

Arch 333 - Architecture: Image and Word II (2-3-3)
This course will present films on Architecture in which architects are speaking about and showing their own work. Theoreticians provide "facts" to create a unified theory of design, which may lie outside the realm of historical reality, or the intention of the architect. The culture of architectural education and the nature of the design studio results in second hand knowledge, and design myth. Surveys of modern architecture leave a fragmentary memory of great works of architecture. **Effective From: Fall 2007**

Arch 334 - Color Theory/Electronic Color (3-0-3)
The multiple-media course includes lectures with supplemental readings, videos, in-class analysis and laboratory work, and homework requiring a variety of media including watercolor and computer graphics - all of which address a range of issues including interaction of color, psychology of color, design for color deficient vision, color mixing and color palettes, color reproduction, color models, color composition in art and architecture, and others. Digital applications are integrated throughout. **Effective From: Fall 2007**

Arch 335 - Digital Tectonics (3-0-3)
This course uses 3D modeling tools to investigate the relationship of digital models to physical construction. The term digital tectonics refers to an idea regarding the qualities of works of contemporary architecture that seem to be influenced by the use of digital tools. In this course, students are asked to investigate this hypothesis by testing structure, skin, assemblage, form and space making methodologies that are aided by digital tools and rationalized through digital operations. **Effective From: Fall 2007**

Arch 337 - Building Information Modeling (3-0-3)
This course explores both technical and philosophical approaches to the use of the computer in architectural analysis, design development, information management, and document delivery. Autodesk Building Systems and Autodesk Revit Building will be used for 3D modeling and 2D documentation employing a systems-approach framework for spatial allocation, energy analysis, and structural considerations. The workings of the foundational information databases of the respective software will be thoroughly explored. Projects requirements will include building program resolution, solar analysis, asset scheduling, document layout, and design visualization. Proficiency with Autodesk Autocad (2D) and understanding of general CAD principles are required prerequisites; the formal prerequisite course is Arch 316/647. **Effective From: Fall 2007**

Arch 363 - Architecture Studio III (1-12-5)
Prerequisite: Arch 264, Arch 223, Arch 227 and Arch 229. This course is a continuation of Arch 264. Lecture hour explores the nature of technology, environment, and social order as they relate to studio work. Course materials purchase required. **Effective From: Spring 2013**

Arch 364 - Architecture Studio IV (1-12-5)
Prerequisites: Arch 363. A continuation of Arch 363. Lecture hour explores in depth the nature of technology, environment, and social order as they relate to studio work. Students will be required to purchase course materials.

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

utopia. **Effective From: Fall 2012**

Arch 382 - History of Architecture IV (3-0-3)
Prerequisite: Arch 381. The last in the sequence of history surveys, this course examines global developments in modern and contemporary architecture and urbanism after World War II and into the 21st century. Social uprisings, economic recessions, post-colonialism, modernization in the developing world, mass production and mass consumption, environmentalism, sustainability, and the computer revolution of the information age provide the historical and cultural framework for the course. The course pays particular attention to early extensions and critiques of modernism, the emergence of postmodernism and current efforts to reevaluate modernism's legacy. **Effective From: Spring 2013**

Arch 403 - The American Home and Household I (3-0-3)
Prerequisite: junior or senior standing. A cultural, architectural analysis of American homes and households throughout history. Included are the Puritan society and Colonial home, the Victorian home and family, the frontier homestead, 19th century utopian communes, immigrants, the working class poor and urban tenements, war housing, and suburban homes. Students explore the meaning, use and design of each domestic setting from the point of view of society, the family and the individual, considering differences based on race, sex and class.

Arch 404 - The American Home and Household II (3-0-3)
Prerequisite: junior or senior standing. Analyzes the architecture of 20th century American homes and households, hotels, apartment houses, war housing, suburban homes, public projects, collectives, communes, self-help housing, and housing concepts for the future. Psychological, sociological, and cultural perspectives are considered insofar as they affect the architecture of the home.

Arch 408 - Advanced Landscape Architecture (2-3-2)
Prerequisite: Arch 331. Introduces the design, construction and management of contemporary landscape projects through case studies, field trips, and personal contact with prominent practicing landscape architects. A historical perspective of landscape architecture is used as a context for discussion.

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

Arch 419 - Architectural Photography (2-3-3)
Prerequisite: Arch 364. Gives a wide range of photographic solutions for presentations and portfolios. Lectures consist of orientation on general topics, including light and space, using relevant text selections and slide presentations for reinforcement. Includes basic demonstrations of darkroom techniques and unorthodox methods to encourage experimentation.

Arch 422 - Mythical House (3-0-3)
Prerequisites: Arch 172, Arch 252, Arch 363. Shows that the house develops not only in response to reasoning, laws of physics, and biological needs, but also in response to magic, ritual, culture, personality, fantasy, and dreams.

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

Arch 429 - Structures III (3-0-3)
Prerequisite: Arch 329. This course focuses on wood systems analysis, steel systems analysis, indeterminate systems and integrated structural systems. Methodology involves finite member analysis.

Arch 431 - Advanced Representational Techniques (3-0-3)
This course is intended for upper level architecture students who have completed a number of academic or professional projects. Students must have a basic understanding of computer use. Topics covered will be critical analysis of content, organization of material, and translation of existing work. Instruction will be given in layout software packages such as Adobe Illustrator. Direction will also be given in web site design using Macromedia Flash in an architectural content. **Effective From: Spring 2008**

Arch 432 - P3 Post Presentation Processing (2-3-3)
The project is deemed Architecture, with a capital A, but there remains nagging questions: What would the project be like if viewed stereoscopically? If it were rendered as a 360 degree panoramic view, what would the space be like? If it was accurately superimposed into the site (lighting, color, texture, camera angle), does the design improve when in the context? Would rendering styles using "natural media" be more descriptive? What would the architecture be like at night? **Effective From: Fall 2007**

Arch 433 - Cinematic Literacy for Architects & Urban Designers (3-0-3)
This course will use the digital video camera, digital compositing, and interactive DVD to introduce alternate means of communicating architectural ideas. The course will explore narrative techniques, linear and random-access sequencing and will cover critical analysis of film technique, storyboarding, and the authoring of short vignettes. The final project will be a digital image set on authored DVD expressing an architectural case study of a chosen building, site analysis, and/or urban issue. **Effective From: Fall 2007**

Arch 434 - Simulated Environments (3-0-3)
This course will explore the application of desktop, non-immersive virtual reality to the representation of architecture. Course exercises and projects are designed to uncover both advantages and limitations of this emerging technology, on both practical and theoretical levels. The major focus of the course will be personal evaluation of these tools in the design of both object-specific and the spatial in architectural problem solving. The collaborative nature of the toolkit will inform design decisions vis-a-vis observation of participant behavior and open discussion with interactive critics. **Effective From: Fall 2007**

Arch 460 - Studio Abroad (1-12-5)
Prerequisite: Arch 364. Studio coursework taken fully or partially abroad with an emphasis on urban design and recognition of local conditions and situations. Lecture hour coordinates with studio subject matter. Course materials purchase required. **Effective From: Spring 2012**

Arch 463 - Option Studio 1 (1-12-5)
Studio methodology allows the students to select from various building programs, the nature of design dealing with technology, environment and the social order. Lecture hour coordinates with studio subject matter. Course materials purchase required. **Effective From: Fall 2011**

Arch 464 - Option Studio II (1-12-5)
Prerequisite: Arch 463. Studio methodology allows students to select from various building programs, the nature of design dealing with technology, environment and the social order. **Effective From: Fall 2007**

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

Arch 483/483H - Special Topics (3)
Group investigation of problem of special interest in architecture.

Arch 491 - Independent Study (1)
null

Arch 492 - Independent Study (2)
null

Arch 493 - Independent Study (3)
null

Arch 525 - Building Systems VII (0-3-3)
Prerquisite: Arch 425. This is an advanced course that uses in-depth, detailed case studies of four to six well-designed buildings of various types, from small scale to large, from simple to complex, to illustrate the totality of building systems integration. **Effective From: Fall 2007 Until: Spring 2013**

Arch 530 - Methodologies of Architectural History, Theory and Criticism (3-0-3)
Prerequisites: Arch 382. A seminar examining the salient methodologies of architectural history, theory and criticism. Structured around a series of critical texts, with each set of core readings intended to provide a basis for analyzing and assessing the approach in question.

Arch 531A - History of Renaissance Architecture (3-0-3)
Prerequisites: Arch 382. An examination of the development of Renaissance architecture and urban design in Italy and elsewhere in Europe. The re-emergence of the classical tradition is considered within the context of social, political and economic developments as well as formal intentions.

Arch 531B - History of Baroque Architecture (3-0-3)
Prerequisites: Arch 382. An investigation of architectural development from the 17th and 18th centuries in Europe and Latin

America, including consideration of stylistic variations, social and political factors, and trends in garden and urban design.

Arch 531C - History of Modern Architecture (3-0-3)
Prerequisites: Arch 382. A study of major tendencies of architectural theory and practice from the mid-19th to the mid-20th centuries. Formal and stylistic transformation is considered in relation to theoretical intentions as well as social, cultural, and technical developments.

Arch 531D - History of American Architecture (3-0-3)
Prerequisites: Arch 382. An investigation of the guiding ideals and dominant stylistic trends in American architecture and planning from colonial times to the mid-20th century. Critical shifts in conception and scope of architectural production considered in relation to the prevailing cultural, socio-economic, and technical contexts out of which they evolved.

Arch 531E - History of Non-Western Architecture (3-0-3)
Prerequisites: Arch 382. An examination of major architectural traditions of China, Japan, Southeastern Asia, India, and the Middle East. Each area is considered with reference to a conceptual, iconographic and stylistic paradigm that evolved from a particular historical context.

Arch 531F - Thresholds of Architectural Theory (3-0-3)
Prerequisites: Arch 382. A seminar that investigates key thresholds of Western architectural theory, from Vitruvius to Robert Venturi, with emphasis on examining the corresponding critical theoretical texts and related didactic buildings and projects.

Arch 531H - Aspects of Urban Form (3-0-3)
Prerequisites: Arch 382. An examination of the major forms and patterns of urban development from classical antiquity to the 20th century, considered in relation to the changing conceptions of the city as well as cultural, socio-economic, and political development.

Arch 532 - Problems and Methods in Architectural Preservation (3-0-3)
Prerequisites: Arch 382. Theory and practice of preservation planning, with emphasis on current concepts, problems and techniques of area preservation in the United States. Exploration of the successive guiding ideals and _approaches to historic preservation in America, together with their European parallels and ante-edents. Discussion of theories of continuity and change in the urban environment and of planning concepts and techniques that further preservation planning objectives in relation to programs for community development and neighborhood conservation.

Arch 533 - Case Studies in Architectural Creativity (3-0-3)
Prerequisite: Arch 364. Considers creativity in architecture from psychological, philosophical and autobiographical perspectives. The buildings, writings and lives of contemporary architects are discussed in the context of general theories of creativity. Each student chooses an individual architect noted for creative accomplishments and prepares a case study of his or her life.

Arch 534 - History of Architectural Technology (3-0-3)
Prerequisites: Arch 382. Survey of the development of building methods and materials. Impact of structural and environmental technology on architectural form and the design process. The role of technology in contemporary architectural theory and practice, including the modern movement, is emphasized.

Arch 535 - History of Architectural Ideas (3-0-3)
Prerequisite: Arch 382. Discusses seminal architectural ideas in the western world from Vitruvius to the present day. Read books written by leading architectural theorists and analyze them in detail.

Arch 536 - Landscape and American Culture (3-0-3)
Prerequisite: Arch 331. As in architecture, the parallel discipline of landscape architecture involves artistic intention set in conjunction with utilitarian concerns. As such, designs on the land include the integration of the arts and sciences of human culture with nature. Discusses landscape as a manifestation of American culture.

Arch 537 - Advanced Structures (3-0-3)
Prerequisite: Arch 384. Covers advanced material in structures related to steel and wood design including: steel industrial buildings, rigid frames and earthquake design, wood structures under axial loads, and combined bending and axial loads.

Arch 538 - Sustainable Architecture (3-0-3)
Follows two precepts: accepting responsibility for the consequences of design decisions upon human well-being, and the long-term viability of natural systems. Topics include sustainable site design and development, environmentally sensitive building materials, lifecycle cost benefit analysis of building systems, and adaptive reuse.

Arch 539 - Advanced Construction (3-0-3)
Pre-requisite: Arch 242. Explores the relationship between an architect's design intention and the construction document. Design

a small building or addition and complete construction drawings of the design. Addresses problems and procedures encountered by an architect during the construction documents phase. **Effective Until: Spring 2013**

Arch 540 - Acoustics (3-0-3)
Prerequisites: Arch 241, Arch 242, Arch 342. Architectural acoustics: how we hear, physics of sound and materials, aesthetics of design and the processes of construction. Audible sounds, their interaction, perception of echo and directional hearing are applied to interior and exterior building transmission, room acoustics, and setting acceptable acoustical environments.

Arch 543 - Lighting (2-2-3)
Prerequisites: Arch 386 and Arch 387 or equivalents. Explores, through modeling and calculation, the means by which architectural form and detail influence the luminous environment. Perceptual responses such as visual comfort and delight are examined. Topics include daylighting footprints, model design and testing, and computer-assisted light level analysis. Areas of investigation include the relationship between daylight and electric light in architecture; the variations of light with time; analysis of seasonal and weather differences; role of task in lighting strategies; and means of control for light quantity and quality.

Arch 545 - Case Studies in Architectural Technology (3-0-3)
Prerequisite: senior standing. Technological systems involved in the construction and use of buildings. Students conduct in-depth investigation of technology-related problems in architecture and construction. Case study method is used. Construction documents and reports are analyzed. Field visits are required.

Arch 546 - Designing and Optimizing the Building Enclosure (3-0-3)
Prerequisites: Arch 386, CIS 104. Considers the "building envelope,?? the boundary dividing the inside of a structure from the outside environment. Study and design optimal enclosures considering energy exchange, the relationship between energy and light, and life cycle costs.

Arch 547 - Special Topics in Computer Applications (2-2-3)
Prerequisite: senior standing. Evaluation, utilization, and development of computer programs for analysis, simulation and information management. Programs range from energy analysis, building structures analysis, and mechanical systems design to spatial allocation, graphics and computer-aided design. Different theories of information transformation and delivery used in terms of architectural applications. Course hardware ranges from computer-aided design and drafting systems, through micro and mini, to mainframe computers.

Arch 549 - Life Safety Issues in Contemporary Buildings (3-0-3)
Prerequisites: Arch 386, Arch 387. A variety of life safety and comfort situations studied in terms of specific building types. Topics include building evacuation, compartmentalization, fire fighting and suppression, evaluation and testing of new building materials and systems, systems control and management. Special emphasis is on such building types as multi-use, high-density, schools, hospitals, and other institutional categories.

Arch 550 - Building Economics (3-0-3)
Prerequisite: senior standing. Economic issues and methods of analysis influencing the building process and product are presented. The focus is on relations between architectural decisions and economic consequences. Students use computer models to manage building cost data and conduct life cycle costing.

Arch 552 - Real Estate Analysis for Architects (3-0-3)
Prerequisite: completion of the third year. Introduction to the economic, financial and political aspects of real estate and their effect on architectural decision-making. Topics include needs assessment, real estate appraisal, financial instruments, regulations and real estate, design as value-adding, and the effect of tax policies on real estate development.

Arch 556 - Systems Approach to Design and Construction (3-0-3)
Prerequisite: completion of the third year. Lectures, case studies and student projects on understanding human aspiration and needs through design. Topics include land, finance, management, technology, and labor.

Arch 557 - Problems in Modern Housing (3-0-3)
Prerequisite: Arch 382 Historical approach places housing in its social, economic, and political context. Attempts to provide decent, affordable and well-designed housing for broad segments of society are examined. Dwelling is examined through analysis of proto-typical design solutions in urban environments.

Arch 558 - Professional Architectural Practice (3-0-3)
Prerequisite: Arch 364. A forum for examination of the structure and practices of the profession of architecture. The formal and informal relationships between architects, and between architects and clients, government officials, and consultants are studied. Basic principles of office management for the small and large architectural firm are introduced.

Arch 559 - Social Issues in Housing (3-0-3)

Lecture/seminar explores the historical, economic, social, technological, and political basis for current American housing policy and practice. Examines government, community-based and private sector attempts, both failed and successful, at providing decent, affordable, and well-designed housing for broad segments of society. Student teams analyze and discuss, in a series of classroom debates, the housing and planning implications of controversial social problems from homelessness and racial segregation to caring for the elderly and people with HIV/AIDS with an emphasis on the role of the architect. **Effective From: Spring 2013**

Arch 563 - Comprehensive Studio I (1-12-5)
Prerequisites: Arch 464, Arch 423, Arch 327 and Arch 429. This studio focuses on the student's ability to assess, select, and conceptually integrate structural systems, building envelope systems, environmental systems, life-safety systems, and building service systems in the building design. Lecture hour coordinates with studio subject matter. Course materials purchase required. **Effective From: Fall 2011**

Arch 564 - Comprehensive Studio II (1-12-5)
Prerequisite: Arch 563. This Studio focuses on the student's ability to produce a comprehensive architectural project based on a building program and site that includes development of programmed spaces demonstrating an understanding of structural and environmental systems, building envelop systems, life-safety provisions, wall sections and building assemblies and the principles of sustainability. Lecture hour coordinates with studio subject matter. Course materials purchase required. **Effective From: Spring 2012**

Arch 565 - Comprehensive Studio Lab (0-3-1)
Prerequisites: Arch464. Corequisite: Arch 563 or Arch 564. Held in design studio each week, the lab consists of presentations by the instructor on relevant technical and life safety -issues and student exercises applying these principles to their current design studio project or to existing buildings.

Arch 566 - Advanced Architectural Design Studio (1-12-5)
Prerequisite: Arch 564. This is an advanced architectural design studio, post Comprehensive Studio, studying contemporary design theories, design methods and construction technologies. Emphasis is placed upon independent design research as it relates to the broad range of architectural practice. Exploratory and experimental architectural projects are the focus of the course. **Effective From: Fall 2011**

Arch 571 - Everyday Life in the Public Realm (3-0-3)
A significant portion of everyday life takes place in the public realm of streets, sidewalks, parks, transit stations, government buildings, commercial establishments, and cultural institutions. Focuses on recent descriptions and critiques of public space and proposals for change.

Arch 572 - Architecture and Social Change (3-0-3)
Prerequisite: senior standing. Architectural form is analyzed in relation to political, economic and technological change, and change in social values. Buildings and other designed environments such as parks, streets and neighborhoods are studied relative to the social processes and institutions that generate and transform them. The role of the design professions in initiating or supporting change also is considered

Arch 573 - Technologies for Community and Urban Design (3-0-3)
Prerequisite: senior standing. Advanced and traditional technologies analyzed with regard to their role in community and city design, construction and reconstruction. Emphasis on technological systems influencing location, configuration and use. Examples are infrastructures, communication systems and construction technologies. Develops skills in using methods to evaluate alternative technologies relative to their social, economic and physical promise, problems and feasibility.

Arch 574 - Case Studies in Community and Urban Design (3-0-3)
Prerequisite: senior standing. In-depth investigation of specific real-world problems of urban or community design carried out using case method approach. Current practices in the U.S. and other countries studied using interviews with designers, developers, community groups and government agencies. Site visits, reports and other documents provide important sources of information. Final report with supporting documentation required.

Arch 576 - The Architecture of Utopia (3-0-3)
Prerequisite: senior standing. Seminar for the review of utopian projects that have attempted to embody and strengthen social ideas through transformations in the structuring of space. Architectural implications of different literary and philosophical utopias analyzed with an emphasis on those experimental proposals which were realized, in whole or in part, in built form.

Arch 583/583H - Special Topics (3)
Group investigation of problem of special interest in architecture.

Arch 584 - Video and Animation (3-0-3)

Prerequisite: Arch 363. Presents the concepts of 3-D surface modeling, rendering, key frame animation, and video production in the context of the design process using the computer program ALIAS STUDIO. Emphasizes the underlying geometric principles of surface modeling, the components of color theory and texture mapping, the principles of key frame animation, and video production. The project for the semester is a short animated video. Also discusses scene Description Language programming. **Effective Until: Spring 2010**

Arch 588 - Architoons (3-0-3)
Prerequisite: Arch 364. Through the medium of film, applies literary devices to architectural contexts, including caricature, parody, lampoon, satire and farce. Studies historical and contemporary animations and short films for their treatment of meaning, story line and sequence, timing, environmental and psychological mood, atmosphere and emotion. Using 3-D modeling and animation software, each student produces an animated short subject illustrating an architectural principle or providing a humorous look at architectural history and theory.

Arch 591 - Independent Study (1)
null

Arch 592 - Independent Study (2)
null

Arch 593 - Independent Study (3)
null

GRADUATE COURSES:

Arch 500G - Advanced Architectural Graphics (3 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. **Effective From: Spring 2014**

Arch 501G - Architectural Design I (6 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. **Effective From: Spring 2014**

Arch 502G - Architectural Design II (6 credits)
Prerequisites: Arch 501G, Arch 528G, Arch 541G, Arch 555G. Core Studio. Extends the knowledge of design, basic concepts and ideas introduced in Arch 501G. Emphasis is on developing technical drawing, and model-making skills. Also covered are two- and three-dimensional composition. Links to the history and theory sequence are made. **Effective From: Spring 2014**

Arch 503G - Architectural Design III (6 credits)
Prerequisites: Arch 500G, Arch 502G, Arch 529G, Arch 543G, and Arch 545G. Core Studio, Intermediate design studio. Introduction to structure. Properties of materials both physical and in the abstract. Builds on knowledge gained from construction and structures courses, spatial demands and design possibilities of different structural systems. Design of structure type, model and context, and comparisons of building typology for rational structure. Drawing and its role in design thinking. **Effective From: Spring 2014**

Arch 504G - Architectural Design IV (6 credits)
Prerequisites: Arch 503G, Arch 542G, Arch 544G. Arch 548G. Corequisite:547G. Second semester intermediate design studio. Design of buildings and integration of systems, physical and conceptual. Design methodology generates new information on buildings as coherent assemblies of systems. Also covers analysis and synthesis of form and introduction to applications of computer-assisted design (CAD). Preparation of design portfolio will complete core studio sequence. **Effective From: Spring 2014**

Arch 505G - Advanced Design Options I (6 credits)
Prerequisites: Arch 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions. **Effective From: Spring 2014**

Arch 506G - Advanced Design Options II (6 credits)
Prerequisites: Arch 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions. **Effective From: Spring 2014**

Arch 507G - Advanced Design Options III (6 credits)
Prerequisites: Arch 504G. Required vertical studio electives; must be taken sequentially. Covers arange of advanced design issues in depth: integration of organizational, social, technical, spatial, and aesthetic issues within consistently articulated applied design solutions. **Effective From: Spring 2014**

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. **Effective Until: Summer 2007**

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 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 541G - Construction I (3 credits)
This course is an introductory survey of the general principles and application of Sustainable Design, Site Systems, Structural Systems, Environmental Systems, Envelope Systems, Materials and Assembly Systems. This course will primarily focus on low-rise wood and steel structures. **Effective From: Spring 2014**

Arch 542G - Integrated Building Technologies (3 credits)
Prerequisites: Arch 541G This course is an introductory survey of the interrelationship of the principles and applications of Sustainable Design, Site Design, Structural Systems, Environmental Systems, Envelope Systems and Materials and Assembly Systems. This course will primarily focus on low and medium-rise concrete and masonry structures and is coordinated with a studio design/build experience. **Effective From: Spring 2014**

Arch 543G - Environmental Control Systems I (3 credits)
An introductory survey of the basic principles of building, environmental control, and service systems as these relate to the building envelope. This course will primarily cover thermal enclosure, climate modification, environmental systems, energy use, and sustainable design. It also introduces the principles of health and safety in the design of buildings. **Effective From: Spring 2014**

Arch 544G - Environmental Control Systems II (3 credits)
This is an intermediate course focusing on the understanding of the principles, performance criteria, and applications of environmental and building service systems including lighting, acoustical, plumbing, electrical, vertical transportations, egress, communication, security, and fire protection systems. **Effective From: Spring 2014**

Arch 545G - Structures I (3 credits)
This is an intermediate course focusing on the principles of structural behavior in withstanding gravity and lateral forces and on the evolution, range, and appropriate application of structural systems and the criteria for selecting various structural systems in contemporary architecture. Specific architectural procedents from the 20th century are used as validating examples. **Effective From: Spring 2014**

Arch 546G - Structures: High Rise and Special Applications (3 credits)
Prerequisite: 545G. This is an advanced course focusing on the integration of all building systems including new materials and methods as they relate to high-rise structures and other specialty building types. **Effective From: Spring 2014**

Arch 547G - 4D Integration (3 credits)
Arch 542G, Arch 544G, Arch 548G. Corecquisite: Arch 504G. This is a required, advanced design course that uses in-depth, detailed case studies of various construction types, from small scale to large, from simple to complex, to illustrate the totality of building systems integration. In conjunction with site visits, coursework will employ software to examine construction sequences, building components and shop drawings and their relationship to the design processes **Effective From: Spring 2014**

Arch 548G - Structures II (3 credits)
Prerequisite: 545G. This is an advanced course dealing with structural computation that will conclude with rigorous case study investigation of hybrid and complex structural systems. **Effective From: Spring 2014**

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 and Arch 502G. Through modeling and calculation, influence of the luminous environment on architectural form and detail. Perceptions of visual comfort and daylight are examined. Topics include daylighting footprints, model design and testing, and computer-assisted, light-level analysis. Relationship between daylight and artificial light in architecture, variations of light with time, analysis of seasonal and weather differences, role of task in lighting strategies, and means of control for light quantity and quality.

Arch 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 679 - Envisioning Newark (3 credits)
This seminar combines classroom discussion based on historical, analytical and literary texts; field visits to Newark's districts and neighborhoods; and meetings with leaders in government, business, art, education, and community-based organizations. The objective is to introduce students to the redevelopment process underway in Newark, and to use the city as a springboard for a broader investigation of the theory and practice of urban development. **Effective From: Spring 2011**

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.

BioInformatics: BioInformatics

UNDERGRADUATE COURSES:

BNFO 135 - Programming for Bioinformatics (3-0-3)
The ability to use existing programs and to write small programs to access bioinformatics information or to combine and manipulate various existing bioinformatics programs has become a valuable part of the skill set of anyone working with biomolecular or genetic data. This course provides an unerstanding of the architecture of bioinformatics toolkits and experience in writing small bioinformatics programs using one or more of the scripting ("glue") languages frequently employed for such tasks. **Effective From: Spring 2009**

BNFO 136 - Programming for Bioinformatics II (3-0-3)
Advanced programming skills in Perl or Python with appliations to bioinformatics. **Effective From: Spring 2010**

BNFO 235 - Programming for Bioinformatics (3-0-3)
The ability to use existing programs and to write small programs to access bioinformatics information or to combine and manipulate various existing bioinformatics programs has become a valuable part of the skill set of anyone working with biomolecular or genetic data. This course provides an understanding of the architecture of bioinformatics toolkits and experience in writing small bioinformatics programs using one or more of the scripting ("glue") languages frequently employed for such tasks. **Effective From: Fall 2006 Until: Fall 2008**

BNFO 240 - Principles of Bioinformatics II (3-0-3)
Prerequisites: Math 211, R120:301, CS 114 or permission of the instructor. This course provides an introduction to the field of bioinformatics. It includes a description of the molecular basis of genomics and proteomics, the computer-based and mathematical methods used in bioinformatics, and the application of these methods toward understanding biological systems at the cellular and molecular level. It also includes a description of the application of bioinformatics to drug discovery. **Effective From: Fall 2006**

BNFO 340 - Data Analysis for Bioinformatics (3-0-3)
Advanced data analysis skills with applicaitons to popular bioinformatics problems. **Effective From: Spring 2010**

BNFO 482 - Databases and Data Mining in Bioinformatics (3-0-3)
Surveys biological databases and tools for managing them. Covers concepts and principles of data mining in bioinfomratics. Hands-on experience for mining genomic data using ORACLE and SQL. **Effective From: Spring 2010**

BNFO 491 - Computer Science Project (3-0-3)
Prerequisites: CS 490, senior standing in the Honors College and project proposal approval. A course similar to CS 491, with a project of greater depth and scope **Effective From: Spring 2011**

GRADUATE COURSES:

BNFO 601 - Foundations of Bioinformatics I (3 credits)
Introduction to script programming and basic biomolecular sequence analysis. Topics covered include sequence alignment, dynamic programming algorithms, hidden Markov models, and their implementation with a scripting language. **Effective From: Fall 2009**

BNFO 602 - Foundations of Bioinformatics II (3 credits)
Topics in bioinformatics such as phylogeny reconstruction, genome-wide association study analysis, structure and sequence analysis, and machine learning and statistical approaches. Focus of the course is on a hands-on project on a contemporary bioinformatics problem. **Effective From: Fall 2009**

BNFO 615 - Data Analysis in Bioinformatics (3 credits)
Data structures, algorithms, and statistical approaches in bioinformatics. The course emphasis is on statistical models, algorithms,

and data structures with relevant biological background and motivation. **Effective From: Fall 2009**

BNFO 620 - Genomic Data Analysis (3 credits)
This course will introduce students to the practice of analyzing large-scale genomic data generated by recent high throughput bio-techniques. It will cover microarray data and short-read sequencing data. It presents widely used analytical methods and software. The course includes several case studies on real large-scale genomics datasets. Students will gain practical experience in large-scale data analysis, which is highly desirable by both industry and academia employers. **Effective From: Spring 2012**

BNFO 644 - Data Mining and Management in Bioinformatics (3 credits)
Concepts and principles of data management in bioinformatics. Presents methods for indexing, querying, and mining data obtained from molecular and evolutionary biology. Provides hands-on experience in designing a simple information system for querying and mining genomic data using ORACLE or MySQL.

Biology: Offered by the Federated Department of Biological Sciences at NJIT and Rutgers-Newark

UNDERGRADUATE COURSES:

Biol 200 - Concepts in Biology (4-0-4)
This course will introduce student to the study of biology at the beginning of their course of study. Central ideas in the biological sciences will be highlighted, with an emphasis on the process of scientific discovery and investigation. The course will provide the basis for more advanced coursework and learning experiences in the biological sciences as students delve into the curriculum of study. **Effective From: Fall 2011**

Biol 205 - Foundations of Biology: Ecology and Evolution Lecture (3-0-3)
Prerequisite: R120:102 or BIOL200 or R120:200. This introductory course considers the population level of biological organizations. Topics include Mendelian and population genetics, evolution, and ecology of populations and communities. **Effective From: Fall 2010**

Biol 206 - Foundations of Biology: Ecology and Evolution Lab (0-3-1)
Prerequisite: R120:102 or R120:101/102 or BIOL 200 or R120:200. The laboratory reinforces the topics covered in Foundations of Ecology and Evolution Lecture (Biol 205) lecture with hands-on activities and exposes students to current methods of research and analysis in these areas. **Effective From: Fall 2010**

Biol 222 - Evolution (3-0-3)
Prerequisite: R120:101 and R120:102 and BIOL 205/206 with grade of C or better. This course will provide a comprehensive introduction to the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic basis of variation and heredity, natural selection, evolution and development, and speciation. **Effective From: Spring 2009**

Biol 225 - Insects and Human Society (3-0-3)
Prerequisite: R120:101 and R120:102 (General Biology sequence). This course, through lecture and discussion, will cover the breadth of influence insects have on society, from the provision of ecosystem services to the economic and social costs associated with their role as vectors of disease. Student will learn how insects are used in science, agriculture and indicators of global climate change and water quality. Students will also learn some insect biology and have the opportunity to observe insects (living and dead) to gain a better understanding of the diversity and complexity of these creatures. **Effective From: Spring 2010**

Biol 250 - Biology of Neotropical Habitats: Ecuador and Galapagos Islands (2-2-3)
This course is an introduction to tropical biology and evolution held in Ecuador's Highlands, Rain Forest, and in the Galapagos islands. The course uses a hands-on approach to study the flora and fauna of these unique habitats. The course also addresses the history, politics, and culture of Ecuador, with emphasis on how these issues influence the management and sustainability of Ecuadorian natural resources. **Effective From: Spring 2014**

Biol 310 - Research and Independent Study (3-0-3)
Prerequisites: Departmental approval and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Biol 315 - Principles of Neurobiology (3-0-3)
Prerequisite: R120:201 with a grade of C or better and R120:202 with a grade of C or better. This course will review neuroscience concepts at a basic level. It will cover basics of cellular physiology, molecular biology and developmental biology of nerve cells, network physiology, behavior, cognition and memory and learning. This course will prepare students who are interested in a neuroscience sequence for their major. **Effective From: Fall 2013**

Biol 320 - Discovering Biological Research (3-0-3)

Prerequisites: Hum 102, Biol 201, Biol 202, Biol 205, Biol 206 all with a grade of C or better. Success in the constantly evolving field of biology necessitates staying current in scientific literature. This requires competency in skills such as analysis of primary sources, synthesis of information from multiple sources, and oral and written communication skills. This course focuses on these competencies. Students will develop skills need to read and analyze scientific literature, and to communicate science. Each semester the content theme of the course will change depending on the expertise of the faculty member teaching the course. **Effective From: Fall 2013**

Biol 338 - Ecology of the Dining Hall (3-0-3)
Prerequisites: BIOL 205 with a C or better and BIOL 206, or permission of instructor. This course will use the examination of an on-campus ecosystem, the dining hall, as a framework for learning about a number of applied ecological concepts. We will investigate topics such as food webs, nutrient cycling, microbial ecology, and agroecology as they apply to the organisms and biological processes, present in our dining hall. Course work will involve extensive reading and discussion of scientific and popular literature, supplemented by regular class trips to the dining hall and related on-campus facilities. **Effective From: Fall 2012**

Biol 340 - Mammalian Physiology (3-3-4)
Prerequisites: R120:201 and R120:202 and BIOL 205 and BIOL 206. This course will review general principles of the function of the human body as a mammal, with emphasis on the function and regulation of neuromuscular, cardiovascular, respiratory, endocrine, digestive, and excretory systems. The goal is to provide students with the basic knowledge to understand how their own bodies operate. **Effective From: Spring 2011**

Biol 341 - Introduction to Neurophysiology (3-0-3)
Prerequisite: R120:201 and R120:202 with a grade of C or better. This course will examine the physiology of neurons such as excitability, impulse conduction, synaptic communication and neural and synaptic plasticity. The objective is to provide students with a basic understanding of neural signaling and communication. **Effective From: Fall 2012**

Biol 342 - Developmental Biology (Embryology) (3-0-3)
Prerequisite: R120:201/202 and BIOL 205/206. Descriptive and experimental approaches to molecular, cellular and organismal changes during embryonic development; mechanisms of cell differentiation, organogenesis, morphogenesis, and pattern formation. **Effective From: Spring 2009**

Biol 344 - Physiological Mechanisms (3-0-3)
Prerequisites: Biol 340. This course will utilize clinical (pathological) case studies to reinforce physiologic knowledge and provide students a strong basis for future studies in biomedical and health related fields. **Effective From: Spring 2013**

Biol 346 - Neurobiology (3-0-3)
Prerequisite: R120:201/202 and BIOL 205/206. This course will examine the basic principles that govern neuronal function, emphasizing cellular, developmental, and physiological aspects. The course begins with cellular properties of neurons and synaptic communication and will review the organization, function, development, and disorders of neural systems. **Effective From: Fall 2010**

Biol 368 - The Ecology and Evolution of Disease (3-0-3)
Prerequisite: R120:201/202 and MATH 111 with grade of C or better. This course addresses those aspects of ecology and evolutionary biology most relevant to understanding the origin, dynamics and treatment of disease (both infectious and hereditary/genetic). The class will be a mixture of lecture and discussion of case studies. Material covered will include biology, mathematical models, and some aspects of human behavior. **Effective From: Spring 2009**

Biol 375 - Conservation Biology (3-0-3)
Prerequisites: R120:201/202 and BIOL 205/206 General Biology I & II. This course will provide a comprehensive introduction to the field of conservation biology, as well as philosophical and economic concerns. **Effective From: Fall 2009**

Biol 383 - Neural Basis of Behavior (3-0-3)
Prerequisite: R120:201/202 and BIOL 205/206. This lecture course explores the neural mechanisms underlying animal behavior. This course is intended for upper-level undergraduate students who have some background in biology, hence the prerequisite for Foundation of Biology. This courses would also be of interest to graduate students interested in neuroscience, such as, students in the Quantitative Neuroscience (QNS) program, students in the Integrative Neuroscience (INS) program, and students at the Center for Molecular and Behavioral Neuroscience (CMB). It is unnecessary for the students to have taken animal behavior or neurobiology; however, these courses would be helpful. **Effective From: Spring 2009**

Biol 385 - Evolution of Animal Behavior Laboratory (2-2-4)
Prerequisite: BIOL 205, BIOL 206, R120:201 and R120:202 with a grade of C or better. A lab course focusing on research in Animal Behavior. This course will cover foraging, predator avoidance, territoriality, and mate choice. Labs will be inquiry based with students designing experiments to test hypotheses concerning aspects of animal behavior. **Effective From: Fall 2012**

Biol 400 - Biology in Science Fiction (3-0-3)
Prerequisite: R120:340/BIOL 340 or R120:345 and R120:355 or R120:356 or R120:352 with a grade of C or better. Popular science fiction media will be utilized to initiate thinking critically and creatively about the biological sciences; from the molecular level to whole organism physiology. Students will explore the potential biology of fictitious organisms, and determine real-life analogues. These topics will be used as a vehicle to improve scientific writing and to apply biological knowledge in a new and unique way. **Effective From: Fall 2012**

Biol 405 - Cell Physiology and Imaging (1-3-4)
NOTE: COURSE HAS BEEN CHANGED TO BIOL 451. Prerequisites: Phys 111, Phys 121 and R120:355. This course will examine celluar phenomena, such as subcellular structure, secretion, intracellular calcium regulation, etc., from a physiological perspective and using imaging techniques as a tool to understand them. Cell biology, and optics and the user of microscopes, will be discussed in detail. **Effective From: Spring 2009 Until: Summer 2010**

Biol 410 - Work Experience II (3-0-3)
Prerequisites: Biol 310, departmental approval and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic progam. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Biol 440 - Cell Biology of Disease: Cells gone Bad! (3-0-3)
Prerequisites: R120340 and R120355 or R120356. This course will briefly review the normal physiology of mammals and humans and will then extensively explore the basis of many human diseases at the cellular level. The goal is to understand how alterations in normal functions of cells affect the function of the whole system by reviewing current research in the field of cell biology abnormalities. **Effective From: Fall 2011**

Biol 445 - Endocrinology (3-0-3)
Prerequisites:R120201, R120202, BIOL340 and CR120355 or R120356. This course will discuss endocrinology from both an enatomical and physicologic view. We will discuss synthesis, distribution and regulation of the entire human endocrine system. The goal is to provide students with a basic knowledge of the complex endocrine system. **Effective From: Fall 2011**

Biol 447 - Cellular and Systems Neuroscience (3-0-3)
Prerequisite: R120:201,R120:202 and BIOL 205/206. Foundations of Biology. This course will examine, from both a cellular and a systems perspective, neurophysiological phenomena such as excitability, impulse conduction, integration of activity at the cellular and at the network level, and network level behavior of the nervous system. The goal is to provide students with the basic knowledge to understand neurobiological processes at all levels of complexity. **Effective From: Spring 2010**

Biol 448 - Neuropathophysiology: Nervous System Gone Bad! (3-0-3)
Prerequisites: R120:340 or R120:346 or Biol 346 or Biol 447. This course will briefly examine the normal physiology of the nervous system and then would extensively explore the basis of many neuronal diseases. The goal is to understand how any alteration in normal functions of the nervous system affects the function of the whole system by reviewing current research in the field of nervous system abnormalities. **Effective From: Fall 2010**

Biol 451 - Cell Physiology and Imaging (1-3-4)
Prerequisites: Phys 111, Phys 121 and R120:355. This course will examine celluar phenomena, such as subcellular structure, secretion, intracellular calcium regulation, etc., from a physiological perspective and using imaging techniques as a tool to understand them. Cell biology, and optics and the user of microscopes, will be discussed in detail. **Effective From: Fall 2010**

Biol 463 - Insects and Human Society (3-0-3)
This course, through lecture and discussion, will cover the breadth of influence insects have on society, from the provision of ecosystem services to the economic and social costs associated with their role as vectors of disease. Students will learn how insects are used in science, agriculture and as indicators of global climate change and water quality. Students will also learn some insect biology and have the opportunity to observe insects (living and dead) to gain a better understanding of the diversity and complexity of these creatures. **Effective From: Spring 2010 Until: Fall 2011**

Biol 475 - Ecological Field Methods and Analysis (3-0-3)
Prerequisites: R120:370 Plant Ecology or R120:280 Animal Ecology or permission of instructor. This field-orientated class will study animal and plant communities using a combination of field, laboratory and theory work. The goal of this course is to understand ecological principles and to introduce students to modern methodology for field work, the techniques and instruments used, as well as the theoretical basis for their application. Students will collect data, analyze them and report the results in written and oral format. **Effective From: Fall 2009**

Biol 491 - Research and Independent Study (0-3-3)

Prerequisites: Departmental approval required. Research in Biology. Each student works under the supervision of a Biology or associated faculty member. A research paper and poster are required. **Effective From: Fall 2012**

Biol 492 - Research and Independent Study (3-0-3)
Prerequisite: Departmental approval required. Research in Biology. Each student works under the supervision of a Biology or associated faculty member. **Effective From: Spring 2007**

Biol 495 - Honors Seminar in Biology (3-0-3)
Prerequisite: Biol 320 with a grade of C or better. The honors seminar allows students the opportunity to work closely with an instructor in a specific area of the instructor's expertise. Students will be required to bring together interests and skills developed in previous courses. Students make in-depth oral and written presentations. This course satisfies NJIT's Honors Capstone requirement. **Effective From: Fall 2014**

R120:101 - General Biology I (3-3-4)
Prerequisite: None. For more details go toRutgers Catalog. **Effective From: Spring 2009**

R120:102 - General Biology II (3-3-4)
Prerequisite: None For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:104 - Human Health and Disease (3)
For more details go to Rutgers Catalog.

R120:109 - Basic Plant Science (3)
For more details go to Rutgers Catalog.

R120:110 - Basic Plant Science Laboratory (1)
For more details go to Rutgers Catalog.

R120:203 - Plant Biology (3)
For more details go to Rutgers Catalog.

R120:204 - Economic Botany (3)
For more details go to Rutgers Catalog.

R120:205 - Environmental Issues (3)
For more details go to Rutgers Catalog.

R120:206 - General Horticulture (3)
For more details go to Rutgers Catalog.

R120:207 - Horticulture Laboratory (1)
For more details go to Rutgers Catalog.

R120:208 - Human Sexuality (3)
For more details go to Rutgers Catalog.

R120:211 - Plant Kingdom (4)
Prerequisite: Biol 205 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:227 - Biology of Invertebrates (4)
Prerequisite: Biol 205/206 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:230 - Biology of Seed Plants (4)
Prerequisite: Biol 205 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:235 - Microbiology (3)
For more details go to Rutgers Catalog.

R120:241 - Anatomy and Physiology (4,4)
For more details go to Rutgers Catalog.

R120:280 - Animal Ecology (3)
Prerequisite: R120:101 and R120:102 with grade of C or better. For more details go to Rutgers Catalog.

R120:282 - Animal Behavior (3)
Prerequisite: Biol 205/206 with grade of C or better. For more details go to Rutgers Catalog.

R120:285 - Comparative Anatomy of Vertebrates (3-3-4)
Prerequisite: Biol 205/206 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:301 - Foundations of Biology: Cell and Molecular Biology (3-0-3)
Prerequisite: R120:101 and R120:102 and Chem 125 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:311 - Taxonomy of Vascular Plants (4)
Prerequisite: R120:211 or R120:230 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:313 - Mycology (4)
Prerequisite: R120:201 and R120:202 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:325 - Animal Parasites (3)
Prerequisite: R120:201 and Biol 205/206 and Hum 102 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:326 - Laboratory Exercises in Parasitology (1)
Corequisite: R120:325. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:328 - Ecology of Birds (3-0-3)
Prerequisite: R120:201/202 and Biol 205/206 with grade of C or better. For more details go to Rutgers Catalog.

R120:330 - Plant Physiology (4)
Prerequisite: R120:201/202 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog.

R120:335 - General Microbiology (4)
Prerequisite: R120:201/202 and Biol 205/206. For more details go to Rutgers Catalog.

R120:340 - Mammalian Physiology (3-3-4)
Prerequisite: R120:201/202 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:342 - Developmental Biology (4)
Prerequisite: R120:201/202 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:343 - Developmental Bio Lab (1)
Corequisite: R120:342. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:346 - Neurobiology (3)
Prerequisite: R120:201 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:350 - Immunology (3)
Prerequisite: R120:201 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:352 - Genetics (3)
Prerequisite: R120:201 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:355 - Cell Biology (3)
Prerequisite: R120:201 and Biol 205/206 and Chem 126 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:356 - Molecular Biology (3)
Prerequisite: R120:201 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:360 - Elementary Biochemistry (3)
Prerequisite: R120:201, Chem 243, Chem 244, and Chem 244A with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:365 - Human Ecology (3-0-3)
Prerequisite: R120:201 and R120:202 an Biol 205/206 and Hum 102 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:370 - Plant Ecology (3)
Prerequisite: R120:201/202 and Biol 205/206 with grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:371 - Field Studies in Plant Ecology (3)
Prerequisite: R120:370 or R120:280 with a grade of C or better; Juniors and Seniors Only. For more details go to Rutgers Catalog.

R120:380 - Field Ecology (3)
Prerequisite: R120:370 or R120:280 with a grade of C or better; Juniors and Seniors Only. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:381 - Field Studies in Animal Ecology (2)
Prerequisite: R120:370 or R120:380 with a grade of C or better, HUM 102; Juniors and Seniors Only. For more details go to Rutgers Catalog.

R120:403 - Biological Ultrastructure (3)
Prerequisite: R120:301 and R120:302 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:404 - Light and Electron Microscopy (4)
For more details go to Rutgers Catalog.

R120:405 - Microanatomy of Cells and Tissues (4)
Prerequisite: R120:201 and R120:202 and Biol 205/206 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:414 - Phycology (4)
For more details go to Rutgers Catalog.

R120:415 - Paleobotany (4)
For more details go to Rutgers Catalog.

R120:422 - Biological Invasions (3)
Prerequisite: R120:370, or R120 280 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:430 - Plant Growth and Development (4)
Prerequisite: R120:201/202 and Biol 205/206 and R120:211 or 230 or 330 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:435 - Microbial Physiology and Metabolism (3)
For more details go to Rutgers Catalog.

R120:445 - Endocrinology (3)
Prerequisite: R120:340 or Biol 340 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:451 - Laboratory in Cellular and Molecular Biology I: Cellular Biophysics (4)
Prerequisite: R120:355 with a grade of C or better; Permission of Instructor. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:452 - Laboratory in Cellular and Molecular Biology II: Molecular Biotechniques (4)
Prerequisite: R120:355 or R120:356 with a grade of C or better; Permission of Instructor. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:455 - Molecular Cell Biology (3)
Prerequisite: R120:355 and R120:356 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:456 - Virology (3)
Prerequisite: R120:335 with a grade of C or better. For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R120:471 - Ecological Physiology (3)
Prerequisite: R120:370 or R120:280 with a grade of C or better. For more details go to Rutgers Catalog.

R120:472 - Environmental Assessment (3)
Prerequisite: R120:370 or 371. For more details go to Rutgers Catalog.

R120:473 - Ecology of Microorganisms (3)
Prerequisite: R120:335. For more details go to Rutgers Catalog.

R120:481 - Marine Biology (4)
Prerequisite: R120:201/202 and Biol 205/206 with grade of C or better. For more details go to Rutgers Catalog.

R120:486 - Tropical Field Biology (2)
Prerequisite: Permission of the Instructor; Juniors and Seniors Only. For more details go to Rutgers Catalog.

R120:491 - Problems in Biology (BA,BA)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

Biol 601 - Computational Biology I (3-0-3)
This course will describe mathematical and simulation techniques used in modeling a variety of biological systems. Students will learn stability analysis, phase space analysis, basic bifurication theory and numerical simulation techniques with examples from neuroscience, cell and molecular biology as well as ecology and evolution. Students enrolling in this course are expected to have basic knowledge of calculus, linear algebra and some programming abilities. **Effective From: Fall 2010**

Biol 612 - Comparative Animal Physiology (3 credits)
This course will explore how animals, from invertebrates to vertebrates, function from the cellular to the organism level. The study of the structure and function of the various organs provides insight into how animals survive extreme environments and how they respond to changes in their environment. The comparative approach shows that the underlying physiological principles that govern life are common to all animals and yet animals have evolved unique and sometimes startling physiological solutions to problems posed by their particular environments. **Effective From: Fall 2009**

Biol 622 - Evolution (3 credits)
This course will provide a comprehensive overview of research in the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic bases of variation and heredity, natural selection, evolution and development, and speciation. The format will be brief lectures to review topics covered in text, followed by class discussions of relevant primary literature. Students will write two papers on the topic of their choice and will be required to lead a minimum of one class discussion. **Effective From: Spring 2010**

Biol 628 - Cell Biology of Disease: Cells Gone Bad (3-0-3)
This course will briefly review normal physiological function of humans and will then extensively explore the basis of many human diseases at cellular lever. The goal is to understand how alterations in normal cell functions affect human physiology by reviewing current research in the field of cell biology. **Effective From: Fall 2011**

Biol 630 - Critical Thinking for the Life Sciences (3 credits)
Researchers in the biological sciences must understand and be able to effectively apply the scientific method, and they must also be able to clearly communicate their ideas and results. This course will involve heavy student participation and discuss the scientific method, analyze and discuss data gathering and organizing, and will analyze existing grant proposals with the goal of enabling graduate students to write a clear and convincing grant proposal. **Effective From: Fall 2009**

Biol 638 - Computational Ecology (3-0-3)
An overview of computational approaches to the study of mathematical models in ecology. Topics include one-, two-, and multi-species models, life history analysis, spatial dynamics, epidemiology. The course is taught as a hands-on computer lab in which students explore models, perform simulations and solve problems. **Effective From: Spring 2006**

Biol 641 - Systems Neuroscience (3 credits)
This course will examine neurophysical phenomena from a systems perspective. The course will review basic concepts of cellular neuroscience, such as excitability, impulse conduction, and integration of activity at the cellular, before focusing on network level physiology of the nervous system and its role in the generation of behavior. The goal is to provide students with the basic knowledge to understand neurobiological processes at all levels of complexity. **Effective From: Spring 2011**

Biol 698 - Selected topics in Biology (3-0-3)
Survey of recent research topics in Biology at the Master's level. **Effective From: Spring 2008**

Biol 699 - Selected Topics in Biology (3-0-3)
Survey of recent research topics in Biology at the Masters level. **Effective From: Spring 2008**

Biol 788 - Selected Topics in Biology (3-0-3)
Survey of recent research topics in Biology at the doctoral level. **Effective From: Spring 2008**

Biol 789 - Selected Topics in Biology (3-0-3)
Survey of recent research topics in Biology at the doctoral level. **Effective From: Spring 2008**

Biol 791 - Biology Seminar (0)
This seminar includes student and faculty presentations on current papers, student presentations related to their research and occasional outside speakers. It will acquaint students with possible topics for dissertation search, and provide an opportunity to present and receive feedback on current work.

Biol 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.

R120:501 - Neuroanatomy (3 credits)
For more details go to Rutgers Catalog.

R120:503 - Plant Morphology (3 credits)
For more details go to Rutgers Catalog.

R120:504 - Plant Physiology (3 credits)
For more details go to Rutgers Catalog.

R120:505 - Biostatistics and Computer Methodology (3 credits)
For more details go to Rutgers Catalog.

R120:506 - Quantitative Plant Ecology (3 credits)
For more details go to Rutgers Catalog.

R120:509 - Advanced Problems in Biology (1 to 6 credits by arrangement)
For more details go to Rutgers Catalog.

R120:512 - Mammalian Physiology (3 credits)
For more details go to Rutgers Catalog.

R120:515 - Molecular Biology of Eukaryotes (3 credits)
For more details go to Rutgers Catalog.

R120:516 - Microbial Ecology (3 credits)
For more details go to Rutgers Catalog.

R120:517 - Developmental Neurobiology (3 credits)
For more details go to Rutgers Catalog.

R120:518 - Nucleic Acids (3 credits)
For more details go to Rutgers Catalog.

R120:519 - Microbial Metabolism (3 credits)
For more details go to Rutgers Catalog.

R120:523 - Biogeography (3 credits)

For more details go to Rutgers Catalog.

R120:526 - Cell Biology (3 credits)
For more details go to Rutgers Catalog.

R120:530 - Biophysical Membrane Physiology (4 credits)
For more details go to Rutgers Catalog.

R120:532 - Evolution (3 credits)
For more details go to Rutgers Catalog.

R120:536 - Multivariate Biostatistics (3 credits)
For more details go to Rutgers Catalog.

R120:538 - Topics in Molecular Genetics (3 credits)
For more details go to Rutgers Catalog.

R120:548 - Biology of Cancer (3 credits)
For more details go to Rutgers Catalog.

R120:551 - Biology of Pollution (3 credits)
For more details go to Rutgers Catalog.

R120:552 - Paleobotany (4 credits)
For more details go to Rutgers Catalog.

R120:561 - Quantitative and Analytical Light Microscopy (4 credits)
For more details go to Rutgers Catalog.

R120:563 - Developmental Plant Physiology (3 credits)
For more details go to Rutgers Catalog.

R120:564 - Techniques in Developmental Botany (2 credits)
For more details go to Rutgers Catalog.

R120:565 - Medical Mycology (3 credits)
For more details go to Rutgers Catalog.

R120:566 - Neurophysiology and Behavior (3 credits)
For more details go to Rutgers Catalog.

R120:568 - Neuroendocrinology and Behavior Laboratory (3 credits)
For more details go to Rutgers Catalog.

R120:571 - Biochemistry (4 credits)
For more details go to Rutgers Catalog.

R120:573 - Pharmacology (3 credits)
For more details go to Rutgers Catalog.

R120:584 - Plant Responses to the Environment (3 credits)
For more details go to Rutgers Catalog.

R120:585 - Behavioral Ecology (3 credits)
For more details go to Rutgers Catalog.

R120:586 - Landscape Ecology (3 credits)
For more details go to Rutgers Catalog.

R120:587 - Systems Ecology: Ecosystems in the Landscape (3 credits)
For more details go to Rutgers Catalog.

R120:588 - Topics in Advanced Ecology (3 credits)
For more details go to Rutgers Catalog.

R120:589 - Chemical Bases of Neural Function (3 credits)
For more details go to Rutgers Catalog.

R120:593 - Physiological Ecology (3 credits)
For more details go to Rutgers Catalog.

R120:594 - Systematics (3 credits)
For more details go to Rutgers Catalog.

R120:601 - Human Molecular Genetics (3 credits)
For more details go to Rutgers Catalog.

R120:604 - Microbiology: Principles and Applications (3 credits)
For more details go to Rutgers Catalog.

R120:616 - Topics in Biology (1 to 3 credits by arrangement)
For more details go to Rutgers Catalog.

R120:640 - Topics in Immunology (3 credits)
For more details go to Rutgers Catalog.

R120:697 - Neuroendocrinology (3 credits)
For more details go to Rutgers Catalog.

Biomedical Engineering: Offered by the Department of Biomedical Engineering

UNDERGRADUATE COURSES:

BME 101 - Introduction to Biomedical Engineering (1-0-0)
This course is open only to freshmen and new transfer students. Faculty members describe their research in biomedical engineering.

BME 105 - Introduction to Human Physiology I (2-0-2)
This course is open only to freshmen and transfer students. An overview of human physiology is presented as an introduction to subsequent core courses in the Biomedical Engineering curriculum. Not intended to be an exhaustive review of physiology, the course will instead emphasize key examples that highlight understanding of the interaction between the biomedical and engineering worlds. This course is the first of two freshman courses; this one will focus on cellular and neural-system basic physiology. **Effective From: Fall 2006**

BME 106 - Introduction to Human Physiology II (1-0-1)
Prerequisite: BME 105. This course is open only to freshmen and transfer students. An overview of human physiology is presented as an introduction to subsequent core courses in the Biomedical Engineering curriculum. Not intended to be an exhaustive review of physiology, the course will instead emphasize key examples that highlight understanding of the interaction between the biomedical and engineering worlds. This course is the first of two freshman courses; this one will focus on basic physiology of respiratory and cardiovascular systems. **Effective From: Spring 2007**

BME 301 - Electrical Fundamentals of Biomedical Engineering (1-3-3)
Prerequisites: Grade of C or higher in Phys 121 & Math 112, or Math 133. Course lectures and laboratories will address important issues for biomedical engineers at the introductory level; covering the origins of bio-electric signals and the instrumentation involved in collection of biopotentials from the electrodes to processing of the signals on the computer. Some other topics included are the transducers/sensors and modern engineering software used in bio-instrumentation. Laboratory work will provide hands-on experience in all of these topics. The course will also address practical issues in design of medical devices such as noise, resolution, linearity, and saturation. This course is offered in Studio format that involves the integration of lectures and labs into one highly participatory structure. **Effective From: Fall 2012**

BME 302 - Mechanical Fundamentals of Biomedical Engineering (1-3-3)
Prerequisites: Grade of C or higher in Phys 121 & Math 112, or Math 133. BME 301 is not a prerequisite. The format is identical to that of BME 301. Course lectures and laboratories will address important issues covering the mechanical fundamentals that are important bases for later learning experiences. This course introduces the students to biomaterials (tissues), biomechanics (forces and motion), biofluids and biostatistics, and then integrates them with a final design project on neuromuscular engineering. **Effective From: Fall 2012**

BME 303 - Biological and Chemical Foundations of Biomedical Engineering (3-0-3)
Prerequisites: Grade of C or higher in Chem 126 and Phys 121. This course covers organic chemistry, biochemistry and cellular mechanics in sufficient depth to give biomedical engineering students a strong enough background for them to understand the introductory aspects of biomedical engineering, which focus on the application of engineering principles to medicine and surgery.

BME 304 - Material fundamentals of Biomedical Engineering (3-0-3)
Prerequisites: R120:102-Bilogy II with a grade of C or better or BME 303 with a grade of C or better. This course is an introduction to the field of biomaterials with an emphasis on the wound healing process and interactions between the human body and implanted devices fabricated from various types of biomaterials. The thrust of this course will be to illuminate the processes occurring at the tissue-biomaterial interface. Attention will be given to the biological events occurring at the molecular level on the surface of an implanted device. The nature of these surfaces and the physiological consequences of these processes will be examined in terms of how the body and functioning of the device are impacted. **Effective From: Fall 2012**

BME 310 - Biomedical Computing (3-1-3)

Prerequisite: Grade of C or higher in BME 301. This course covers the application of digtal signal processing to biomedical problems. Labview, a graphical programming language common in engineering, is used for both signal acquisition and processing. Applications include analysis of the electrocardiogram and other electrical signals generated by the body. **Effective From: Fall 2012**

BME 311 - Co-op Work Experience (3 degree credits)
Prerequisites: sophomore standing, approval of department, and permission of Career Development Services. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

BME 333 - Biomedical Signals and Systems (3-0-3)
Prerequisites: BME 310 and Math 222. BME Tools such as the Laplace and Fourier Transforms, time-frequency analysis are introduced. Applications include signals and noise, processing of the ECG, mathematics of imaging and derivation of useful physiological parameters from input signals. **Effective From: Fall 2006**

BME 351 - Introduction to Biofluid Mechanics (3-0-3)
Prerequisites: BME 302 and Mech 236. Recommended co-requisite: Mech 320. Introduction to the principles of fluid flow. Basic fluid principles, such as fluid properties, fluid statics, conservation of mass, momentum, and energy will be discussed and presented in bioengineering context. Special attention will be given to the non-Newtonian nature of blood, viscous flow in arteries, unsteady flows, and to the fluidic output of the heart. The textbook material will be supplemented throughout the course to emphasize examples relative to bioengineering. **Effective From: Spring 2007**

BME 372 - Biomedical Electronics (3-0-3)
Prerequisite: BME 301. The first of a two-semester sequence. It covers the design of electronic circuits for Biomedical applications. This course covers basic operational amplifier circuits as well as the operation of semiconductor diodes and transistors. An introduction to digital logic circuits is also provided. Pspice computer simulation as well as hands-on breadboarding of electronic circuits are used throughout the course to supplement the lectures.

BME 373 - Biomedical Electronics II (3-0-3)
Prerequisite: BME 372. A continuation of BME 372 emphasizing biomedical applications of oscillators, active filters, and wave-shaping circuits.

BME 381 - Engineering Models in Physiology I (3-2-3)
Prerequisites: Math 222, BME 106 and Phys 121. Some knowledge of programming required. Mathematical models of organs and organ systems are described from an engineering viewpoint. Anatomy and physiology are quantified. Heart and circulation, gas exchange in the lungs, electrical properties of excitable membranes, renal countercurrent mechanism and muscle mechanics are among the topics covered. Emphasis will be placed on feedback control, mathematical modeling and numerical simulation. **Effective From: Spring 2006**

BME 382 - Engineering Models in Physiology II (3-2-3)
Prerequisites: Math 222, BME 106 and Phys 121. BME 381 is not a prerequisite. Some knowledge of programming required. Mathematical models of organs and organ systems are described from an engineering viewpoint. Anatomy and physiology are quantified. Heart and circulation, gas exchange in the lungs, electrical properties of excitable membranes, renal countercurrent mechanism and muscle mechanics are among the topics covered. **Effective From: Spring 2006**

BME 383 - Measurement Lab for Physiological Systems & Tissue (1-3-3)
Prerequisites: BME 105, BME 106, BME 302, BME 310. Through laboratory experiences, students will apply engineering methods for measuring and interpretating the properties of physiological systems and biological tissues. Topics include measurements relevant to cardio-pulmonary, nerve and muscular systems, and epithelial transport. **Effective From: Spring 2008**

BME 384 - Biomechanics Laboratory (1-3-3)
Prerequisites: BME 105, BME 106, BME 301, BME 302 and CS 101. Introduction to the experimental analysis of the biomechanics of human motion. Laboratory experiments include the application and integration of anatomical and mechanical concepts to a wide variety of activities. Students will develop basic competence in a systematic approach to the observation, analysis and evaluation of human movement in clinical, educational, and industrial environments. **Effective From: Spring 2009**

BME 385 - Cell and Biomaterial Engineering Laborarory (1-3-3)
Prerequisite: BME 303. Co-requisite: BME 420. This laboratory course is designed to provide students with valuable hands-on experience in the field of cell and biomaterial engineering. Experiments include biomaterial fabrication and characterization, mechanical testing of biomaterials, colorimetric protein assay, cell-based assay, the basics of cell culture techniques, the basics of light and electron microscopy, and image capture and analysis. A lecture on the principles of a given technique will be followed by

laboratory activity. **Effective From: Spring 200**

BME 386 - Bioinstrumentation Laboratory (1-3-3)
Prerequisites: ECE 251, BME 372 and BME 373. Laboratory exercises involve projects at all levels of a bioinstrumentation system from sensors to data acquisition and data processing. Analog and digital circuits are constructed to condition the signals from sensors and convert them into a format that can be displayed or acquired into a computer. The final projects help to develope the skills to integrate various parts of a bioinstrumentation system, collect and analyze data and troubleshoot a circuit. **Effective From: Spring 2009**

BME 411 - Co-op Work Experience (0 credits)
Prerequisites: BME 311 and completion of sophomore year, approval of department, and permission of Career Development Services. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report. May count as BME or approved elective. Grade will now be issued as a letter grade. **Effective From: Fall 2011**

BME 420 - Advanced Biomaterials Science (3-0-3)
Prerequisites: BME 304 and (MTSE 301 or MECH 320). The goal of this course is to understand material selection, important properties of materials for use in the body and failure modes of applied biomaterials. The course will cover the structure and properties of materials used as biomaterials including metals, ceramics, synthetic polymers, and biopolymers. The structure of these materials will be explored to understand how it defines the behavior of a material. The bulk behavior of materials will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced (including thermal strain, surface properties, and viscoelasticity). Students will be presented with problems of property characterization, failure analysis and performance testing. Students will work in teams to analyze a marketed implant or device using biomaterial(s) using the tool and concepts learned in the course. **Effective From: Fall 2012**

BME 422 - Biomaterials Characterization (3-0-3)
Prerequisites: BME 420 or MTSE 301. The quantum mechanical origins of spectroscopy, the relationship of spectroscopic behavior to thermal characteristics of a material, and the differences in approach to the chemical and physical characterization of synthetic and biological polymers are discussed. **Effective From: Spring 2007**

BME 427 - Biotransport (3-0-3)
Prerequisite: Math 222 and CHE 230. Introduction to basic concepts in thermodynamics and transport phenomena as applied to biological systems. The structure and composition of the body will be covered followed by an exploration of the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Design of artificial kidneys and heart-lung machines is also explored.

BME 430 - Fundamentals of Tissue Engineering (3-0-3)
Prerequisite: BME 420. This course is an introduction to the field of tissue engineering as a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated by delivering cells, scaffolds, DNA, proteins, and/or protein fragments at surgery. This course will cover the advances in the fields of cell biology, molecular biology, material science and their relationship towards developing novel "tissue engineered" therapies. **Effective From: Fall 2006**

BME 451 - Biomechanics I (3-0-3)
Prerequisites: Mech 320 and BME 351. Tensor analysis. Kinematics of continuous media. Stress. The elastic solid. Newtonian fluid. Conservation principles of mass, momentum and energy. Viscometric flows. Formulation of constitutive equations. Applications to the modeling of bone and other living tissues. **Effective From: Fall 2007**

BME 452 - Mechanical Behavior & Performance of Biomaterials (3-0-3)
Prerequisite: BME 302, BME 304, MATH 222, and MECH 320. Biomaterial selection and performance is essential to the design and implementation of most any biomedical application. Students will learn about important properties of materials for use in the body and failure modes of applied biomaterials. Material behavior will be reviewed, including the generalized Hooke?s Law, and new concepts will be introduced including thermal strain, surface properties, and viscoelasticity. Material biocompatibility will be introduced in regards to body responses including cell and tissue interaction, toxicity and safety. **Effective From: Spring 2013**

BME 469 - Introduction to Human Physiology (3-0-3)
This course is not open to Biomedical Engineering students. Available to non-biomedical engineering students who have an interest in going on to medical, dental or allied health careers. An introduction to mammalian physiology, particularly the heart, circulation, lungs and kidneys. **Effective Until: Fall 2003**

BME 478 - Introduction to CAD for Biomechanics (2-2-3)

Prerequisites: BME 302 and Mech 320. Introduction to Computer Aided Designing and analysis as applied to biomedical engineering design programs. Topics include theoretical insight into the process of design and geometrical modeling and design using industry standard CAD (Computer Aided Design) software packages. The course will also include several projects involving the applicaiton of design principles to standard problems in biomedical design. **Effective From: Spring 2007**

BME 479 - BioMicroElectroMechanical Systems (3-0-3)
Prerequisites: Chem 126 and Phys 121. 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 488 - Introduction to Nanotechnology (2-2-3)
This course introduces students to nanotechnology through a variety of topics that cover nanoscience and nanotechnology from different points of view including engineering, chemistry, biology, management, ethics, public safety and policy, mathematics, etc. The course is designed in a studio format that complements lectures with hands-on experimental activities. The course will feature on or two lectures per semester given by invited nanotechnology-experts from NJIT or elsewhere. This course is mandatory for any student willing to take the Minor in Nanotechnology. **Effective From: Spring 2014**

BME 489 - Medical Instrumentation (3-0-3)
Prerequisites: BME 373, BME 310 and ECE 251. The hardware and instrumentation needed to measure variables from different physiological systems. Electrodes, sensors and transducers. Bioelectric amplifiers. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system . Clinical laboratory instruments. Medical ultrasound. Electrical safety. Computers in biomedical instrumentation.

BME 491 - Research and Independent Study I (3-0-3)
Needs permission of professor. Senior standing. Planning and execution of engineering projects. Intellectual property: publications and priority documents; invention disclosures and patents. Safety: engineering codes and standards. Engineering ethics. Professional organizations. Professional registration. Preparation of a technical proposal for a senior project and its approval are required.

BME 492 - Research and Independent Study II (1-2-3)
Needs permission of professor. A biomedical engineering design project, selected by the student, which has been approved in BME 491. Involves information from the professional literature, research, design and prototype testing. An oral presentation and a written report are required.

BME 495 - Capstone Design I (2-3-3)
Prerequisites: BME 372 or BME 420 or BME 351. Senior standing or permission of the instructor. To provide students with the guidance to choose a capstone design topic and advisor and to prepare the design proposal. The course introduces the student to the definition of design as well as introducing issues of intellectual property, bioethics and safety, and professional societies. **Effective From: Fall 2008**

BME 496 - Capstone Design 2 (2-5-3)
Prerequisites: BME 495 Implementation of the project approved in BME 491. This portion of the project includes library research, time and cost planning, oral and written reports, as well as construction, troubleshooting and demonstration of a working prototype. **Effective From: Fall 2008**

GRADUATE COURSES:

BME 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 611 - Engineering Aspect of Molecular and Cellular Bio I (1 credit)
Molecular and cellular biology is a foundation of the understanding of the biological sciences and is vital to the study of advanced biomedical engineering. This course is to be taken simultaneously with UMDNJ N551 to enrich the crossover between engieering

and life sciences. Course topics parallel those covered in N551 and both add engineering relevance, and provide engineering students with a stronger understanding of molecular and cellular biology. For students in joint BME PhD program. **Effective From: Fall 2009**

BME 612 - Engineering Aspects of Molecular and Cellular Bio 2 (1 credit)
Molecular and cellular biology is a foundation of the understanding of the biological sciences and is vital to the study of advanced biomedical engineering. This course is to be taken simultaneously with UMDNJ N552 to enrich the crossover between engineering and life sciences. Course topics parallel those covered in N552 and both add engineering relevance, and provide engineering students with a stronger understanding of molecular and cellular biology. For students in joint BME PhD program. **Effective From: Fall 2009**

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 651 - Principles of Tissue Engineering (3-0-3)
Tissue Engineering is a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated using living cells combined with a scaffolding material to guide tissue development. Such scaffolds can be synthetic, natural, or a combination of both. This course will cover the advances in the fields of cell biology, molecular biology, and materials science towards developing novel "tissue engineered" materials. **Effective From: Spring 2005**

BME 652 - Cellular and Molecular Tissue Engineering (3 credits)
This course explores molecular, cellular and tissue level interactions that are an important component of all tissue engineering strategies. Topics include how a cell moves, reacts and maintains viability and function based on its surroundings. We will discuss how to engineer our materials, tissue grafts and implants to integrate with the body. We will also liearn about bodily reactions and the biocompatibility of tissue engineered devices such as immunoreactivity and blood coagulation. **Effective From: Spring 2010**

BME 653 - Micro/Nanotechnologies for Interfacing Live Cells (3 credits)
In this course, we will study technologies and tools available for interfacing live cells from a sub-cellular, single-cell, and multi-cellular (tissue models) approach. We will introduce key concepts of the biology of cells and tissues and will explore the technologies (micro-/nanotechnologies) and tools (sensors and actuators) available for the investigation of cell and tissue biology. Same as ECE 653. **Effective From: Spring 2010**

BME 654 - Cardiovascular Mechanic (3 credits)
Fundamental biomechanical mechanisms at work in the cardiovascular system. Topics include the fundamental molecular structure of heart muscle, the biomechanical principles that transform the contraction of heart muscle into stress-strain functions of muscle fibers, pressure-volume flow relations in the vasculature when it is considered as a hemodynamic (blood hydraulic) system, growth and disease of the cardiovascular system, resistance, compliance, inertance, and catheter-tip transducers. **Effective From: Fall 2011**

BME 655 - Advanced Characterization of Biomaterials (3-0-3)
Methods used to discover the structures of proteins, enzymes, DNA, and carbohydrates at the molecular level, as well as complex structures such as collagen, the chromosome, and the cell. Topics will include protein and DNA sequencing, separation methods, and spectroscopies such as 2 and 3D NMR, x-ray diffraction, SEM, AFM and microscopic imaging techniques. **Effective From: Spring 2012**

BME 661 - 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 667 - Bio-Control Systems (3 credits)
The course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves which govern the basic operations of all living organisms and especially higher order life forms. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Same as ECE 667. **Effective From: Spring 2010**

BME 668 - Medical Imaging Systems (3 credits)
This course provides a detailed introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound and optical imaging modalities are included. Same as ECE 668. **Effective From: Spring 2010**

BME 669 - Engineering Physiology (3 credits)
To enable students to apply basic tools in engineering analysis, mathematics, computer science, general physics and chemistry courses so that they can develop models that quantitatively predict the functioning of physiological systems in the human body. To enable students to apply engineering systems analysis to systematic physiology and employ the ideas of feedback control, signal procession, mathematical modeling and numerical simulation. Same as ECE 669. **Effective From: Spring 2010**

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)
Basics of control of a robot and telemanipulation are studied. Computer simulations, MATLAB are used to explore biomimetic autonomous robots. This is a studio-based course with hands-on exercises with small robots and actuators. Topics include understanding how biological robots (humans and animals) differ from designed robots, as well as sensors (touch, stereo and position), actuators (muscles, smart materials), and intelligent (neural and computer controlled systems. **Effective From: Spring 2009**

BME 674 - Principles of Neuromuscular Engineering (3 credits)
Neurophysiology, motor control and robotics are used to study the human motor system. Sensorimotor learning and acquisition of new motor skills are emphasized. Topics include the central nervous system, muscle properties, spinal motor circuitry and dynamics of limb motion. The relation of motor control problems to neurophysiology of the motor system and how motor disorders affect movement control are studied. MATLAB and Simulink are used in simulations and movement date analysis. **Effective From: Fall 2009**

BME 675 - Computer Methods in Biomedical Engineering (3 credits)
This course uses MATLAB to concentrate on methods that allow students to produce original software that can be used to acquire, process, analyze and present data. Topics include advanced graphics and animation, graphical user interfaces, interfacing to and data acquisition from laboratory instrumentation, filtering and processing of acquired data, and interfacing to user interfaces (e.g. joysticks). Applications in speech, bioelectrical signals, images and virtual reality will be included. **Effective From: Fall 2009**

BME 676 - Computational Biomechanics (3 credits)
Prerequisites: BME 670 or equivalent. The use of commercially available software to solve complex engineering problems has become standard practice to reduce time and cost and results in a better product. This is an intro course on computational methods and the use of commercial software such as ANSYS, Fluent, and MATLAB to solve problems related to the BME device industry. Suitable for students interested in Computer Aided Design and Engineering (CAD/CAE). **Effective From: Fall 2010**

BME 677 - CAD for Biomechanics and Biomaterials (3-0-3)
Introduction to Computer Aided Design theory and application using software. Topics include datum planes, extrude, cut, sweep, swept cuts, and parallel, rotational, and general blends. Assemblies and generating, dimensioning, editing, and modifying drawing views and creation of balloons, imaging and scanning techniques of anatomical structures such as bone and arteries and 3D printing are also covered. **Effective From: Fall 2011**

BME 678 - Design of Orthopedic Implants (3-0-3)

Prerequisites: BME 677. First of a two part course on design of orthopedic implants using ProEngineer. Additional topics include machanical properties of implant materials, material selection and introduction to FEA. Methods for prototype development with the use of 3D printing will also be discussed. A critical objective of this course is the preparetion of design reports and project presentations. **Effective From: Spring 2012**

BME 679 - Advanced Design of Orthopedic Implants (3-0-3)
Prerequisites: BME 677, BME 678 or equivalent. Advanced modeling techniques for the design of hip, knee, and spine implants. Mechanical properties of materials, including wear and failure modes associated with typical implants. Kinematics and surgical protocols of implants will be discussed. Course will cover assemblies and FEA analysis of implants. Additional topics include large deformations, fatigue, optimization, review and analysis of results. **Effective From: Fall 2011**

BME 680 - BioMEMS Design and Applications (3 credits)
The advance of bioMEMS (Micro Electrical Mechanical Systems) technology is a key component in making the next generation medical diagnostic tools possible. We will learn how bioMEMS devices are fabricated and combine engineering analysis with knowledge of known biological responses and biomolecule interactions to understand how bioMEMS are designed and function. Topics will include biological, mechanical, electrical, and chemical biosensors, and microfluidics as applied to biotechnology. **Effective From: Fall 2009**

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 684 - Medical Device Development (3 credits)
This course will provide a detailed overview of medical device development from a realistic industrial and academic perspective. The processes used in corporations and academic laboratories to conceive and develop devices will be explored from a research, regulatory, clinical, QA/QC, marketing, engineering, and legal perpective under the umbrella of project management techniques. Material will be presented as an aide to students who wish to decide on careers in either industry or academia. **Effective From: Fall 2010**

BME 686 - Intro. to Instrumentation for Physiomeasurements (3-0-3)
Introduction to instrumentation for students without instrumentation background only. This course teaches the hardware and instrumentation needed to measure variables from different physiological systems. Electrodes, sensors and transducers, bioelectric amplifiers safety and digital acquisition will be discussed. Hardware for measurement of the ECG, EEG, EMG, respiratory system, nervous system, clinical laboratory instruments, electrical safety and computers in biomedical instrumentation. **Effective From: Fall 2011**

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 698 - Selected Topics (3 credits)
Selected topics for Biomedical Engineering.

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 774 - Principles of Neurorehabilitation (3 credits)
This is a research-focused course providing in-depth review of current studies in the following fields: Pathophysiology of disability; Advanced therapeutic interventions; Emerging neurorehabilitation technologies that are intended to encourage neural reorganization and relearning; Novel interfaces through chronic implementation in the brain, spinal cord and muscles used in deep brain stimulation, brain-machine interfaces, and functional electrical stimulation and Methods of assessing outcomes. **Effective From: Spring 2010**

BME 788 - Selected Topics (3 credits)
Selected topics for Biomedical Engineering.

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.

UMDNJ 313 - Membranes and Transport (null)
For more details go to UMDNJ website.

UMDNJ 501 - General Pathology (null)
For more details go to UMDNJ website.

UMDNJ 5040 - Biostatistics (null)
For more details go to UMDNJ website.

UMDNJ 507 - Introduction to Animal Experiments (null)
For more details go to UMDNJ website.

UMDNJ 602 - Principles of Pharmacology (null)
For more details go to UMDNJ website.

UMDNJ 605 - Advanced Biometrics (null)
For more details go to UMDNJ website.

UMDNJ 610 - Topics in Biochemical Pharmacology (null)
For more details go to UMDNJ website.

UMDNJ 612 - Clinical Pharmacology (null)
For more details go to UMDNJ website.

UMDNJ 701 - Human Physiology (null)
For more details go to UMDNJ website.

UMDNJ 703 - General Endocrinology (null)
For more details go to UMDNJ website.

UMDNJ 704 - Neuroscience (null)
For more details go to UMDNJ website.

UMDNJ 705 - Cardiorespiratory Physiology (null)
For more details go to UMDNJ website.

UMDNJ 715 - Neurophysiology Seminar (null)
For more details go to UMDNJ website.

UMDNJ 716 - Microcirculatory Physiology (null)
For more details go to UMDNJ website.

Biostatistics: Offered by the UMDNJ-New Jersey Medical School

GRADUATE COURSES:

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 Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering.

UNDERGRADUATE COURSES:

ChE 101 - Introduction to Chemical Engineering (1-0-0)
Prerequisites: None. An introduction to the field of chemical engineering and to the Otto H. York Department of Chemical Engineering. Topics include the curriculum, tours of department teaching laboratories and computing facilities, undergraduate research opportunities, cooperative employment, and student professional societies. Also included are visits by alumni who discuss their careers after graduation from the department.

ChE 210 - Chemical Process Calculations I (3-0-2)
Prerequisites: Chem 126 (or Chem 122). Corequisites: Math 112 and CS 101. Analysis of chemical processes is introduced, emphasizing steady and unsteady-state mass and species balances. This course uses primarily chemistry and algebra to determine, for a wide variety of processes and applications, the flow and concentrations of different chemical species. **Effective From: Fall 2009**

ChE 210W - Chemical Process Calculations I (0-1-0)
Workshop **Effective From: Fall 2008**

ChE 221 - Material Balances (4-0-4)
Prerequisites: Chem 126 or Chem 123, and Math 112. Co-requisites: CIS 101, FED 101. An introduction to the analysis of chemical processes with special emphasis on steady state mass balances. The course introduces mass balances in unsteady state. **Effective Until: Spring 2005**

ChE 230 - Chemical Engineering Thermodynamics I (3-0-3)
Prerequisites: Chem 126, (or Chem 122), Math 112, Phys 111. Corequisite Math 211 (or Math 213). The Fundamentals of thermodynamics are applied to chemical engineering processes. Thermophysical properties and their engineering correlations are covered. Applications include chemical engineering and related fields such as environmental and biomedical engineering. **Effective From: Fall 2008**

ChE 230W - Chemical Engineering Thermodynamics I Workshop (0-1-0)
Workshop **Effective From: Fall 2008**

ChE 232 - Chemical Engineering Thermodynamics I (2-2-3)
Prerequisite: ChE 221. Corequisite: Chem 231. A course emphasizing the concepts of energy balances and energy balance calculations. Uses engineering correlations and thermodynamics to estimate properties used in batch and flow systems. **Effective Until: Fall 2005**

ChE 240 - Chemical Process Calculations II (3-0-3)
Prerequisites: ChE 210, ChE 230, Math 211 (or Math 213). Corequisite: Math 222. This course covers the basic principles of energy balances for a variety of engineering systems. Combined with material from other sophomore courses, simple designs of chemical processes are considered. The course also introduces chemical process simulation software. **Effective From: Fall 2008**

ChE 240W - Chemical Process Calculations II (0-1-0)
Workshop **Effective From: Fall 2008**

ChE 260 - Fluid Flow (3-0-3)
Prerequisite: ChE 230. Corequisite: ChE 240, Math 222. This course considers the principles of molecular and turbulent transport of momentum, particularly as they apply to pressure drop calculations in piping systems, packed columns, and other flow devices. Flow around submerged objects is also considered. **Effective From: Fall 2005**

ChE 310 - Co-op Work Experience I (0-0-3)

(3 degree credits). Prerequisites: Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report.Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

ChE 311 - Co-op Work Experience II (0-0-0)
(0 credits) Prerequisites: ChE 310. Requires permission of undergraduate advisor. Cannot be used for degree credit. **Effective From: Spring 2011**

ChE 312 - Chemical Process Safety (3-0-3)
Prerequisite: Junior standing. A study of the technical fundamentals of chemical process safety: includes impact of chemical plant accidents and concepts of societal and individual risk; hazards associated with chemicals and other agents used in chemical plants, including toxic, flammable and reactive hazards: concepts of inherently safer design; control and mitigation of hazards to prevent accidents, including plant procedures and designs; major regulations that impact safety of chemical plants; consequences of chemical plant incidents due to acute and chronic chemical release and exposures; hazard identification procedures; introduction to risk assessment. **Effective From: Spring 2011**

ChE 342 - Chemical Engineering Thermodynamics II (3-0-3)
Prerequisites: ChE 230, Math 211 (or Math 213), Chem 236. The principles and methods developed in Chemical Engineering Thermodynamics I are extended to multicomponent systems, and used to treat phase and chemical equilibrium as well as such applications as chemical reactors and refrigeration systems. **Effective From: Fall 2005**

ChE 349 - Kinetics and Reactor Design (3-0-3)
Prerequisites: ChE 342, ChE 370, Math 222, Chem 236. Derive and solve species and energy balances for single chemical reactors; introduces heterogeneous catalysis, non-ideal reactors as ideal reactor combinations, and special topics such as polymeric or biochemical reactions. **Effective From: Fall 2005**

ChE 360 - Separation Processes I (3-0-2)
Prerequisites: ChE 342, ChE 370. This is the first course in separations, examines traditional methods and technologies by which chemical engineers separate and purify mixtures. Emphasis here is on strippers, absorbers, distillations, and extractions. **Effective From: Fall 2008**

ChE 363 - Transport Operations I (3-0-3)
Prerequisites: ChE 232, Phys 111, CIS 101, and FED 101. Corequisite: Math 222 Considers principles of the molecular and turbulent transport of momentum, particularly as they apply to pressure drop calculations in piping systems, packed columns, and other flow devices. Also considered is flow around submerged objects. **Effective Until: Spring 2007**

ChE 364 - Transport Operations II (3-0-3)
Prerequisites: ChE 232, Math 222. Corequisite: ChE 363. The principles of molecular and turbulent transport of energy are considered, particularly as they apply to design of heat exchangers. Also considered is radiant heat transfer. **Effective Until: Spring 2011**

ChE 365 - Techniques for Process Simulation (3-0-2)
Prerequisites: ChE 370. Corequisite: ChE 360. This course reviews chemical engineering applications of LaPlace transforms, partial fractions, and linear algebra in preparation for the ChE course in process control. It introduces dedicated software for chemical process simulation and control used in the senior capstone courses. **Effective From: Fall 2010**

ChE 367 - Diffusional Systems (3-0-3)
Prerequisites: ChE 363, Math 222. Covers principles of molecular and turbulent transport of mass, particularly as they apply to design of packed columns, and other mass transfer devices. **Effective Until: Spring 2007**

ChE 370 - Heat and Mass Transfer (4-0-4)
Prerequisites: ChE 240, ChE 260, Math 222. The principles of heat and mass transfer in chemical engineering systems are covered. Steady and unsteady heat transfer is examined, with emphasis on the heat exchanger design. Mass transfer by steady and unsteady molecular diffusion, and turbulent convective mass transfer is studied. **Effective From: Fall 2005**

ChE 375 - Structure, Properties and Processing of Materials (3-0-3)
Prerequisites: Chem 236, (or Chem 235), Mech 320 (can be taken as co-requisite). Tailoring materials properties by engineering their microscopic/macroscopic structures via processing is central to product design and development in the chemical industry. This course introduces the principles of materials engineering from the perspective of structure-property-processing relationships. Instead of covering different types of materials separately, this course will use the principles common to engineering of all important materials as an underlying theme. These are atomic/molecular structure, nanoscale, morphology, principles of phase

transformation, structure development during processing, and property dependence on structure. All these topics will be introduced through the paradigm of comparing metals, ceramics and polymers. Besides single component systems, advanced materials such as multiphase and/or multicomponent systems (e.g. composites and gels) and nanomaterials will be discussed based on these principles. An integral part of this course will be the criteria for selection of materials for the chemical process industry. **Effective From: Fall 2004**

ChE 380 - Introduction to Biotechnology (3-0-3)
Prerequisites: Chem 122 or Chem 126. Basic principles of molecular biotechnology with selected examples of applications. **Effective From: Fall 2004**

ChE 396 - Chemical Engineering Laboratory I (0-5-3)
Prerequisites: ChE 370, Eng 352. Corequisite: Math 225A. In this first course in chemical engineering capstone laboratory, experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students. **Effective From: Fall 2005**

ChE 402 - Applied Optics in Chemical Engineering (3-0-3)
Prerequisites: Junior or senior standing in chemical engineering. Combined laboratory and lecture course emphasizing photonics and laser applications in chemical engineering.

ChE 411 - Work Experience III (0 credits)
Prerequisites: ChE 311. Continuation of ChE 311. Cannot be used for degree credit. **Effective From: Fall 2011**

ChE 427 - Biotransport (3-0-3)
Prerequisites: ChE 230 and Math 222. Introduction to basic concepts of transport phenomena as applied to biological systems. Topics include the structure and composition of the human body, the properties of the blood and its flow in the cardiovascular system, and the body as a heat source and as a series of compartments involved in the mass transfer of materials (such as those in the kidneys and lungs). Students learn to analyze solute transport in biological systems and apply it to the design of biomedical devices. **Effective From: Spring 2004**

ChE 444 - Introduction to Polymer Engineering (3-0-3)
Prerequisites: ChE 370. Introduction to the basic concepts of polymer engineering. Topics covered include rheology, heat transfer, and kinetics of polymerization reactors.

ChE 460 - Separation Processes II (3-0-2)
Prerequisites: ChE 360. This second course in separations examines non-traditional methods and technologies such as fixed-bed processes, membranes, crystallization, and mechanical separations. **Effective From: Fall 2008**

ChE 461 - Fate and Transport of Pollutants in the Environment (3-0-3)
Prerequisites: Math 222, Chem 235 or Chem 360, ChE 370 or CE 320. 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. Two of the most important parameters in mass transport are the driving force or concentration gradient and the transport mechanism. Methods for defining these parameters are discussed during the first six weeks of the class. Concepts and models presented in the first six weeks are applied to air-water, sediment-water, and soil-air interfaces during the rest of the term. The semester ends with a group project, where students are asked to apply material from the course to resolve a comprehensive problem. **Effective Until: Spring 2011**

ChE 466 - Pollution Control in Chemical Processes (3-0-3)
Prerequisites: ChE 349, ChE 360. A course applying chemical engineering principles to the appropriate treatment of gaseous and liquid effluents from manufacturing and utility plants. The course will take into consideration toxicity, safety, and economic constraints. A case study approach is used to evaluate processes and pinpoint pollution sources. Quantitative designs and calculations will be required. **Effective Until: Spring 2011**

ChE 468 - Air Pollution Control Principles (3-0-3)
Prerequisites: ChE 360, ChE 349. A course focusing on the sources and control of air pollution. The course emphasizes design of modern air pollution control equipment and associated economics. **Effective Until: Spring 2011**

ChE 471 - Equilibrium Stage Processes (3-0-3)
Prerequisite: ChE 342, ChE 364. Corequisite: ChE 367. Covers the design of distillation columns, extraction columns, leaching, and other stagewise separation processes. **Effective Until: Fall 2007**

ChE 472 - Process and Plant Design (4-0-4)
Prerequisites: ChE 349, ChE 365, ChE 375, ChE 380, ChE 460, IE 492. A capstone course in the chemical engineering program. This class is divided into three- or four-person groups. Each group must complete an open-ended process design problem,

including equipment specification and economics. **Effective From: Fall 2001**

ChE 472H* - Process and Plant Design Honors (4-0-4)
Same as ChE 472, with special projects for Honors students.

ChE 473 - Mathematical Methods in Chemical Engineering (3-0-3)
Prerequisites: Math 222, ChE 349, ChE 360, and ChE 370. An introduction to the use of differential equations to solve chemical engineering problems.

ChE 476 - Introduction to Biochemical Engineering (3-0-3)
Prerequisites: Chem 245, ChE 349. Corequisite: ChE 349. The application of chemical engineering to biochemical processes. Topics include enzyme reactions, dynamics of microbial populations, fermentation equipment, bioreactor design, and sterilization. **Effective From: Fall 2010**

ChE 477 - Process Dynamics and Control (4-0-4)
Prerequisites: ChE 349, ChE 363, ChE 364. Mathematical description of transient and steady state behavior of chemical engineering processes. Study of the open-loop response of output process variables to varying inputs. Theory and applications of chemical process control. **Effective Until: Fall 2007**

ChE 485 - Chemical Engineering Laboratory I (1-6-4)
Prerequisites: Chem 235A, ChE 363, ChE 364, Math 225. Engineering experimentation and data analysis. Experiments are conducted in the areas of fluid mechanics and heat transfer. Bench and pilot-scale equipment is used. Results are presented in both oral and written reports. **Effective Until: Fall 2007**

ChE 486 - Chemical Engineering Laboratory II (0-8-4)
Prerequisites: ChE 349, ChE 367, ChE 471, ChE 485. Corequisite: ChE 477. Engineering experimentation and data analysis. Experiments are conducted in the areas of distillation, extraction, and chemical/biochemical reactions. Bench and pilot-scale equipment is used. Results are presented in both oral and written reports. **Effective Until: Fall 2007**

ChE 486H - Chemical Engineering Laboratory II Honors (0-8-4)
Same as ChE 486, with special projects for Honors students. **Effective Until: Fall 2007**

ChE 489 - Process Dynamics and Control (2-2-3)
Prerequisites: ChE 349, ChE 365. This course is an introduction to chemical process dynamics and control. Topics include analysis of the dynamics of open-loop systems, the design of control systems, and the dynamics of closed-loop systems. Control techniques and methodologies, used by practicing chemical engineers, are emphasized. **Effective From: Fall 2005**

ChE 490 - Special Topics in Chemical Engineering (3-0-3)
Prerequisites: ChE 349, ChE 360. Topics of current interest in chemical engineering, such as supercritical fluid extraction, combustion research, environmental problems, biotechnology, technologies in hazardous and toxic substance management, etc. As interests develop, other topics will be considered.

ChE 491 - Research and Independent Study I (3-0-3)
Prerequisites: senior standing in chemical engineering, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. Normally a GPA greater than 3.0 is required to participate in the course. Provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion.

ChE 491H - Research and Independent Study I Honors (3-0-3)
Same as ChE 491, with special projects for Honors students.

ChE 492 - Research and Independent Study II (3-0-3)
Prerequisite: ChE 491. A continuation of ChE 491.

ChE 492H - Research and Independent Study II Honors (3-0-3)
Prerequisite: ChE 491H. Same as ChE 492, with special projects for Honors students.

ChE 496 - Chemical Engineering Laboratory II (0-6-3)
Prerequisites: ChE 349, ChE 360, ChE 380, ChE 396, Chem 339, Math 225A. Corequisites: ChE 460, ChE 489. In this second course in chemical engineering capstone laboratory, experiments are conducted in the areas of mass transfer, separations, reaction engineering, and process dynamics and control. Bench and pilot-scale equipment is used. Oral and written reports are prepared by the students. **Effective From: Fall 2005**

GRADUATE COURSES:

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. **Effective Until: Spring 2005**

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 603 - Separation Process Principles (3-0-3)
Prerequisites: ChE 342, ChE 349, ChE 363, ChE 364, ChE 367, ChE 471. The course covers the basic principles of separation with or without chemical reaction in phase equilibrium-based, external field-driven and membrane-based separation processes. **Effective From: Fall 2004**

ChE 604 - Membrane Separation Processes (3-0-3)
Prerequisites: ChE 342, ChE 349, ChE 363, ChE 364, ChE 367, ChE 471. This course covers the science, technology, engineering analysis and design of membrane separation processes, membrane reactors, membrane-based equilibrium separation processes and hybrid membrane processes. **Effective From: Spring 2005**

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 619 - Nano-scale Characterization of Materials (3 credits)
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy; near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project. **Effective From: Fall 2007**

ChE 623 - Heat Transfer (3-0-3)
Prerequisite: undergraduate course in heat transfer. Heat transmission applied to practical problems in design. An introduction will include review of conduction, convection and radiation heat transfer modes. Related topics covered will be heat exchangers, types and design principles (including Kern & Bell?s methods), effectiveness, (NTU Design and Rating methods), Fired Heaters, Design & Rating and Cooling Towers, Design & Rating. **Effective From: Fall 2012**

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: Math 222 or equivalent undergraduate degree in Chemical Engineering. The purpose of the course is to emphasize the importance of mathematics to chemical engineering practice. Applications of ordinary differential equations, Sturm-Liouville problems arising from partial differential equations, regular Perturbation approaches to some nonlinear systems of chemical engineering interests, use of Laplace transfroms expecially the Residue Theorem for inversions and some numerical methods. It is suggested that students take this course before taking ChE 624. **Effective From: Fall 2011**

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. **Effective Until: Spring 2005**

ChE 654 - Corrosion (3-0-3)
Prerequisite: Undergraduate courses in Chemistry. Fundamental principles including thermodynamics and kinetics of corrosion; forms of corrosion (e.g. galvanic, crevice and stress); methods of corrosion measurement; high temperature corrosion; and special case histories. **Effective From: Fall 2004**

ChE 656 - Industrial Catalysis: Fundamentals & Applications (3 credits)
The class provides an introduction to catalytic phenomena as well as catalysts. It provides the background information necessary to understand industrial catalytic processes. Examples which will be discussed are hydrogen, ammonia and methanol synthesis, inorganic and organic oxidation reactions, petrochemical processes as well as pollution abatement and other important processes. The course provides insight into the theory of catalytic phenomena and also provides practical information about these processes from an industrial perspective. **Effective From: Spring 2008**

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. **Effective Until: Spring 2005**

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 an 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 and mechanical properties, rubbers, polymer blends and composites, biological polymers, and special applications. New areas and innovative applications of polymers will be introduced.

ChE 683 - Polymer Processing (3 credits)
Prerequisite: Undergraduate courses in transport phenomena, fluid flow, or heat transfer or approval of graduate advisor. The course provides a systematic approach to the physical phenomena occurring in polymer processing machinery. The synthesis of the elementary steps of polymer processing are shown in relation to the development of extrusion die flow and extrusion products and injection mold flows and molded products. Structural and residual stresses are examined.

ChE 684 - Materials and Process Selection for Polymer Product Design (3 credits)
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 721 - Combustion Reaction Engineering (3-0-3)
Prerequisites: Undergraduate degree in Chemical or Mechanical Engineering. Topics related to the engineering of combustion systems will be discussed. These include laminar flames, turbulent combustion, ideal reactor modeling of complex combustion systems, combustion chemistry, heterogeneous combustion and incineration. **Effective From: Fall 2004**

ChE 724 - Sustainable Energy (3-0-3)
The course is a project-based advanced graduate course which requires strong background in engineering thermodynamics and transport phenomena. The main goals of this course are to gain an understanding of the cost-benefit ratio of various alternative energy sources and to understand some of the various obstacles associated with current and conventional technologies and industrial applications. Different renewable and conventional energy technologies will be discussed in class. Course materials include biomass energy, fossil fuels, geothermal energy, nuclear power, wind power, solar energy, hydrogen fuel, hydropower, and fuel cells. Students will learn a quantitative framework to aid in evaluation and analysis of energy technology systems in the context of engineering, political, social, economic, and environmental goals. **Effective From: Spring 2013**

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 students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

ChE 792 - Pre-Doctoral Research (3 credits)
Prerequisite: Permission of Associate Chairperson for Graduate Studies. For students admitted to the Doctor of Philosophy Program in Chemical Engineering who have not yet passed the qualifying examination. Research is carried out under the supervision of designated chemical engineering faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied to the 36 credits required under ChE 790. **Effective From: Fall 2007**

ChE 794 - Professional Presentations for Ph.D. Students (0 credits)
Intended to help students make better technical presentations. Each student is required to make a presentation on a research topic; guest lectures will occur during the semester. **Effective From: Fall 2007**

Chemistry: Offered by the Department of Chemistry and Environmental Science

UNDERGRADUATE COURSES:

Chem 105 - Applied Chemical Principles (3-2-4)
Prerequisite: high school algebra or equivalent. The fundamentals and relation of chemistry to living in today's society. Suitable laboratory experiments illustrate the course material. Not open to engineering or science students, or students who have completed a college level chemistry course.

Chem 108 - College Chemistry I (3-1-3)
Prerequisites: a one-year college prep high school chemistry course, high school math including algebra and trigonometry. Delivered as a telecourse, the course provides the first of a two-semester sequence of college chemistry for high school students and other distance learners seeking college credit and/or preparation for the AP Examination. Matriculated undergraduates may not receive credit for this course.

Chem 109 - College Chemistry II (3-1-3)
Prerequisite: Chem 108. A continuation of Chem 108.

Chem 121 - Fundamentals of Chemical Principles I (3-0-3)
Prerequisites: high school math including algebra and trigonometry; chemistry placement examination required. Introduces the basic concepts of chemistry, including chemical reactions, and bonding, electronic and molecular structure, gases and thermochemistry. Alternative course to meet the requirement of Chem 125, 126. Emphasis is on mastering the material at the level of the ACS standardized final. **Effective From: Spring 2011**

Chem 121(Archived - Fundamentals of Chemistry I (3-0-3)
Prerequisites: High School math including algebra and trigonometry; chemistry placement examination required. The first semester of a three-semester sequence in chemistry, designed for undergraduate students. Introduces the basic concepts of chemistry, including chemical reactions, electronic structure, gases and thermochemistry. Enrollment in Chem 121, 122, 123 is determined by a placement exam prior to initial registration. This sequence takes the place of Chem 125, 126. However, 3 credits its of Chem 121, 122, 123 are addictive only. The remaining 6 credits count toward degree requirements. **Effective Until: Fall 2011**

Chem 122 - Fundamentals of Chemical Principles II (3-0-3)
Prerequisite: Chem 121 and Chem 125 with a grade of C or better. Introduces the basic concepts of chemistry, including equilibrium, chemical kinetics, thermodynamics, electrochemistry, and nuclear chemistry. Emphasis is on mastering at the level of the ACS standardized final. Students should also register for Chem 124. **Effective From: Spring 2012**

Chem 122(Archived) - Fundamentals of Chemistry II (3-0-3)
Prerequisite: Chem 121. Continuation of the Chem 121 sequence. This course introduces the student to the basic concepts of Chemistry, including molecular structure, solutions and solids, and equilibrium. **Effective Until: Fall 2011**

Chem 123 - Fundamentals of Chemistry III (3-0-3)
Prerequisite: Chem 122 with a grade of C or better. Continuation of the Chem 121 sequence. Introduces the student to the basic concepts of chemistry, including equilibrium in solution, kinetics and thermo-dynamics. Students should also register for Chem 124. **Effective Until: Spring 2012**

Chem 124 - General Chemistry Laboratory (0-2-1)
Corequisite: Chem 122 or 123 or Chem 126 with a grade of C or better. Chemical principles studied in the Chem 125 and 126 or Chem 121, 122 and 123 sequence are illustrated and reinforced by performance of laboratory experiments. **Effective From: Spring 2009**

Chem 124H - General Chemistry II Honors Laboratory (0-2-1)

Corequisite: Chem 126H with a grade of C or better. The laboratory consists of special research projects and other developmental labs. **Effective From: Spring 2009**

Chem 125 - General Chemistry I (3-0-3)
Prerequisites: At least 620 on the SAT. The first semester of a two-semester sequence in chemistry. Introduces the basic concepts of chemistry, including chemical reactions and bonding, electronic and molecular structure, gases and thermochemistry. **Effective From: Fall 2013**

Chem 125H - General Chemistry I Honors (3-0-3)
Prerequisites: High school math including algebra and trigonometry; chemistry placement examination. Admission is by invitation only. An honors chemistry course which parallels Chem 125 but is more comprehensive and rigorous. Field trips, molecular model building, laboratory projects, journal reading assignments and reports, and supplementary problems are required -aspects of the program. **Effective From: Spring 2009**

Chem 126 - General Chemistry II (3-0-3)
Prerequisite: (Chem 125 or Chem 122) with a grade of C or better. The second semester of a two-semester sequence in chemistry. Introduces the basic concepts of chemistry, including equilibrium, chemical kinetics, thermodynamics, and electrochemistry. Students should also register for Chem 124. **Effective From: Fall 2013**

Chem 126H - General Chemistry II Honors (3-0-3)
Prerequisite: Chem 125H with a grade of C or better. A continuation of Chem 125H, which parallels the course content of Chem 126. An individual research project is completed. Chem 124H must be taken concurrently. **Effective From: Spring 2009**

Chem 221 - Analytical Chemical Methods (0-4-2)
Prerequisite: Chem 222 with grade of C or better. Laboratory introducing quantitative chemical analyses by gravimetry, titration, spectroscopy, chromatography, and potentiometry. **Effective From: Fall 2013**

Chem 222 - Analytical Chemistry (3-0-3)
Prerequisite: Chem 123 or Chem 126, Chem 124 with grade of C or better. Lecture course introducing concepts of chemical analyses by gravimetry, titration, spectroscopy, chromatography, and potentiometry. **Effective From: Spring 2009**

Chem 231 - Physical Chemistry I (3-0-3)
Prerequisites: Chem 122 or Chem 126, Phys 111 with a grade of C or better. Corequisite: Math 211. The topics covered include the properties of ideal and non-ideal gases and liquids, solutions, thermochemistry, thermodynamics, the phase rule, and phase equilibria. **Effective From: Fall 2013**

Chem 235 - Physical Chemistry II (3-0-3)
Prerequisite: Chem 231 with a grade of C or better. A continuation of Chem 231. The topics include homogeneous and heterogeneous chemical equilibria, ionic equilibria, electrochemistry, kinetic theory of gases, transport phenomena, kinetics, and irreversible processes. **Effective From: Spring 2009**

Chem 235A - Physical Chemistry II Laboratory (0-4-2)
Prerequisite: Chem 221, Chem 235 with a grade of C or better. Corequisite: Math 225 (special section for chemical engineering and chemistry majors). Laboratory experiments apply and extend the basic knowledge of physical chemistry acquired in the lecture. Reports and presentations are an essential part of the course. **Effective From: Spring 2009**

Chem 236 - Physical Chemistry for Chemical Engineers (4-1-4)
Prerequisites: (Chem 122 or Chem 126)and chem 124 and (Che 230 or Che 232) with a grade C or better. This course will introduce the chemical engineering students to the concepts of order, disorder, chemical equilibrium and phase equilibrium. Credit for this course will not be given if credit for Chem 235 has been given. **Effective From: Fall 2013**

Chem 238 - Analytical/Organic Chem Lab for Chemical Engineers (0-4-2)
Prerequisite: Chem 124 and Chem 245 with a grade of C or better. This course will offer the ChE students experience in organic and analytical laboratory experiments. These experiments will reinforce concepts learned in the organic chemistry lecture classes. This laboratory course will also provide exposure to analytical and other techniques useful in the chemistry and chemical engineering laboratories. **Effective From: Spring 2009**

Chem 243 - Organic Chemistry I (3-0-3)
Prerequisite: Chem 123 or Chem 126 with a grade of C or better. The preparation and properties of the various classes of organic compounds are discussed, with attention given to industrial sources such as coal and petroleum. Also covers the commercial utilization of these materials in the synthesis of useful products used in areas such as foods, cosmetics, textiles, plastics, and pharmaceuticals. **Effective From: Spring 2009**

Chem 244 - Organic Chemistry II (3-0-3)
Prerequisite: Chem 243 with a grade of C or better. **Effective From: Spring 2009**

Chem 244A - Organic Chemistry II Laboratory (0-4-2)
Prerequisite: Chem 124 with a grade C or better. Corequisite: Chem 244. Synthesis and characterization of organic compounds are performed in a unique multi-scale manner: micro, macro and a kilo scale. **Effective From: Spring 2009**

Chem 245 - Organic Chemistry for Chemical Engineers (4-1-4)
Prerequisite: Chem 126 or Chem 122 with a grade of C or better. This course is a one-semester course(opposed to classic two-semester sequence) to provide chemical engineering students with a basic understanding of organic compounds and their reactions. **Effective From: Spring 2013**

Chem 246A - Organic Chemistry Laboratory (0-2-1)
Prerequisite: Chem 244A with a grade of C or better. This course will cover some common reaction types that are not included in Chem 244A. The experiments will be carried out in microscale. Students will learn new concepts in organic synthesis, including multi-step synthesis, organometallic reagents, and green chemistry for chemical synthesis, catalytic reactions, protecting groups, and peptide couplings. NMR and IR will be used for compound characterization. **Effective From: Spring 2013**

Chem 301 - Chemical Technology (2-2-3)
Prerequisites: high school algebra and trigonometry or equivalent with a grade of C or better. Designed for engineering technology majors. Not open to students who have completed a college level chemistry course. Covers principles of chemistry, with a focus on chemical energetics and chemistry of materials. Suitable laboratory experiments illus-trate the course material. **Effective From: Spring 2009**

Chem 310 - Co-op Work Experience I (3 additive credits)
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Cannot be used for degree credit.Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Chem 311 - Co-op Work Experience II (3 additive credits)
Prerequisites: ChE 310 with a grade C or better. **Effective From: Spring 2009**

Chem 336 - Physical Chemistry III (3-0-3)
Prerequisite: Chem 235 with a grade of C or better. An introduction to quantum mechanics, statistical mechanics, spectroscopy, and solid state. **Effective From: Spring 2009**

Chem 337 - Physical Chemistry for Biological Science (3-0-3)
Prerequisites: Chem 123 or 126 with a grade of C or better. The course covers fundamental principles of physical chemistry related to biochemical processes such as metabolism and other biochemistry. Descriptions and example applications use DNA, proteins, amino acids, including properties of hydrophobic interactions. Thermochemistry of biochemical systems including chemical energy (enthalpy of reaction) along with chemical activities and non-ideal behavior are illustrated. The importance of entropy in control of biochemical reactions is also covered. Ionic systems and redox reactions and acids and bases in biological systems are presented. The course also illustrates a number of biochemical analytical methods. **Effective From: Spring 2009**

Chem 338 - Analytical/Organic Chem Lab for Chemical Engineers (0-4-2)
Prerequisite: Chem 124 and Chem 245 with a grade of C or better. This course will offer the ChE students experience in organic and analytical laboratory experiments. These experiments will reinforce concepts learned in the organic chemistry lecture classes. This laboratory course will also provide exposure to analytical and other techniques useful in the chemistry and chemical engineering laboratories. **Effective From: Spring 2009**

Chem 339 - Analytical/Physical Chem Lab for Chemical Engineers (0-4-2)
Prerequisites: Chem 245, or Chem 236 with a grade of C or better. Co-requisite: Math 225. This course will offer students an introduction to physical and analytical chemistry laboratory techniques. The application of principles learned in lecture will be reinforced by the experiments done in this lab. They will also provide exposure to analytical and other techniques used in chemistry and chemical engineering. **Effective From: Fall 2013**

Chem 340 - Chemistry and Engineering of Materials (3-0-3)
Prerequistes: Chem 235, Chem 244 with a grade of C or better. Emphasizes processing/property relationships for a variety of engineering materials, including polymers, metals, ceramics, composites, semiconductors, optical fibers, and biomaterials. Introduces concepts of chemical structure, bonding and crystallinity. Covers important chemical, physical, electrical, and mechanical properties and corrosion and materials degradation. Also includes materials selection in the chemical process

industries. **Effective From: Spring 2009**

Chem 350 - Industrial Chemistry (3-0-3)
Prerequisite: Chem 244 with a grade of C or better. Applications of chemistry to the development of products from basic research and development through scale-up and marketing. Covers inorganic and organic processes, environmental considerations, industrial catalysis, and cost calculations. **Effective From: Spring 2009**

Chem 360 - Environmental Chemistry I (3-0-3)
Prerequisites: (Chem 126 or Chem 122, or Chem 124) with a grade of C or better. Chem 360 is a prerequisite for Chem 361. Chemistry of the environment is covered with emphasis on water chemistry. The course includes treatment of chemical bonding, basic thermodynamics, chemical equilibrium, kinetics, and the chemistry of ideal and non-ideal solutions. Water chemistry is covered, including acid/base equilibria, alkalinity, buffers, precipitation, and the sources of fates of water pollutants. **Effective From: Fall 2013**

Chem 361 - Environmental Chemistry II (3-0-3)
Prerequisites: Chem 360 with a grade of C or better. Chemistry of the environment is covered with emphasis on atmospheric and geo-chemistry. Organic and biochemical processes in the environment are treated. The applications of chemical principles to industrial ecology, green chemistry, pollution prevention and sustainability are discussed. **Effective From: Fall 2013**

Chem 365 - Environmental Organic Chemistry (3-0-3)
Prerequisite: Chem 122 or 126 with a grade of C or better. An introduction to organic chemistry intended for students studying environmental science or environmental engineering. Covers the traditional functional groups, but focuses on their environmental impact and industrial synthesis. Not open to students who have taken organic chemistry. **Effective From: Spring 2009**

Chem 391 - Research and Independent Study (3-0-3)
Prerequisite: Prerequisite: Junior standing in Chem. Provides an opportunity to work on a reserch project under the individual guidance of a member of the department. **Effective From: Spring 2009**

Chem 412 - Inorganic Chemistry (3-0-3)
Prerequisite: Prerequisite: Chem 231 with a grade of C or better. A lecture-recitation-laboratory course in practical inorganic chemistry. Covers the chemistry of most of the elements and their compounds. Preparation in the laboratory is followed by purification and characterization. **Effective From: Spring 2009**

Chem 437 - Applications of Computational Chemistry and Molecular Modeling (3-0-3)
This class introduces students to applications and fundamental aspects of computational chemistry and molecular modeling for application and understanding in organic, bio- or physical chemistry. It is an introductory course involving hands-on applications of computational chemistry and molecular modeling. The course provides training application and computer programs for students to use in determining fundamental thermochemical parameters, elementary reaction paths, and design of molecular structures to try and optimize and/or improve biochemical / pharmaceutical products or industrial chemical processes. Students will use chemical software packages to perform calculations in order to identify optimum interaction structures for pharmaceutical or industrial chemical systems. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium rations in chemical environments. The course is relevant to organic, inorganic, physical bio- and pharmaceutical chemistry. It is also relevant to optimization of chemical engineering processes. **Effective From: Spring 2013**

Chem 440 - Fundamentals of Polymers (3-0-3)
Prerequisites: Chem 235, Chem 244 with a grade of C or better. An introduction to the important fundamental aspects of polymers including preparation, structure, physical states and transitions, molecular weight distributions, viscous flow, and mechanical properties. **Effective From: Spring 2009**

Chem 443 - Introductory Polymer Laboratory (1-4-3)
Prerequisite: Chem 440 with a grade of C or better. Practical methods useful in the preparation and characterization of macromolecules, including radical, ionic, emulsion, and condensation polymerization. Various methods useful in characterizing polymers, such as solution and bulk viscosity, light scattering, osmometry, thermal analysis, and various spectroscopic techniques. Melt spinning and extrusion of polymers along with mechan-ical properties. **Effective From: Spring 2009**

Chem 448 - Preparation and Analysis of Organic Compounds (0-4-2)
Prerequisites: Chem 244 and Chem 244A with a grade of C or better. The application of laboratory techniques learned in Chem 344A laboratory to the synthesis and characterization of organic compounds. **Effective From: Spring 2009**

Chem 473 - Biochemistry (3-0-3)
Prerequisite: Chem 244 or Chem 245 with a grade of C or better. Covers the fundamentals of biochemistry including buffers, blood, proteins, enzymes, carbohydrates, fats, and nucleic acids. Emphasis on the relationship of biochemistry to biotechnology

and medicine. **Effective From: Spring 2009**

Chem 474 - Biochemistry II (3-0-3)
Biochemistry II will focus on transducing and storing energy, synthesizing the molecules of life, and responding to environmental changes. Topics include basic concepts of metabolism, glycolysis and gluconeogenesis, citric acid cycle, oxidative phosphorylation, photosynthesis, fatty acid metabolism, protein turnover and amino acid catabolism, biosynthesis of amino acids, DNA replication and recombination, RNA synthesis and processing, protein synthesis, control of gene expression, the immune system, and drug development. **Effective From: Spring 2013**

Chem 475 - Biochemistry Lab I (0-4-2)
Prerequisites: Chem 244 or 473 with a grade of C or better. This course will offer the chemistry and related (chemical engineering, biology, bioinformatics, bioengineering)students fundamental laboratory approaches for biochemistry and biotechnology. These experiments will reinforce concepts learned in biochemistry lecture classes. **Effective From: Spring 2009**

Chem 480 - Instrumental Analysis (0-4-2)
Prerequisite: Chem 221, Chem 222 or equivalent with a grade of C or better. Laboratory exploring the principles of operation of modern instruments for chemical analysis. Ultra-violet and infrared spectroscopy, mass spectrometry, gas chromatography, high performance liquid chromatography, voltametry, and potentiometry are among the instruments utilized. Apply calibration methods, statistical data treatment, and sample preparation techniques are applied. **Effective From: Spring 2009**

Chem 484 - Modern Analytical Chemistry (1-4-3)
Prerequisite: Chem 222 or Chem 235 with a grade of C or better. Basic principles and techniques of quantitative analysis, with emphasis on application of modern analytical instrumentation. Atomic and molecular spectroscopy, chromatography, and electrochemical methods are studied and applied in the laboratory. Calibration, sampling methodology and sample preparation are also treated. **Effective From: Spring 2009**

Chem 490 - Special Topics in Chemistry (3-0-3)
Prerequisite: depends upon the nature of the course given. Course is offered in specific areas as interest develops. **Effective From: Spring 2009**

Chem 491 - Research and Independent Study I (3-0-3)
Prerequisite: senior standing in chemistry or chemical engineering. Provides an opportunity to work on a research project under the individual guidance of a member of the department. **Effective From: Spring 2009**

Chem 491H - Honors Research and Independent Study I (3-0-3)
Same as Chem 491, with special projects for Honors students. **Effective From: Spring 2009**

Chem 492 - Research and Independent Study II (3-0-3)
Prerequisite: Chem 491 with a grade of C or better. A continuation of Chem 491. **Effective From: Spring 2009**

Chem 492H - Research and Independent Study II ? Honors (3-0-3)
Prerequisite: Chem 491H for Honors students. Same as Chem 492, with special projects for Honors students. **Effective From: Spring 2009**

R160:108 - Organic Biochemistry (3)
For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R160:207 - Structure And Bonding (3)
For more details go to Rutgers Catalog.

R160:227 - Experimental Analytical Chemistry (3)
For more details go to Rutgers Catalog.

R160:333 - Organic Chemistry Laboratory (2)
For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R160:345/346 - Physical Chemistry (3,3)
For more details go to Rutgers Catalog. **Effective From: Spring 2009**

R160:413 - Inorganic Chemistry (3)
For more details go to Rutgers Catalog. **Effective From: Spring 2009**

GRADUATE COURSES:

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 Laboratory (3 credits)
Prerequisites: one year of undergraduate physical chemistry. Instruments for chemical analysis are discussed in class and used in the laboratory; basic theory; sample preparation; use of instruments and interpretation of data are covered for spectroscopy including UV0VIS, FTIR, AA, and NMR; HPLC, GC, ion chromatography, mass spectrometry. Applications to food science, pharmaceuticals, polymers, and other chemical areas. 1 hr. lecture, 3 hrs. lab.

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. **Effective From: Spring 2009**

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 677 - Introduction to Medicinal Chemistry (3-0-3)
The course introduces Medicinal Chemistry with mechanisms of drug action and the classification of drugs into the various categories of activity from a pharmaceutical viewpoint that encompasses chemical, biological and pharmacological parameters. Course includes material on: Chemistry, Structure Activity, Structure-Activity Relationships, Synthetic Pathways and Metabolic Pathways. **Effective From: Fall 2004 Until: Fall 2008**

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 714 - Pharmaceutical Analysis (3 credits)
The objective of this course is to provide an overview of instrumental techniques used in the analysis of different pharmaceutical products. Many different types of analysis are carried out in the pharmaceutical industry pertaining to active ingredients, formulations as well as impurities and dgradants. The focus will be on instrumentation such as chromatography, mass spectroscopy, different types of spectroscopy, quality assurance and GMP. **Effective From: Spring 2009**

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 718 - Organic Synthesis (3-0-3)
Organic Synthesis is widely used in the production of organic materials and pharmaceutical drugs. The course introduces modern synthetic methods to the graduate students of NJIT. The first part of the course teaches organic reactions categorized by their roles in synthesis. Topics include substitution and addition of carbon nucleophiles, functional group conversion, oxidation, reduction, concerted cycloadditions, aromatic substitutions, and organometallic catalysis. The second part of the course teaches general strategies to develop synthetic plans, special considerations for difficult synthetic targets, and examples of natural product synthesis. **Effective From: Fall 2012**

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 736 - Inorganic Biological Chemistry (3-0-3)
This class introduces fundamental aspects of metals' roles at the interface of inorganic/organic and biological worlds. Both the "why" and "how" questions of the role of metals in materials and biological sciences will be answered based on the concept of symmetry and its consequences. Special attention will be paid to understanding the electronic structure, spectroscopic signatures and reactivity of metal ions in coordination environments related to chemical and biological catalysis. **Effective From: Fall 2008**

Chem 737 - Applications of Computational Chemistry and Molecular Modeling (3-1-3)
Students are exposed to hands-on applications and fundamental aspects of computational chemistry and molecular modeling in organic, inorganic, bio- and physical chemistry. The course provides methods to determine the thermochemistry of a reaction, and strength (energy)of interactions by organic drug-like molecules with proteins. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium ratios in chemical environments. **Effective From: Spring 2009**

Chem 748 - Nanomaterials (3)
Prerequisites: New feature of the 700 level course will be hands-on small projects carried out by groups of two students in Professor Iqbal's laboratories during the second half of the semester. The projects will be selected from the topics covered in the course. A second feature will involve a lecture on a specialized nanomaterial topic given by an invited outside lecturer. This 3 credit interdisciplinary course is designed to teach and provide hands-on project experience to M.S. and Ph.D. graduate students in chemistry, physics/materials science, and chemical/biomedical/electrical engineering on the fundamentals, synthesis, characterization and applications of nanomaterials. 75% of the course will comprise of lectures-one or two of which will be given by invited outside lecturers. 25% of the course will involve small projects based on the syllabus and conducted in the research laboratories of the instructor. **Effective From: Spring 2009**

Chem 777 - Principles of Medicinal Chemistry (3)
Teaches about drug design, and the molecular mechanisms by which drugs act in the body. Covers pharmacodynamics, pharmacokinetics, molecular targets used by drugs, the interaction of a drug with a target, and the consequences of this interaction. Covers strategies used in discovering and designing new drugs, and surveys the "tools of the trade" involved, e.g., QSAR, combichem and computer aided design. Covers special topics like chlorinergics, analgesics, opiates, antibacterials, antivirals, and antiulcer agents. **Effective From: Spring 2009**

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

UNDERGRADUATE COURSES:

CE 200 - Surveying (3-0-3)
Prerequisite: Math 111. Angle and distance measurement; leveling; topographic mapping; traverse and area computations; horizontal and vertical curves; cross sections; triangulation; state plane coordinates; global positioning system. Emphasis on the use of the computer for solving typical field and office problems. Lab should be taken concurrently.

CE 200A - Surveying Laboratory (0-3-1)
Corequisite: CE 200. Field exercises in conjunction with the classroom exercises in CE 200 utilizing classical and electronic instruments and COGO/CAD software.

CE 200B - Surveying Laboratory (0-3-1)
For geoscience engineering majors. Field exercises using survey instruments including tapes, levels, theodolites, and total stations. Covers principles of topographic mapping, traverses, triangulation, and computer data reduction.

CE 210 - Construction Materials and Procedures (3-0-3)
Prerequisites: HSS 101. Introduction to construction management organization, contracts, construction safety, engineering economics, and engineering ethics. Studies current practices of heavy construction including soil and rock excavation productivity, and building construction materials and procedures. Field trips to construction sites provide opportunities to directly view many of the practices.

CE 260 - Civil Engineering Methods (2-2-3)
Prerequisite: HSS 101 and FED 101. Provides students with in-depth experience in computer applications in civil engineering and with written and oral communication. **Effective From: Spring 2013**

CE 307 - Geometric Design for Highways (3-0-3)
Prerequisite: CE 200, CE 200A. Highway design based on a study of traffic distribution, volume, and speed with consideration for the predictable future. Analysis of elements of at-grade intersections and interchanges and the geometrics of highway design and intersection layout with advanced curve work including compound and transition curves.

CE 311 - Co-op Work Experience I (zero)
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a -report.

CE 320 - Fluid Mechanics (4-0-4)
Prerequisites: Mech 235 with a grade of C or better. Corequisite: Mech 236. This course is designed to present the fundamental laws relating to the static and dynamic behavior of fluids. The emphasis is placed on applications dealing with the flow of water and other incompressible fluids. These include flow in pipe systems and natural channels.

CE 320A - Hydraulics Laboratory (0-3-1)
Prerequisite or corequisite: CE 320. Explores the principles of fluid mechanics through laboratory experiments. Investigates various hydraulic phenomena with both physical and computer models. Demonstrates basic civil engineering design principles for pipe networks, open channel systems, and ground water regimes.

CE 321 - Water Resources Engineering (3-0-3)
Prerequisite: CE 200, CE 200A, Math 225. Training in methods of developing water supplies and the means to treat supplies for consumptive use. Covers hydrologic techniques such as surface and ground water yield, hydrograph and routing analyses, and probabilistic methods related to hydrologic studies.

CE 322 - Hydraulic Engineering (3-0-3)
Prerequisites: CE 320, CE 321. The objective is to provide the tools required to design water distribution systems, storm drains, and sanitary sewers. Examines related hydrologic and hydraulic techniques.

CE 332 - Structural Analysis (3-0-3)
Prerequisites: Mech 237 with a grade of C or better. A working knowledge of free body diagrams, equilibrium conditions for force systems and moments. The primary objective is an understanding of the various methods of analyzing determinate and indeterminate beams, frames, and trusses encountered in practice.

CE 333 - Reinforced Concrete Design (3-0-3)
Prerequisites: CE 332. The student must have a working knowledge of structural analysis including determinate and indeterminate beams and frames. Primary objectives include the following: to acquaint the student with the properties of concrete and steel and with the behavior of reinforced concrete as a structural material; also, to develop methods for the design of reinforced concrete structural members such as beams, slabs, footings, and columns. Both ultimate strength design and working stress method will be studied.

CE 341 - Soil Mechanics (3-0-3)
Prerequisite: Mech 237 with a grade of C or better or equivalent. Corequisite: CE341A. A study of soil types and properties is made with the objective of developing a basic understanding of soil behavior. The methods of subsurface investigation and compaction are presented. Fundamentals pertaining to permeability, seepage, consolidation, and shear strength are introduced. Settlement analysis is also presented. Lab must be taken concurrently.

CE 341A - Soil Mechanics Laboratory (0-3-1)
Corequisite: CE 341. Students perform basic experiments in soil mechanics.

CE 342 - Geology (3-0-3)
Prerequisite: consult the advisor. Studies science of geology with emphasis on physical geological processes. Stresses the principle of uniformity of process in the context of rock and soil formation, transformation, deformation, and mass movement. Includes aspects of historical geology and geomorphology.

CE 343 - Geology with Laboratory (3-3-4)
Covers the material given in CE 342 with the addition of a laboratory component. It provides a more in-depth understanding of geology through rock and mineral identification, laboratory experiments, field trips, and selected case studies.

CE 350 - Transportation Engineering (3-0-3)
Prerequisite: CE 200, CE 200A. A study of the principal modes of transportation, with emphasis on the planning, design and construction of facilities for modern transportation systems.

CE 381 - Geomorphology (3-0-3)
This is a course in geomorphology, the study of landforms and the contemporary processes that create and modify them. The course will emphasize earth surface processes and quantitative analysis of landform change. Lectures will stress geomorphic principles and two field-based problems will enable students to apply these principles to contemporary geomorphic problems in engineering and management with a focus on the natural environment. **Effective From: Fall 2010**

CE 406 - Remote Sensing (3-0-3)
Prerequisite: Phys 234. Principles of remote sensing are covered including general concepts, data acquisition procedures, data analysis and role of remote sensing in terrain investigations for civil engineering practices.

CE 410 - Construction Scheduling and Estimating (3-0-3)
Prerequisites: CE 210. Quantity take off, cost estimate and CPM computer analysis of typical building or highway projects. A study is made of construction project organization, contract requirements and management control techniques with an introduction to computer applications.

CE 412 - Construction Codes and Specifications (3-0-3)
Prerequisite: CE 210. Code and specification aspects of engineered construction. Topics include professional ethics, contracts, specifications, bidding procedures, building codes such as B.O.C.A. and New Jersey Uniform Construction Code, Energy Code Provisions, construction safety, and the impact of the EPA on construction.

CE 413 - Co-op Work Experience II (3 degree credits)
Prerequisites: CE 311 or equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements including a report and/or project.Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

CE 414 - Engineered Construction (3-0-3)
Prerequisites: CE 210, CE 332, CE 341. Design, erection, and maintenance of temporary structures and procedures used to construct an engineering project. Business practices, codes, design philosophies, construction methods, hardware, inspection, safety, and cost as they pertain to engineered construction projects.

CE 431 - Construction Materials Lab (0-3-1)
Prerequisites: Mech 237 with a grade of C or better, CE 210. This course provides an understanding of the basic properties of construction materials, and presents current field and laboratory standards and testing requirements for these materials. Students select a material or component assembly for testing, design a testing procedure, and present their results.

CE 432 - Steel Design (3-0-3)
Prerequisites: CE 332. A working knowledge of structural analysis including determinate and indeterminate beams and frames is essential. The development of current design procedures for structural steel elements and their use in multistory buildings, bridges, and industrial buildings.

CE 443 - Foundation Design (3-0-3)
Prerequisites: CE 341, CE 341A. Site investigation, selection of foundation types and basis for design, allowable loads, and permissible settlements of shallow and deep foundations. Computations of earth pressure and design of retaining walls.

CE 450 - Urban Planning (3-0-3)
Prerequisite: junior engineering standing. Introduction to urban planning, its principles, techniques, and use. Topics include development of cities, planning of new towns, redevelopment of central cities, and land use and transportation planning.

CE 461 - Professional Practice in CEE (3-0-3)
Develop an understanding of the process to become a licensed professional engineer and familiarize the students with the professional practice of engineering including codes of ethics and professional business practices and to provide an adequate background for the Fundamentals of Engineering. **Effective From: Fall 2006**

CE 465 - Green and Sustainable Civil Engineering (3-0-3)
Prerequisites: CE 210 and Junior standing. Designed to teach students currently available approaches that incorporate renewable energy and sustainable development concepts in civil engineering projects. This will include various methods of planning, design, and evaluation which promote increased energy efficiency and sustainable use of materials. Cost estimating and life cycle planning will also be included. The course will encourage students to look beyond the information in the course, to come up with additional methodologies which may not currently be in use. **Effective From: Spring 2011**

CE 485 - Special Topics in Civil Engineering (3-0-3)
The study of new and/or advanced topics in an area of civil engineering not regularly covered in any other CE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. **Effective From: Spring 2010**

CE 490 - Civil Engineering Projects (3-0-3)
Prerequisites: senior standing in civil engineering and approval of the department. Work on an individually selected project, guided by the department faculty advisor. The project may include planning, research (library or laboratory), engineering reports, statistical or analytical investigations, and designs. Any of these may follow class-inspired direction or the student may select his or her own topic. The project must be completed and professionally presented by assigned due dates for appropriate review and recording of accomplishment.

CE 490H - Honors Civil Engineering Projects (3-0-3)
Prerequisites: senior standing, enrolled in Honors College, and approval of the department. Same as CE 490.

CE 491H - Honors Research Experience in Civil Engineering (3-0-3)
Prerequisites: Junior standing, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. This course provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion. Open to students with a GPA of 3.0 or higher.

CE 494 - Civil Engineering Design I (3-0-3)
Prerequisite: CE 210, CE 260, CE 320, CE 321, CE 350, CE 341 and senior standing in civil engineering. Simulates the submission and acceptance process normally associated with the initial design phases for a civil engineering project. Familiarizes students with the preparation of sketch plats, preliminary engineering design, and a related environmental assessment. Requirements include written submittals and oral presentations in defense of the project. **Effective From: Fall 2011**

CE 494H - Honors Civil Engineering Design I (3-0-3)

Prerequisites: senior standing, enrolled in Honors College. Same as CE 494.

CE 495 - Civil Engineering Design II (3-0-3)
Prerequisite: CE 494. Provides students with the type of design experience they would receive if engaged in civil and environmental engineering design practice. Course will focus on one or more of these design areas: structural, geotechnical, transportation and planning, and sanitary and environmental engineering. **Effective From: Spring 2012**

CE 495H - Honors Civil Engineering Design II (3-0-3)
Prerequisites: senior standing, enrolled in Honors College. Same as CE 495.

GRADUATE COURSES:

CE 501 - Introduction to Soil Behavior (3 credits)
Prerequisites: Mech 320, Mech 235 with a grade of C or better and Mech 236 with a grade of C or better(see undergraduate catalog for descriptions). Open only to the students in bridge program. Permission from CEE department graduate advisor is required. Covers the necessary concepts in strength of materials, geology and soil mechanics required for the bridge program in M.S. in Environmental Engineering and Geoenvironmental Engineering option. **Effective From: Fall 2013**

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 593 - Graduate Co-op Work Experience IV (0 credits)

Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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 environmental problems presented by outside experts; and presentation of student projects. **Effective Until: Fall 2011**

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 606 - Geospatial Data Applications (3 credits)
Prerequisite: CE 602. The course focuses on geospatial data processing, information extraction and analysis tools. It provides visualization and decision support applications using desktop GIS software. Examples of the student projects include: Applications of integrated geospatial date in environmental, infrastructure, urban planning and homeland security. **Effective From: Spring 2010**

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 617 - Historic Preservation (3-0-3)
This course addresses the many aspects of structural preservation from both an engineering and aesthetic perspective. Course topics include: permits and regulations, an overview of architectural styles, designation of historic structures, past methods of construction, current methods of preservation and the availability of grants and funding. Knowledge gained from the course will be applied directly to course projects involving the evaluation and recommendations needed for the proposed preservation of an existing structure. **Effective From: Fall 2012**

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. **Effective From: Fall 2012**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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 course in geology or permission of instructor. Geology has a significant influence on how we plan, design, and construct engineering works. This course examines how the geologic formations underlying a locale will ultimately determine land use, control structure design, and affect construction material availability. Included is a study of the various rock-forming processes and geologic agents that have shaped Earth's surface. The course also explores the role of geologic factors in assessing environmental impacts and natural hazards such as earthquakes, subsiding soils, and landslides. Case study applications and a field trip are included. **Effective From: Fall 2005**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

CE 671 - Performance and Risk Analysis of Infrastructure Systems (3 credits)
This course presents a comprehensive systems approach to infrastructure asset management across areas of public and private infrastructure. Topics include the framework of integrated asset management illustrated in transportation, water and wastewater systems, the economic evaluation of infrastructure options, using life cycle cost analysis (LCCA) and cost-benefit analysis (CBA). The elements of performance measurement and modeling, including condition assessment and information management, failure and impact analysis are covered. Decision and risk analysis are covered to enable students to develop a holistic economic, performance and risk analysis approach to infrastructure management illustrated in a term project. **Effective From: Fall 2007**

CE 672 - Security Management of Critical Infrastructure (3 credits)
This course focuses on the areas of vulnerability assessment and security management of critical infrastructure systems. A review of techniques for facility and network modeling and performance simulation, leads to sector-specific approaches to vulnerability

analysis and critical infrastructure protection strategies using a Model-Based Vulnerability Analysis (MBVA). Covered critical infrastructure systems include water supply/environmental, transportation, power and energy systems, SCADA systems, cyber-infrastructure and telecommunications. The course ends with a review of the combined use of multi-criteria analysis techniques, expert heuristic response to scenarios and network analysis techniques in a general framework for vulnerability and security management of infrastructure systems in its key aspects: prevention, warning/detection and event mitigation and response planning and execution. **Effective From: Spring 2008**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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 Science:

UNDERGRADUATE COURSES:

CS 100 - Roadmap to Computing (3-0-3)
An introduction to programming and problem solving skills using Python or other very high level language. Topics include basic strategies for problem solving, constructs that control the flow of execution of a program and the use of high level data types such as lists, strings and dictionaries in problem representation. The course also presents an overview of selected topics in computing, such as networking and databases. **Effective From: Fall 2010**

CS 101 - Computer Programming and Problem Solving (3-0-3)
An introductory course in computer science and programming (using MATLAB, or other languages) and its use in solving engineering and scientific problems. The emphasis is on the logical analysis of a problem and the formulation of a computer program leading to its solution. Topics include basic concepts of computer systems, algorithm design, programming languages and data abstraction. Designed for students not specializing in computer science. **Effective From: Fall 2009**

CS 102* - Computer Science with Problem Solving (3-1-3)**
An introductory course in computer science, with applications to engineering and technology problems. Emphasis on programming methodology using a high level language (such as FORTRAN) as the vehicle to illustrate concepts. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications. **Effective From: Fall 2006**

CS 103* - Computer Science with Business Problems (3-0-3)**
An introductory course in computer science, with applications to business and managerial decision making. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and abstraction, with applications. **Effective From: Fall 2012**

CS 104 - Computer Programming and Graphics Problems (3-0-3)
Corequisite: Math 138. An introductory course in computer science with applications in computer graphics for architecture. Emphasis on programming methodology using a high level language as the vehicle to illustrate the concepts. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications. **Effective From: Spring 2010**

CS 106 - Roadmap to Computing Engineers (3-0-3)
An introduction to programming and problem solving skills for engineering majors using Python programming languages. Topics include basic strategies for problem solving, constructs that control the flow execution of a program and the use of high level data types such as lists, strings, and dictionaries in problem representation. The course also presents an overview of selected "big idea" topics in computing. **Effective From: Spring 2012**

CS 107 - Computing as a Career (1-0-1)
In this course, students will learn about time management, communication skills, and getting acclimated to NJIT. Through meetings with faculty, upperclassman students and current computing employers, students will explore CCS and learn about many exciting career opportunities within the computing field. **Effective From: Fall 2010**

CS 110 - Introduction to Computer Science IA (3-0-3)
First semester of a two course sequence, equivalent to CS 113. Introduces fundamentals of computer science, with emphasis on programming methodology and problem solving. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, including the development environment, native types, expressions, objects, classes, decisions, iteration, and methods. A high level language (Java) is fully discussed and serves as the vehicle to illustrate many of the concepts. **Effective From: Fall 2006 Until: Spring 2012**

CS 110A - CS 110A Computer Science Lab for CS 111 ((0-1.5-0))

Laboratory module for the first course of the sequence equivalent to CS 113. **Effective From: Fall 2006 Until: Spring 2012**

CS 111 - Introduction to Computer Science IB (3-0-3)
Second semester of a two course sequence, equivalent to CS 113. Introduces fundamentals of computer science, with emphasis on programming methodology and problem solving. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, including methods and classes, arrays, collections, inheritance and polymorphism, exceptions, recursion, testing and debugging. A high level language (Java) is fully discussed and serves as the vehicle to illustrate many of the concepts. **Effective From: Fall 2006 Until: Spring 2012**

CS 111A - CS111A Computer Science Lab for CS 111 ((0-1.5-0))
Laboratory module for the second course of the sequence equivalent to CS 113. **Effective From: Fall 2006 Until: Spring 2012**

CS 113 - Introduction to Computer Science (3-0-3)
Prerequisites: CS 100 with a grade C or better. Intensive introduction to computer science. Problem solving decomposition. Writing, debugging, and analyzing computer programs. Introduction to arrays and lists. Iteration and recursion. The Java language is introduced and used to highlight these concepts. A student receiving degree credit for CS 113 cannot receive degree credit for CS 115. **Effective From: Fall 2012**

CS 113A - Lab (0-1.5-0)
Lab for CS 113. **Effective From: Fall 2006 Until: Spring 2012**

CS 113H - Honors Introduction to Computer Science I (3-0-3)
Prerequisite: Satisfactory performance on placement exam and/or departmental approval. A course similar to CS 113, but material is covered in greater depth. Honors students contemplating a major in computer science, or who plan to take advanced electives in computer science, should take CS 113H instead of CS 101H. Students who receive degree credit for CS 113H cannot receive degree credit for CS 213. **Effective From: Fall 2006**

CS 114 - Introduction to Computer Science II (3-0-3)
Prerequisites:; CS 113 or completion of a required 100 level GUR course in CIS, plus an approved CIS 105. A study of advanced programming topics with logical structures of data, their physical representation, design and analysis of computer algorithms operating on the structures, and techniques for program development and debugging. Course covers program specifications, correctness and efficiency, data abstraction, basic aspects of simple data structures, internal searching and sorting, recursion and string processing. Algorithmic analysis is also discussed. Students receiving degree credit for CS 114 cannot receive degree credit for CIS 335 or CIS 505. **Effective From: Fall 2006**

CS 114A - Lab (0-1.5-0)
Lab for CS 114. **Effective From: Fall 2006 Until: Spring 2012**

CS 114H - Honors Introduction to Computer Science II (3-0-3)
Prerequisites: CS 113H or department approval; A course similar to CS 114, but material is covered in greater depth. Students receiving degree credit for CS 114H cannot receive degree credit for CS 335 or CS 505. **Effective Until: Fall 2006**

CS 115 - Intro. to CS I in C++ (3-0-3)
Fundamentals of computer science are introduced, with emphasis on programming methodology and problem solving. Topics include basic concepts of computer systems, software engineering, algorithm design, programming languages and data abstraction, with applications. The high level language C++ is fully discussed and serves as the vehicle to illustrate many of the concepts. CIS majors should enroll in CS 113. **Effective From: Fall 2006**

CS 115A - Computer Science I Lab/C++ (0-1.5-0)
Laboratory for CS 115. **Effective From: Fall 2006 Until: Spring 2012**

CS 116 - Intro. to Computer Science II/C++ (3-0-3)
Prerequisites: CS 115 or completion of a required 100 level GUR course in CS, plus an approved CS 105. A study of advanced programming topics with logical structures of data, their physical representation, design and analysis of computer algorithms operating on the structures, and techniques for program development and debugging. Course covers program specifications, correctness and efficiency, data abstraction, basic aspects of simple data structures, internal searching and sorting, recursion and string processing. Algorithmic analysis is also discussed. Students receiving degree credit for CS 116 cannot receive degree credit for CS 505. **Effective From: Fall 2006**

CS 116A - Computer Science II Lab/C++ (0-1.5-0)
Laboratory for CS 116. **Effective From: Fall 2006 Until: Spring 2012**

CS 207 - Computing and Effective Communication (1-0-1)

Prerequisites: CS 107. Through encouraging collaboration and communication, this course addresses how to best present oneself via verbal and nonverbal communication. Students will learn how to effectively network, create resumes, interview and best present ideas. The skills learned in this course prepare students for co-op/internship opportunities as well as future employment. **Effective From: Fall 2010**

CS 241 - Foundations of Computer Science I (3-0-3)
Prerequisites: CS 114 AND Math 112 OR CS 114 AND Math 133. An introduction to the foundations of computer science with emphasis on the development of techniques for the design and proof of correctness of algorithms and the analysis of their computational complexity. Reasoning techniques based on propositional and predicate logic and relational calculus operations with applications to databases will also be introduced. Auxiliary topics such as combinatorics of finite sets, functions and relations, and graph-theory definitions and graph storage alternatives will also be examined. **Effective From: Fall 2006**

CS 251 - Computer Organization (3-0-3)
Prerequisite: CS 113. An introduction to computer system structure and organization. Topics include representation of information, circuit analysis and design, register-transfer level, processor architecture and input/output. **Effective From: Fall 2006**

CS 252 - Computer Organization and Architecture (3-0-3)
Prerequisite: CS 113. An introduction to the organization and architecture of computer systems, including the standard Von Neumann model and more recent architectural concepts. Among the topics covered are numeric data representation, assembly language organization, memory addressing, memory systems, both real and virtual, coding and compression, input/output structures treated as programmed, interrupt, and direct memory access, and functional organization of the CPU and the computer system. **Effective From: Spring 2006**

CS 265 - Game Architecture and Design (3-0-3)
Prerequisite: IT 201 or equivalent. Course introduces students to the core concepts and design methodologies integral to designing and developing games and other Entertainment Software. **Effective From: Spring 2007**

CS 266 - Game Modification Development (3-0-3)
Prerequisites: IT 102 OR IT 114 OR CS 116, OR CS 114. This course introduces students to the basic concepts of game programming and development. Students will learn how to reprogram a professional game engine, or Modification (Mod) development as it is referred to in the industry. Students will work with C extensively. Students will work on their own game projects utilizing the professional game engine. **Effective From: Fall 2007**

CS 276 - 2D Game Development (3-0-3)
Prerequisites: CS 265 and CS 266 or IT 265 and IT 266. This course introduces students to the core concepts and skills necessary for the development of games utilizing 2D graphics. Students will learn how to set up and program their own 2D graphics based game engine. The engine will integrate 2D graphics, audio, input handling and network socket programming. Students will learn how to utilize their own custom 2D graphics and sounds into their projects. Once complete, students will have created two fully functional games. **Effective From: Spring 2007**

CS 280 - Programming Language Concepts (3-0-3)
Prerequisite: CS 114 OR CS 116 OR IT 114 OR IT 102. Conceptual study of programming language syntax, semantics and implementation. Course covers language definition structure, data types and structures, control structures and data flow, run-time consideration, and interpretative languages. **Effective From: Fall 2006**

CS 288 - Intensive Programming in Linux (3-0-3)
Prerequisite: CS 114. The course covers Linux programming with Apache Web and MySql database using Php/Python and C as primary languages. It consists of four stages: basic tools such as Bash and C programming; searching trees and matrix computing, end-to-end applications such as one that constantly presents top 100 stocks; and extending the applications to run on multiple machines. The course provides students with hands-on experience for programming relatively large applications. **Effective From: Spring 2013**

CS 310 - Co-op Work Experience I (3)
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

CS 332 - Principles of Operating Systems (3-0-3)
Prerequisite: CS 114 OR CS 116 OR IT 114 OR IT 102. Organization of operating systems covering structure, process management and scheduling; interaction of concurrent processes; interrupts; I/O, device handling; memory and virtual memory management and file management. **Effective From: Fall 2006**

CS 332H - Honors Principles of Operating Systems (3-1-3)
Prerequisite: CS 114 or equivalent. A course similar to CS 332, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 333 - Introduction to UNIX Operating Systems (3-0-3)
Prerequisite: CS 332 or equivalent and knowledge of C language. The course covers the UNIX system kernel including initialization, scheduling, context switching, process management, memory management, device management, and the file system. The course also includes the organization of shells, editors, utilities, and programming tools of the UNIX operating system. **Effective From: Fall 2006**

CS 337 - Performance Modeling in Computing (3-0-3)
Prerequisites: CS 114 and (Math 333 or Math 341). Introduction to probability models and techniques useful in computer science. Performance evaluation, discrete-event simulation, classification and optimization. **Effective From: Fall 2012**

CS 341 - Foundations of Computer Science II (3-0-3)
Prerequisites: (CS 241 or MATH 226) and CS 280. This course provides an introduction to automata theory, computability theory, and complexity theory. Theoretical models such as finite state machines, push-down stack machines, and Turing machines are developed and related to issues in programming language theory. Also, the course covers undecidability and complexity theory, including the classes P and NP. **Effective From: Fall 2006**

CS 341H - Honors Introduction to Logic and Automata (3-0-3)
Prerequisites: completion of a 100-level GUR course in CS; CS 280, Math 226 or Math 326. A course similar to CS 341, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 345 - Web Search (3-0-3)
Prerequisites: CS 280 and CS 241 or CS 252. An introductory course on the web searching. The architecture of a search engine. Information vs. data retrieval. Web crawling. Processing text(tokenization, stemming, stopwords, link analysis). The indexing process and inverted indexes. Query processing. Ranking algorithms based on indexes and links (e.g. Kleinberg's HITS, Google's PAGERANK). Retrieval Models. Search engine evaluation. Case studies (e.g. Google cluster architecture). **Effective From: Spring 2012**

CS 352 - Parallel Computers and Programming (3-1-3)
Prerequisites: CS 252, CS 332. A course introducing parallel computers and parallel programming. General structures and design techniques of parallel computers are described. Programming paradigms and algorithm design considerations for parallel processors will be discussed. **Effective From: Fall 2006**

CS 353 - Advanced Computer Organization (3-0-3)
Prerequisite: CS 252 or instructor approved equivalent. This course emphasizes the basic design principles of various components in a computer, as well as how the components are organized to build a computer. Topics include: design methodology, arithmetic and logic unit design, control unit design, memory hierarchy, memory system design, input and output devices, peripheral devices, and interfacing computers using software. A software simulation package is used to help the learning process. By the end of the semester, students will have built simulated computer. **Effective From: Fall 2006**

CS 356 - Introduction to Computer Networks (3-0-3)
Computer Science students should take CS 288 before taking CS 356. This course provides an introduction to computer networks, with a special focus on the Internet architecture and protocols. Topics include layered network architectures, addressing, naming, forwarding, routing, communication reliability, the client-server model, web and email protocols. Besides the theoretical foundations, students aquire practical experience by programming reduced versions of real Internet protocols. **Effective From: Fall 2011**

CS 357 - Fundamentals of Network Security (3-0-3)
Prerequisite: CS 356 or IT 120. This course is designed for Computer Science and Information Technology students. They must have a networking course before taking CS 357. IT students take IT 120 and Computer Science students take CS 356. This course offers an in depth study of network security issues, types of computer and network attacks, and effective defenses. It provides both a theoretical foundation in the area of security and hands-on experience with various attack tools, firewalls, and intrusion detection systems. Topics include: network scanning, TCP/IP stack fingerprinting, system vulnerability analysis, buffer overflows, password cracking, session hijacking, denial of service attacks, intrusion detection. **Effective From: Fall 2010**

CS 366 - 3D Game Development (3-0-3)
This course introduces students to the core concepts and skills necessary for the development of games utilizing 3D graphics. Students will learn how to set up and program their own 3D graphics based game engine using OpenGL. Students will learn how to load and display custom 3D models created using existing 3D modeling tools. Once complete, students will have created two

fully functional 3D games and tools to work with them. **Effective From: Fall 2009**

CS 370 - Introduction to Artificial Intelligence (3-1-3)
Prerequisites: CS 114 and (Math 226 or CS 241). An exploration of concepts, approaches and techniques of artificial intelligence. Emphasizes both underlying theory and applications. Topics include knowledge representation, parsing language, search, logic, adduction, uncertainty, and learning. LISP and Prolog programming languages used extensively. Students are required to do programming assignments, complete a programming term project and review case studies. **Effective From: Fall 2006**

CS 370H - Honors Introduction to Artificial Intelligence (3-1-3)
Prerequisites: CS 114, Math 226. A course similar to CS 370, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 371 - Logic with Applications to Computer Science (3-0-3)
Prerequisites: CS 114, Math 211 and (Math 226 or CS 241). An introduction to both the syntax and semantics (basic model theory) of first-order logic, covering one set of inference rules, sequent calculus or a tableau system and prove the completeness theorem for the proof system. You will also cover a relatively modern (and simpler) form of Incompleteness theorems and relate it to computational issues such as the halting problem, as well as issues related to automating logical reasoning. These will include Herbrand's theorem, resolution, and logic programming. **Effective From: Fall 2006**

CS 371H - Honors Logic with Applications to Computer Science (3-0-3)
Prerequisites: CS 114; Math 211 and 226. A course similar to CS 371, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 375 - Application Development for WWW (3-0-3)
Prerequisite: CIS 114. A state-of-the-art computer programming language/environment, such as Java and related tools, is studied and used as a vehicle to build applications that involve graphical user-interfaces, simple graphics, multithreading, images, animation, audio, database connectivity, remote objects, and networking. **Effective From: Fall 2006**

CS 407 - Professional Development in Computing (1-0-1)
Prerequisites: CS 107 and CS 207.This course is designed for final year students to reflect back on the college experience and to help plan for the future as a computing professional. The course will explore transitional issues that occur during the progression from student to professional through reflection on co-op and/or internship experiences. Through collaborative communication, students will reflect on global issues, explore how to best use new communication technologies and effectively communicate in the workplace. **Effective From: Fall 2010**

CS 408 - Cryptography and Internet Security (3-0-3)
Prerequisite: Math 226 or CS 241. Covers security require-ments for telecommunication over the Internet and other communication networks, various conventional and public-key encryption protocols, digital encryption standard, RSA and ElGamal cryptographic systems, digital signature algorithm and analysis of its cryptoimmunity, and access sharing schemes. Students receiving credit for CS 408 may not enroll in CIS 608. **Effective From: Fall 2006**

CS 410 - Co-op Work Experience II (3 additive credits)
Prerequisites: CS 310 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

CS 421 - Numerical Algorithms (3-0-3)
Prerequisite: completion of a 100-level GUR course in CIS. Corequisite: Math 222. This course deals with fundamentals of numerical methods, including discussion of errors, interpolation and approximation, linear systems of equations, solution of nonlinear equations, and numerical solution of ordinary differential equations. The algorithmic approach and the efficient use of the computer are emphasized. **Effective From: Fall 2006**

CS 431 - Database System Design and Management (3-0-3)
Prerequisite: CS 114 or equivalent. Database system architecture; data modeling using the entity-relationship model; storage of databases; the hierarchical, network and relational data models; formal and commercial query languages; functional dependencies and normalization for relational database design; relation decomposition; concurrency control and transactions management. Student projects involve the use of a DBMS package. **Effective From: Fall 2006**

CS 431H - Honors Database System Design and Management (3-0-3)
Prerequisite: CS 114 or equivalent. A course similar to CS 431, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 432 - Advanced Operating Systems (3-0-3)
Prerequisites: CS 252, CS 332. A survey of the design and implementation of distributed operating systems, both by introducing basic concepts and considering examples of current systems. Topics include: communication, synchronization, processor allocation, and distributed file systems. **Effective From: Fall 2006**

CS 433 - Introduction to Linux Kernel Programming (3-0-3)
An introductory study of how the Linux operating system is built from scratch. As a hands-on course, students will perform intensive programming using Linux kernel. The contents include booting, segmentation and paging, creating and destroying processes, process switching and scheduling, handling exceptions and interrupts, software interrupts, creating system calls, creating file systems, networking with TCP/IP, device driver writing and module programming, etc. At the end of the course, students will be able to modify the Linux operating system to create their own. **Effective From: Spring 2010**

CS 434 - Advanced Database Systems (3-0-3)
Prerequisites: CS 431. The course covers the basic concepts of traditional files and file processing, provides a "classic" introduction to the relational data model and its languages, and discusses database design methodology and application developments. Students are expected to learn the design of database application systems through a small project and to get some practical hands-on experience with commercial database management systems (DBMS) by writing application programs using the commercial DBMS query languages. **Effective From: Fall 2006**

CS 434H - Honors Advanced Database Systems (3-0-3)
Prerequisites: CS 431. A course similar to CS 434, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 435 - Advanced Data Structures and Algorithm Design (3-0-3)
Prerequisite: CS 241 and CS 288. Advanced topics in data structures and algorithms, involving sequences, sets, and graphs such as searching, sorting, order statistics, balanced search tree operations, hash tables, graph traversals, graph connectivity and path problems. Algebraic and numeric algorithms. Performance measures, analysis techniques, and complexity of such algorithms. **Effective From: Fall 2010**

CS 435H - Honors Advanced Data Structures and Algorithm Design (3-0-3)
Prerequisite: CS 241 and CS 288. A course similar to CS 435, with a project of greater depth and scope. **Effective From: Fall 2012**

CS 438 - Interactive Computer Graphics (3-0-3)
Prerequisites: completion of a 100-level course in CIS, plus knowledge of a higher level language. This course introduces fundamental concepts of interactive graphics oriented toward computer-aided design systems. Such systems emerge in engineering, architecture, and manufacturing. Topics include computer data structures for representation of two- and three-dimensional objects and algorithms for definition, modification, and display of these objects in applications. This course will also discuss a selection of special topics in interactive graphics. **Effective From: Fall 2006**

CS 439 - Image Processing and Analysis (3-0-3)
Prerequisites: CS 114 and Math 333. This course is an intensive study of the fundamentals of image processing, analysis and understanding. Topics to be covered include: a brief review of the necessary mathematical tools, human visual perception, sampling and quantization, image transformation, enhancement, restoration, compression, reconstruction, image geometric transformation, matching, segmentation, feature extraction, representation and description, recognition and interpretation. **Effective From: Fall 2006**

CS 440 - Computer Vision (3-0-3)
Prerequisite: Math 333. This course introduces basic concepts and methodologies of computer vision, and focuses on material that is fundamental and has a broad scope of applications. Topics include contemporary developments in all mainstream areas of computer vision e.g., Image Formation, Feature Representation, Classification and Recognition, Motion Analysis, Camera Calibration, Stereo Vision, Shape From X (shading, texture, motion, etc.), and typical applications such as Biometrics. **Effective From: Fall 2006**

CS 441 - Database Programming (3-0-3)
Many technologies have been developed due to the interplay between World-Wide Web Development and Databases on one hand and the growth of Database applications in E-Commerce on the other hand. Today, practically every E-Commerce application has at least a Web component and a Database Component. Many languages have been developed in order to deal with these interactions. The proposed course will focus on accessing databases through the web but also mention new developments in the field. **Effective From: Fall 2006**

CS 451 - Network Technologies (3-0-3)
This course provides an in-depth study of the different transmission and network technologies that make up the Internet

infrastructure. Topics include: physical layer technologies, multiplexing and switching, Wired and Wireless LANS, cellular networks, ATM networks, Multimedia formats and protocols, multicasting, traffic characteristics and measurements, QoS. **Effective From: Spring 2009**

CS 456 - Open Systems Networking (3-0-3)
Prerequisite: CS 114. An introduction to internetworking, including an in-depth study of the architecture of network interconnections, the internet services, and the protocols needed to provide these services. Topics include: architecture of interconnected networks, internet addresses and the address resolution problem, internet protocols, the domain name system, the socket interface, the client-server model of interaction, the OSI transport and application support protocols, and the TCP/IP application protocols. **Effective From: Fall 2006 Until: Fall 2008**

CS 458 - Technologies-Network Security (3-0-3)
Prerequisite: CS 356 or CS 456 or IT 420. This course provides both an in depth theoretical study and a practical exposure to technologies which are critical in providing secure communication over the Internet. Topics include: remote access security, web security, wireless security, e-mail security, spam and spam filtering techniques, computer viruses and internet worms, honeypots and honeynets, security liability issues and compliance. **Effective From: Spring 2009**

CS 467H - Honors Efficient Algorithm Design (3-0-3)
Prerequisite: CS 435 or CS 335; Math 333. The course focuses on presenting techniques for efficient sequential and parallel algorithm design. Algorithms for numerical and combinatorial problems will be discussed. The use of randomization in the solution of algorithmic problems will be explored. Applications to be considered include string matching, polynomials and FFT algorithms, sorting networks, algebraic computations and primality testing and factoring, matrix operations, randomized algorithms for sorting and selection, and data compression. **Effective From: Fall 2006**

CS 478 - Software Tools for Solving Problems (3-0-3)
Prerequisites: junior or senior standing, permission of instructor. Provides students with an opportunity to interact directly with industry and solve actual problems using various -information-systems software tools. At the beginning of the semester, company representatives present actual problems they are facing, and the students work in groups to develop a solution, which they present at the end of the term. Presentation skills, working in groups, and using software tools for problem solving are stressed. **Effective From: Fall 2006**

CS 482 - Data Mining (3-0-3)
Prerequisite: CS 431. The course covers the concepts and principles of advanced data mining systems design; presents methods for association and dependency analysis, classification; prediction; and clustering analysis. **Effective From: Fall 2006**

CS 485 - Special Topics in Computer Science/Information Systems (3-0-3)
Prerequisites: junior standing and/or department approval. The study of new and/or advanced topics in an area of computer science not regularly covered in any other CIS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. A student may register for no more than two semesters of Special Topics. **Effective From: Fall 2006**

CS 486 - Topics in Computer Science/Information Systems (3-0-3)
Prerequisites: Same as for CS 485. A continuation of CS 485. **Effective From: Fall 2006**

CS 488 - Independent Study in Computer Science (3-0-3)
Prerequisites: open only to students in the Honors Program who are computer science majors and who have the prior approval of the department and the CIS faculty member who will guide the independent study. Independent studies, investigations, research, and reports on advanced topics in computer science. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of Independent Study. **Effective From: Fall 2006**

CS 488H - Honors Independent Study in Computer Science/Information Systems (3-0-3)
Prerequisites: honors college computer science or information systems majors who have the prior approval of the department and the CS faculty member who will guide the independent study. Independent studies, investi-gations, research, and reports on advanced topics in computer science. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of independent study **Effective From: Fall 2006**

CS 490 - Guided Design in Software Engineering (3-0-3)
Prerequisite: senior standing or departmental approval. This course focuses on the methodology for developing software systems.

Methods and techniques for functional requirements analysis and specifications, design, coding, testing and proving, integration and maintenance are discussed. **Effective From: Fall 2006**

CS 491 - Senior Project (3-0-3)
Prerequisites: CS 490, senior standing and project proposal approval. An opportunity for the student to integrate the knowledge and skills gained in previous computer science work into a team-based project. The project involves investigation of current literature as well as computer implementation of either a part of a large program or the whole of a small system. **Effective From: Fall 2006**

CS 491H - Honors Computer Science Project (3-0-3)
Prerequisites: CS 490, senior standing in the Honors College and project proposal approval. A course similar to CS 491, with a project of greater depth and scope. **Effective From: Fall 2006**

CS 493 - Computing and Business Senior Project (3-0-3)
The Computing and Business Senior Project is intended to provide a real-world project-based learning experience for seniors in the Computing and Business and Business and Information Systems BS degrees. The overall objectives of this course are to investigate the nature and techniques of a business and computing development project. Projects are either provided by industry partners or proposed by students who wish to become entrepreneurs. **Effective From: Fall 2008**

GRADUATE COURSES:

CS 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. **Effective From: Fall 2006**

CS 506 - Foundations of Computer Science (3 credits)
Prerequisite: knowledge of C/PASCAL. Corequisite: CS 505. Cannot be used for graduate credit towards the M.S. in Computer Science. Introduction to the concepts of iteration, asymptotic performance analysis of algorithms, recursion, recurrence relations, graphs, automata and logic, and also surveys the main data models used in computer science including trees, lists, sets, and relations. Programming assignments are given. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 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. **Effective From: Fall 2006**

CS 603 - Advanced Programming Environments and Tools (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 604 - Client/Server Computing (3 credits)
Prerequisites: CS 333 and CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 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. **Effective From: Fall 2006**

CS 610 - Data Structures and Algorithms (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 630 - Operating System Design (3 credits)
Prerequisites: CS 332, CS 432 (see undergraduate catalog for descriptions) and CS 505. An intensive study of computer operating system design including multiprogramming, time-sharing, real-time processing, job and task control, synchronization of concurrent processes and processors, resource scheduling, protection, and management of hierarchical storage. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 632 - Advanced Database System Design (3 credits)
Prerequisites: CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 634 - Data Mining (3 credits)
This course covers the principles of data mining system design and implementation. It presents methods for association and dependency analysis as well as classification, prediction, and clustering. Optional topics may include time series and graph mining,

current trends in data mining, and data mining for scientific, medical and engineering applications. **Effective From: Spring 2011**

CS 635 - Computer Programming Languages (3 credits)
Prerequisites: CS 505 and CS 510. The theory and design of computer language systems; the formal theory of syntax and language classification; a survey of procedure and problem-oriented computer programming languages, their syntax rules, data structures, and operations; control structures and the appropriate environments and methods of their use; a survey of translator types. **Effective From: Fall 2006**

CS 636 - Compiling System Design (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 639 - Elec. Medical Records: Med Terminologies & Comp. Imp. (3 credits)
This course presents a graduate introduction to Medical Informatics for Computer Science students covering (1) the design, use and auditing of medical terminologies, such as the Unified Medical Language System (UMLS) and the Systematized Nomenclature of Medicine (SNOMED); and (2) principles of Electronic Medical Records (EMR), Electronic Health Records (EHR) and Personal Health Records (PHR), including issues of privacy and security. **Effective From: Fall 2011**

CS 640 - Recursive Function Theory (3 credits)
Prerequisite: CS 540 or equivalent. Review of basic computability theory. Topics include Church's thesis; unsolvability results; creative, productive, and simple sets; computational complexity; P=NP problem; and classification of solvable problems according to their complexity. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 643 - Cloud Computing (3 credits)
Prerequisites: CS 633 or CS 656. This course presents a top-down view of cloud computing, from applications and administration to programming and infrastructure. Its main focus is on parallel programming techniques for cloud computing and large scale distributed systems which form the cloud infrastructure. The topics include: overview of cloud computing, cloud systems, parallel processing in the cloud, distributed storage systems, virtualization, secure distributed computing, and multicore programming. **Effective From: Fall 2011**

CS 645 - Security and Privacy in Computer Systems (3-0-3)
Prerequisites: Students are expected to enter this course with a basic knowledge of operating systems, networking, algorithms, and data structures. Also, students should be able to program in Java and C/C++. The course covers fundamental principles of building secure systems and techniques to ensure data security and privacy. Topics include access control mechanisms, operating systems security, malicious code threats and software security, trusted computing, content protection, and database security . The course will also study existing technical approaches to protecting privacy, including Web anonymizers and ant-censorship tools, as well as policy and legal aspects of privacy. **Effective From: Fall 2012**

CS 650 - Computer Architecture (3 credits)
Prerequisites: CS 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. **Effective**

From: Fall 2006

CS 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. **Effective From: Fall 2006**

CS 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 Interconnetion (OSI) model. Topics include: analog and digital transmission, circuit and packet switching, the Integrated Services Digital Network (ISDN), Frame Relay, Broadband ISDN, Cell Relay, SONET, Local Area Networks (CSMA/CD, Token Bus, Token Ring, switched and isochronous Ethernets), Metropolitan Area Networks (FDDI, FDDI-II, DQDB), wireless and satellite networks, synchronization and error control, routing and congestion control, X.25 standard. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 654 - Telecommunication Networks Performance Analysis (3 credits)
Prerequisites: CS 651, CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 656 - Internet and Higher-Layer Protocols (3 credits)
The course introduces the protocols and standards of the TCP/IP suite that govern the functioning of the Internet. The material covered in class is a top-down approach on introduction, discussion, and analysis of protocols from the data-link layer to the application layer. Alternative protocols to the TCP/IP suite and new protocols adopted by this suite are discussed. Numerical examples related to network planning and proocol functioning are analyzed. **Effective From: Spring 2010**

CS 657 - Principles of Interactive Computer Graphics (3 credits)
Prerequisites: CS 505 or familiarity with the organization of at least one computer system, and knowledge of a structured programming language such as C. Graduate-level introduction to computer graphics concepts, algorithms, and systems. Includes 2-D raster graphics, algorithms, 2-D and 3-D geometric transformations, 3-D viewing, curves and surfaces. Emphasis on PC-based graphics programming projects. Principles of interactive graphics systems in terms of the hardware, software and mathematics required for interactive image production. **Effective From: Fall 2006**

CS 659 - Image Processing and Analysis (3 credits)
Prerequisite: CS 505. Fundamentals of image processing, analysis and understanding. Topics include image representation, image data compression, image enhancement and restoration, feature extraction and shape analysis, region analysis, image sequence analysis and computer vision. **Effective From: Fall 2006**

CS 660 - Digital Watermarking (3)
Digital watermarking and steganography is important to ensure data security because of widely used digital multimedia and rapid growth of the Internet. Digital watermarking is a suitable tool to identify the source, creator, owner, distributor, or authorized consumer of a document or an image. Digital steganography aims at hiding digital information into covert channels, so one can conceal the information and prevent detection. This course intends to provide students an overview on different aspects of mechanisms and techniques for digital watermarking and steganography. **Effective From: Spring 2009**

CS 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. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 665 - Algorithmic Graph Theory (3 credits)
Prerequisite: CS 610. The elements of the theory of graphs and directed graphs with motivating examples from communication networks, data structures, etc; shortest paths, depth first search, matching algorithms, parallel algorithms, minimum spanning trees, basic complexity theory, planarity, and other topics. Programming assignments are included. **Effective From: Fall 2006**

CS 666 - Simulation for Finance (3 credits)
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/Math 666. **Effective From: Spring 2010**

CS 667 - Design Techniques for Algorithms (3 credits)
Prerequisite: CS 610. An introduction to the principles of major design techniques in algorithms. Examples from a variety of topics and problems in computer science are used to demonstrate these design techniques and their appropriate application. **Effective From: Fall 2006**

CS 668 - Parallel Algorithms (3 credits)
Prerequisites: CS 610 and CS 650. This course examines a variety of parallel algorithms and architectures. Shared memory algorithms and algorithms for special architectures (tree processors, grids, systolic arrays, butterflies) are considered. The basic theory of algorithm/architecture performance will be described. **Effective From: Fall 2006**

CS 669 - Computational Geometry (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 670 - Artificial Intelligence (3 credits)
Prerequisite: CS 610 and CS 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. **Effective From: Fall 2006**

CS 671 - Knowledge-Based Systems (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 672 - Expert System Methods and Design (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 673 - Software Design and Production Methodology (3 credits)
Prerequisite: CS 631. Modern techniques and methods employed in the development of large software systems, including a study of each of the major activities occurring during the lifetime of a software system, from conception to obsolescence and replacement. Topics include cost/performance evaluation, documentation requirements, system design and production techniques, system verification techniques, automated aids to system development, and project organization and management. **Effective From: Fall 2006**

CS 674 - Natural Language Processing (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 680 - Linux Kernel Programming (3)
An in-depth study of how the Linux operating system is built from scratch. As a hands-on course, students will perform intensive programming using Linux Kernel. The contents include machine booting, segmentation and paging memory management, creating and destroying processes, process switching and scheduling, handling exceptions and hardware interrupts, software interrupts, creating system calls, creating file systems, networking with TCP/IP, device driver writing and module programming, etc. At the end of the course, students will be able to modify Linux operating system to create their own. **Effective From: Spring 2009**

CS 681 - Computer Vision (3-0-3)
This course introduces computational models of computer vision and their implementation on computers, and focuses on material that is fundamental and has a broad scope of application. Topics include comtemporary developments in all mainstream areas of computer vision e.g., Image Formation, Feature Detection/Representation, Classification and Recognition, Motion Analysis, Camera Calibration, 3D/Stero Vision, Shape From X (motion, shading, texture, etc.), and typical applications such as Biometrics. **Effective From: Fall 2010**

CS 682 - Geometric Modeling (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 683 - Software Project Management (3-0-3)
This course gives the student the necessary background to allow her/him to manage software projects; this includes economic, managerial and organizational aspects. The essence of software engineering is not only to introduce a valuable software product, but to do so economically and competitively. Like any engineering discipline, software engineering depends critically on managerial, economic and organizational considerations. Students will learn software management technique, various software costing techniques including COCOMO and ROI, team organization and management, and various methods of software development including Cleanroom and Agile. **Effective From: Spring 2012**

CS 684 - Software Testing and Quality Assurance (3-0-3)
This course discusses software faults and techniques to reduce faults and improve software quality. Software systems are some of the most complex human artifacts ever built and also some of the most critical means to ensure our safety, well being, and prosperity. This course teaches techniques to ensure software systems perform their function correctly. Topics include software specifications, goals of testing, techniques of test data selection, test oracle design, test data analysis, test lifecycle and quality impacts of testing. **Effective From: Spring 2012**

CS 685 - Software Architecture (3-0-3)
The software architecture defines the structure and interactions of software modules. This course provides a working knowledge of the terms, principles and methods of software architecture and module design. It explains the constraints on the design and the properties of capacity, response time, and consistency. The "4+1" architecture model is taught with architectural styles, interface isolation, decoupling, reuse, agile design with software patterns, data structures, queuing effects, design simplification and refactoring. The non-functional requirements of reliability, performance and power consumption, component based design and good industry practices for documenting and managing the architectural process are taught. **Effective From: Spring 2012**

CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 696 - Network Management and Security (3 credits)
Prerequisites: CS 652 or ECE 683, and CS 656. Thorough introduction to current network management technology and techniques, and emerging network management standards. In-depth study of the existing network security technology and the various practical techniques that have been implemented for protecting data from disclosure, for guaranteeing authenticity of messages, and 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. **Effective From: Fall 2006**

CS 697 - Principles of Broadband ISDN and ATM (3 credits)

Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 704 - Sequencing and Scheduling (3-0-3)
Advanced sequencing and scheduling for job shops, flow lines, and other general manufacturing and production systems are discussed in this course. Both deterministic and stochastic scheduling models are covered in detail. Heuristics and worst case analysis for "unsolvable" hard scheduling problems (NP-C problems) are introduced. **Effective From: Fall 2006**

CS 708 - Advanced Data Security and Privacy (3 credits)
Prerequisites: CS 608,CS 645, CS 696, or instructor approval. In-depth study of the security and privacy issues associated with the massive amount of data that is collected, stored, shared and distributed in today's society. New paradigms are needed to address the security/privacy challenges when data is outsourced at untrusted servers (such as in cloud computing), when data is anonymized in order to be shared among untrusted parties, or when copyrighted data needs to be protected from unauthorized use. **Effective From: Fall 2013**

CS 725 - Independent Study in Computer Science I, II (3 credits)
Prerequisites: graduate standing and department consent. **Effective From: Fall 2006**

CS 730 - Seminar in Database Management Topics (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006**

CS 731 - Applications of Database Systems (3 credits)
Prerequisites: IS 675 and CS 631. Restricted to students who are specializing in computer and information systems management. Comparative study of different models of database management systems and their applications. Emphasis on the functions of the database administrator. Includes a survey of physical and logical organization of data, methods of accessing data, characteristics of different models of generalized database management systems, and case studies using these systems from various applications. Student teams design database systems for class projects. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006 Until: Fall 2010**

CS 741 - Communication Network Design (3 credits)
Prerequisites: CS 651 and CS 652. Basic problems of communication network design: analyzes their complexity and provides algorithms, heuristics and other techniques for their solution. **Effective From: Fall 2006 Until: Spring 2009**

CS 744 - Data Mining and Management in Bioinformatics (3 credits)
Prerequisites: CS 610 or permission of the instructor. Concepts and principles of bioinformatic data mining and management with focus on efficiency and scalability. Methods for indexing and querying biological databases, biological data mining, and algorithmic development for bimolecular and phlyogenetic data analysis. Trends and advances in areas such as functional genomics and proteomics, genetic engineering, and large-scale gene expression data analysis. **Effective From: Fall 2006**

CS 750 - High Performance Computing (3 credits)
Prerequisite: CS 650. An in-depth study of the state of the art in high performance computing. Topics parallel computer architectures, programming paradigms, and their applications. Parallel architectures include PC clusters, shared-memory multiprocessors, distributed-memory multiprocessors, and multithreaded architectures. Parallel programming paradigms include message passing interface (MPI), its second-generation MPI-2, and multithreaded programming. Applications include computational science and high performance Web and database servers for Internet-based electronic commerce. Students program a parallel machine in class projects. First-hand experience in stable, scalable, high performance computing for Internet-based electronic commerce. **Effective From: Fall 2006**

CS 752 - Communication Protocol Synthesis and Analysis (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Spring 2009**

CS 755 - Security and Privacy in Wireless Networks (3 credits)
This course covers selected topics on security and privacy in wireless networks and is intended for graduate students who are interested in network security. This course can help the students learn the state of the art and open challenges in wireless network security and privacy, thus enhancing their potential to perform research or pursue a career in this emerging area. **Effective From: Spring 2011**

CS 756 - Mobile Computing and Sensor Networks (3 credits)
This course provides an in-depth study of mobile computing and sensor networks, which are becoming major components of the transition from today's world of desktop computers to a world where computing is ubiquitous. The main topics include: techniques to handle mobility in the Internet and ad hoc networks; operating systems, programming languages, and protocols for sensor networks; applications, middleware, programming models, and security ubiquitous computing environments. **Effective From: Spring 2008**

CS 759 - Advanced Image Processing and Analysis (3 credits)
Prerequisite: CS 659. Advanced study of recent research in image processing, analysis, and understanding. Topics include all image processing techniques, high-level recognition approaches, and automated expert vision systems. **Effective From: Fall 2006**

CS 775 - Seminar in Software Engineering (3 credits)
Prerequisite: CS 673. A seminar in which students pursue intensive study of specialized topics in the current literature of software engineering. Each topic is supported by an initial reading list on current problems in theory and practice. The results of the studies are discussed in class with students, faculty and invited specialists. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 780 - Computer Vision (3 credits)
Prerequisite: CS 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. **Effective From: Fall 2006 Until: Fall 2010**

CS 782 - Pattern Recognition and Applications (3 credits)
Prerequisite: CS 610. Study of recent advances in development of (statistical and syntactic) pattern algorithm, approximation, and estimation techniques. Topics include statistical estimation theory, classifier design, parameter estimation and unsupervised learning, bias vs. variance, nonparametric techniques, linear discriminant functions, tree classifiers, feature extraction, and clustering. Additional topics include Support Vector machines (SVM), Bayesian Learning, Hidden Markov Models (HMM), evolutionary computation, neural networks, with applications to signal interpretation, time-series prediction, and Biometrics. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 786 - Special Topics (3 credits)
Prerequisites: same as for CS 785. A continuation of CS 785. **Effective From: Fall 2006**

CS 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. **Effective From: Fall 2006**

CS 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 CS 792 may be applied to the CIS 790 requirement. **Effective From: Fall 2006**

CS 794 - Computer Science/Information Systems 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. **Effective From: Fall 2006**

Ecology and Evolution: Offered by the Department of Ecology and Evolution at Rutgers-New Brunswick

GRADUATE COURSES:

R215:533 - The Behavior of Animal Populations (3 credits)
For more details go to Rutgers Catalog.

R215:565 - Community Dynamics (4 credits)
For more details go to Rutgers Catalog.

R215:590 - Population Ecology (4 credits)
For more details go to Rutgers Catalog.

Economics: Offered by the School of Management. See Management course list for faculty.

UNDERGRADUATE COURSES:

Econ 201 - Economics (3-0-3)
The nature of a market economy. Microeconomics, demand theory, production possibilities, cost and price, equilibrium analysis, and applications to decision making in the firm. Macroeconomics, national income accounts, consumption, investment, government monetary and fiscal policy, and problems of employment and price levels. Economic analysis leading to an understanding of current developments in the United States economy and international trade and currency problems. Students who have received credit for Econ 265 or Econ 266 may not subsequently receive credit for Econ 201. **Effective From: Fall 2009**

Econ 265 - Microeconomics (3-0-3)
The theory of price determination and resource allocation under various market structures. The theory of demand, production, costs, factor and product pricing, income distribution, market failure, implications of government intervention in the market, and comparison of the free enterprise and alternative systems. Students who have received credit for SS 201 may not subsequently receive credit for Econ 265.

Econ 266 - Macroeconomics (3-0-3)
The theory of national income determination. The determinants of aggregate production, employment and prices, as well as money and banking, business cycles and monetary and fiscal policy. Students who have received credit for SS 201 may not subsequently receive credit for Econ 266.

Econ 485 - Special Topics in Economics (3-0-3)
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. **Effective From: Fall 2009**

R220:102 - Introduction to Economics, Macro (3)
For more details go to Rutgers Catalog.

R220:304 - Economics of Labor (3)
For more details go to Rutgers Catalog.

R220:322 - Introduction to Econometrics (3)
For more details go to Rutgers Catalog.

R220:323 - Intermediate Microeconomic Theory (3)
For more details go to Rutgers Catalog.

R220:324 - Intermediate Macroeconomic Theory (3)
For more details go to Rutgers Catalog.

R220:339 - Economic Development (3)
For more details go to Rutgers Catalog.

R220:402 - Advanced Econometrics (3)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

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.

Econ 610 - Managerial Economics (3-0-3)
Managerial Economics covers the role of economic theory in management analysis and decisions. The study of demand, cost, and supply theories from a business viewpoint are also covered. This course is about economic principles and their relevance to business decision-making. The course examines the interaction of information, economic incentives and market competition and how these interact to determine prices, products available, profits, and patterns of trade and organization. **Effective From: Fall 2013**

Electrical and Computer Engineering: Offered by the Department of Electrical and Computer Engineering.

UNDERGRADUATE COURSES:

ECE 101 - Introduction to Electrical and Computer Engineering (1-0-0)
Prerequisite: None. Familiarize students with various disciplines, career opportunities and curricula in electrical and computer enginneering. Invited speakers include faculty and industrial representatives. **Effective From: Fall 2003**

ECE 231 - Circuits and Systems I (3-1-3)
Prerequisites: Phys 121 and Math 112 or Math 133. The basic concepts of electric circuit theory and system analysis. Topics include basic circuit elements, loop and node analysis, network theorems, sinusoidal steady-state analysis, power, resonance, mutual inductance, and ideal transformers.

ECE 232 - Circuits and Systems II (3-1-3)
Prerequisite: ECE 231. Corequisite: Math 222. A continuation of circuits and systems with special emphasis on transient response. Topics include Laplace transform analysis, transfer functions, convolution, Bode diagrams, and Fourier series.

ECE 251 - Digital Design (3-1-3)
Prerequisites: Phys 121. The design of combinational and sequential logic circuits used in digital processing systems and computers. Basic register transfer operations are covered. Topics include Boolean algebra, minimization techniques and the design of logic circuits such as adders, comparators, decoders, multiplexers, counters, arithmetic logic units, and memory systems.

ECE 252 - Microprocessors (3-0-3)
Prerequisites: ECE 251. An introduction to microprocessor system organization and assembly language programming. The course covers the architecture, instruction set and assembly language of a specific microprocessor. Other topics included are memory organization, input/output interfacing, interrupt processing as well as exception processing. The problems associated with the design of a single board computer are also covered. Students receiving degree credit for CIS 453 cannot receive degree credit for ECE 352. Co-listed as CoE 252.

ECE 271 - Electronic Circuits I (3-1-3)
Prerequisite: ECE 231. The electronic devices, junction diodes, bipolar transistors and field-effect transistors, are introduced and studied based on semiconductor physics models. The study then continues with analysis and design of main digital electronic circuits (NMOS and CMOS) inverters and logic gates, MOS memory and storage circuits) and with introduction to analog electronic circuits such as simple one transistor amplifiers.

ECE 291 - Electrical Engineering Laboratory I (0-3-1)
Prerequisites: ECE 231, HSS 101. Corequisites: ECE 232. Laboratory work in the areas covered in ECE 231, ECE 232. Assembling, testing and analysis of basic analog circuits. Emphasis electronic measurement techniques, instrumentation and data analysis. Simulations of dc, ac, and transient circuit response on the personal computer. **Effective From: Spring 2011**

ECE 310 - Co-op Work Experience I (0 credits)
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. **Effective From: Fall 2011**

ECE 321 - Random Signals and Noise (3-0-3)
Prerequisite: ECE 232 and ECE 333. Random processes occurring in electrical engineering. An introduction to probability and random variables is followed by stochastic processes and noise. Topics include auto- and cross-correlation functions, power spectral density, response of linear systems to random signals, and noise figure calculations.

ECE 333 - Signals and Systems (3-0-3)

Prerequisites: ECE 232, Math 222. A continuation of circuits and systems. Topics include signal models, system representations and properties, convolution, Fourier transform, sampling, z-transform, and an introduction to IIR and FIR filter design.

ECE 341 - Energy Conversion (3-0-3)
Prerequisite: ECE 231. Magnetic materials and their applications including the design of singly- and multiply-excited magnetic circuits and transformers, and the steady-state performance of dc and ac electromechanical energy converters.

ECE 353 - Computer Organization and Architecture (3-0-3)
Prerequisites: ECE 252. Emphasizes the hardware design of computer systems. Topics include register transfer logic, central processing unit design, microprogramming, ALU design, pipelining, vector processing, micro-coded arithmetic algorithms, I/O organization, memory organization and multiprocessing. **Effective From: Fall 2003**

ECE 354 - Digital Test (2-0-2)
Prerequisites: ECE 251 or equivalent, Math 333 or equivalent. Covers theory and practice related to test technology. Topics include fault modeling, test generation, fault simulation, design for testability, fault diagnosis, built-in self-test, scan design, and many others. Surveys several industrial design for testability structures. **Effective From: Fall 2003**

ECE 361 - Electromagnetic Fields I (3-0-3)
Prerequisites: ECE 231, Math 213. Vector analysis and calculus, static electric and magnetic fields, capacitance and inductance, electric currents, resistance, time dependent fields and introduction to Maxwell's equations. **Effective From: Fall 2013**

ECE 362 - Electromagnetic Fields II (3-0-3)
Prerequisites: ECE 361. Maxwell's equations solutions, reflection and refraction of plane waves in dielectric and conducting media, transmission lines; transients and frequency domain solutions in lossy and lossless lines, Smith chart and its applications, parallel plate and rectangular waveguides.

ECE 368 - Signal Transmission (2-0-2)
Prerequisites: ECE 232, ECE 251. Familiarization with signal transmission both within and between digital systems. Topics include the telegrapher's equations, wave propagation, lattice diagrams, transients in digital systems, crosstalk, proper termination for high-speed logic, and the transmission characteristics of various interconnecting geometries. **Effective From: Fall 2003**

ECE 372 - Electronic Circuits II (3-0-3)
Prerequisites: ECE 232, ECE 271. Principles of MOSFET and BJT small signal amplifiers: Q point design, input and output impedance, gain, and signal range limitations for different single stage configurations. Design of analog integrated circuits including differential amplifiers, current sources, active loads. Transistor high frequency models, Miller effect, and frequency response of multistage amplifiers. Feedback in multistage amplifiers. Design and analysis of nonlinear circuits based on comparators. Design and analysis of signal generators.

ECE 373 - Electronic Circuits III (3-0-3)
Prerequisites: ECE 372. Topics include operational amplifier fundamentals, linear op-amp circuits, instrumentation amplifiers, feedback theory, active filters, practical op-amp limitations, Schmitt triggers, oscillators, multivibrators, timers, and waveform generators. **Effective Until: Spring 2012**

ECE 374 - Electronic Device I (3-0-3)
Prerequisite: ECE 271. This course addresses electronic devices on a fundamental level. Topics include semiconductors, structure and properties of p/n junction, Schottky barrier, BJT, MOS, MOS FET, semiconductor optoelectronics. **Effective From: Fall 2010**

ECE 392 - Electrical Engineering Laboratory II (1-2-2)
Prerequisite: ECE 271, and ECE 291. Laboratory work in some of the areas covered in ECE 251, ECE 333 and ECE 372. Design, testing and performance analysis of analog and digital electronic circuits. Simulations of the designed circuit's performance on the personal computer. **Effective From: Fall 2013**

ECE 394 - Digital Systems Lab (0-3-1)
Prerequisites: ECE 251, ECE 271 and ECE 291. Experiments emphasize digital design from basic electronic circuits to complex logic. Topics include switching speed, basic sequential circuits, the arithmetic/logic unit, and computer memories. **Effective From: Fall 2003**

ECE 395 - Microprocessor Laboratory (0-4-2)
Prerequisites: ECE 291, ECE 252. In this laboratory the students are expected to learn to apply their theoretical knowledge of both the hardware and software aspects of microprocessors. To attain this objective the students are required to construct a microprocessor based single board computer (SBC), with adequate interfacing capabilities to be able to perform some useful control tasks. Programming of the device is done in assembly language. Some of the experiments that follow the construction project deal with software while others deal with the problems of interfacing of microprocessors.

ECE 405 - Electrical Engineering Principles (3-0-3)
Prerequisites: Phys 121. (No credit for ECE students.) For non-electrical engineering majors. Topics include basic dc and ac circuits, basic electronics, an introduction to electromechanical energy conversion and control theory.

ECE 410 - Co-op Work Experience II (3 degree credits)
Prerequisites: ECE 310, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. May count as EE or approved elective. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

ECE 413 - Introduction to Electrical Engineering Practice (1-0-1)
Prerequisite: senior standing or permission of the instructor. Planning and execution of engineering projects. Intellectual property: publications and proprietary documents, invention disclosures and patents. Safety: the role of engineering codes and standards. Engineering ethics. Professional organizations. Professional registration. Preparation of a technical proposal for a senior project and its approval required. **Effective Until: Summer 2005**

ECE 414 - Electrical and Computer Engineering Project I (1-0-1)
Prerequisite: Senior standing. Student teams prepare and submit technical proposals for the senior design ("capstone") project to be completed the following semester in ECE 416 or ECE 417. Discussion of issues related to the engineering profession, including such topics as: intellectual property, sources of technical information, engineering codes and standards, professional organizations, professional registration. Required of all ECE students. **Effective From: Fall 2005**

ECE 415 - Electrical Engineering Project (1-2-2)
Prerequisites: ECE 373, ECE 413, ECE 494. A synthesis and focusing of previous experience, in and out of college, upon one or more electrical engineering projects selected by the student. Involves library research, design, cost analysis, construction and testing. Projects are shared in final project presentations. **Effective Until: Summer 2005**

ECE 416 - Electrical and Computer Engineering Project II (3-0-3)
Prerequisites: ECE 414. Continuation and completion of the project based on the proposal approved in ECE 414. Progress of the project is monitored by the instructor with demonstrations and presentations at given due dates of the regularly scheduled course. An oral presentation and demonstration of the project by the student team must be given and a written report submitted at the end of the course. Successful projects are approved for the presentation at the Senior Design Project Workshop in the presence of students, faculty and industry representatives. **Effective From: Fall 2007**

ECE 417 - Independent Study (3-0-3)
Prerequisites: ECE 414. Students work on various individually selected projects guided by the individual faculty or faculty and industrial mentors. There are no scheduled course meetings but the project progress is continuously monitored with meetings scheduled as needed. A formal written report is presented to the faculty advisor at the end of the course. An oral presentation of a successful project is made at the Senior Design Project Workshop in the present of students, faculty and industry representatives. **Effective From: Fall 2007**

ECE 421 - Digital Data Communications (3-0-3)
Prerequisites: ECE 232, Math 333, or ECE 321. Covers communications basics and some topics in digital communications most germane to data communication. Topics include signal classification, correlation, spectral analysis, energy and power spectral density, white noise, signal transmission through linear systems, sampling and quantization, and principles of digital data transmission. **Effective From: Fall 2007**

ECE 422 - Computer Communications Networks (3-0-3)
Prerequisites: ECE 321 or Math 333. Introduction to the fundamental concepts of computer communication networks. Topics include the OSI reference model, the physical, data link, network, and transport layers, TCP/IP, LANs (including token ring, token bus, and ethernet), ALOHA, routing and flow control. **Effective From: Fall 2003**

ECE 423 - Data Communications Networking Devices (3-0-3)
Prerequisites: ECE 421 or ECE 481. Provides a working knowledge of data communication networking devices, including modems, routers, multiplexers, switches, and concentrators and are used as building blocks in the implementation, modification, or optimization of data communications networks. Emphasizes device design, functionality and physical layer protocols. **Effective From: Fall 2003**

ECE 424 - Optical Communication Network (3-0-3)
Prerequisites: ECE 232 and either ECE 321 or Math 333. Focuses on digital optical networks, architecture, modulation techniques, and detection noise. Related topics are wireless communication, infrared link, and CATV. Computer simulations of network systems are done with commercial software packages. **Effective From: Fall 2003**

ECE 425 - Wireless Communication Systems (3-0-3)
Prerequisites: ECE 481 or ECE 421. Introduction to wireless system design and engineering. Develops an understanding and appreciation of the wireless engineering problems such as cellular layout design, resource allocation, mobility management, capacity and performance and signaling load calculations. Introduces physical layer building blockssuch as modulation, synchronization, coding, diversity, equalization, and spreading. **Effective From: Fall 2003**

ECE 429 - Computer Communications Lab (0-4-2)
Prerequisites: ECE 422. Experiments with different protocols and standards used in the TCP/IP computer communications, including Ethernet/802.3 standard, Address Resolution Protocol (ARP), Internet Protocol (IP), Transport Control Protocol (TCP), User Datagram Protocol (UDP), and others. Exercises with network measurements and virtualization tools, and configurations of some commercial routers are included. **Effective From: Spring 2013**

ECE 431 - Introduction to Feedback Control Systems (3-0-3)
Prerequisite: ECE 232. Concept of feedback control. Typical feedback control systems. System dynamics by Laplace transform and state space methods. Stability definition and assessment: Routh ?Hurwitx criteria. Graphical stability methods: Root locus, Nyquist and Bode plots. Performance evaluation and simulation. Matlab/Simulink used extensively. A good background in Laplace transform and linear (matrix) algebra highly desirable. **Effective From: Spring 2013**

ECE 432 - Control Systems Elective (3-0-3)
Prerequisites: ECE 431. A continuation of the study of automatic control systems with emphasis on computer-aided design and problem solving. Topics covered include state feedback control, observers, industrial regulators, linear quadratic regulators, and the analysis of various common system nonlinearities. Implementation techniques on both analog and digital platforms will be addressed. **Effective From: Fall 2003**

ECE 435 - Medical Imaging Instrumentation & Data Acquisition Systems (3-0-3)
Prerequisites: ECE 231, ECE 252 and ECE 333. Three-Dimensional medical imaging modalities including X-ray Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, and Ultrasound utilizes advanced highly integrated electronic sensors, fast processor-based computers, and advanced signal proessing and reconstruction methods. **Effective From: Fall 2007**

ECE 436 - Bio Control Systems (3-0-3)
Prerequisite: ECE 431. This course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Real time signal acquisition and processing are also adressed. **Effective From: Fall 2007**

ECE 438 - Bio Electronic Systems Laboratory (0-4-2)
This laboratory provides the laboratory experience for students interested in medical applications from the perspective of electrical and computer engineering. It consists of 3 modules: Bio-electronics, Bio-control and Bio-imaging. **Effective From: Fall 2006**

ECE 439 - Control Systems Laboratory (0-4-2)
Prerequisites: ECE 431. Laboratory work in the design and synthesis of control systems, closely coordinated with the control systems elective. **Effective From: Fall 2007**

ECE 441 - Power Electronics (3-0-3)
Prerequisites: ECE 373. Electronic devices and circuits used to energize various apparatus and systems. Topics include circuits, freewheeling diodes, thyristors, firing and commutation of silicon-controlled rectifiers, converters, dc choppers, and power supplies. **Effective From: Fall 2003**

ECE 442 - Power Systems Elective (3-0-3)
Prerequisite: ECE 341. Introduction to power plants and power networks. Topics include transmission line parameters, system modeling, economic operations of power systems, load flow studies, short circuit analysis, and power system stability. **Effective From: Fall 2003**

ECE 443 - Renewable Energy Systems (3-0-3)
Prerequisites: ECE 231 and ECE 271. This course presents the various sources of renewable energy including wind, solar, and biomass as potential sources of energy and investigates the contribution they can make to the energy profile of the nation. The technology used to harness these resources will be presented. Discussions of economic,environment, politics and social policy are integral components of the course. **Effective From: Fall 2009**

ECE 449 - Power Systems Laboratory (0-4-2)
Prerequisites: ECE 494. Corequisite: ECE 442. Laboratory work in the design and synthesis of power systems, closely

coordinated with the power systems elective. **Effective From: Fall 2007**

ECE 451 - Advanced Computer Architecture (3-0-3)
Prerequisites: ECE 353. Focues on dvanced concepts in computer systems design, and the interaction between hardware and software components at various levels (i.e., hardware/_software codesign). Introduces common performance measures used by hardware and software designers to facilitate comparative analysis. Main topics are: advanced pipelining, good instruction sets, CISC and RISC microprocessors, introduction to parallel computing, and a brief historical survey of computer designs. **Effective From: Fall 2003**

ECE 452 - Advanced Computer Architecture II (3-0-3)
Prerequisite: ECE 451. Topics include memory allocation, single-instruction stream parallelism, parallelism by message passing, shared-resource systems, protection and security, stack-oriented systems, systolic array systems, and data-flow systems. Discusses the relationships between software and hardware levels of system implementation and -operation. **Effective From: Fall 2003**

ECE 453 - Introduction to Discrete Event Systems (3-0-3)
Prerequisites: ECE 251 or CIS 251 or equivalent, and Math 333 or ECE 321 or equivalent. Introduces logical models, timed models, and stochastic timed models of discrete event systems. Applies petri net methodology to the modeling of computer systems, flexible manufacturing systems, communication networks, and robotics. Contrasts the approaches of _simulation, elementary queueing theory, and Markov processes. **Effective From: Fall 2003**

ECE 457 - Digital Image Processing (3-0-3)
Prerequisites: ECE 333. An introduction to the fundamental techniques for digital image processing. Covers human visual sstems, image sensing and acquisition, image sampling and quantization, 1-D and 2-D systems, image enhancement, image restoration, image degradation, features extraction, and image segmentation. **Effective From: Fall 2007**

ECE 459 - Advanced Computer Systems Design Lab (0-4-2)
Prerequisites: ECE 451, ECE 495. Corequisite: ECE 452. Design laboratory component of the advanced computer systems technical track offered to CoE majors in the senior year. Experiments emphasize advanced CPU design concepts, such as RISC approaches and exception handling, multiprocessor and systolic array computers, and FPGAs. Develop software programs to test the capabilities of these hardware designs. **Effective From: Fall 2007**

ECE 461 - Microwave and Integrated Optics (3-0-3)
Prerequisite: ECE 362. The analysis and design of microwave transistor amplifiers and oscillators using scattering parameter techniques. Topics include transmission line theory, scattering parameters, matching networks, signal flow graphs, amplifier design considerations (power gain stability, noise and band width), and negative resistance oscillator design. **Effective From: Fall 2007**

ECE 462 - RF/Fiber Optics Systems Elective (3-0-3)
Prerequisite: ECE 362. Topics include dielectric waveguides and optical fibers, semiconductor optical sources and detectors; rf/microwave modulation and demodulation of an optical carrier; design concepts in optical transmitters and receivers; and usage of CAD software tools for rf/microwave simulations. **Effective From: Fall 2003**

ECE 463 - Optoelectronics (3-0-3)
Prerequisite: ECE 374. The course addresses electronic and optoelectronics device concepts. Topics include optical materials, semiconductor materials,light propagination in waveguide, solar cell, LED and modulation of light. **Effective From: Fall 2007**

ECE 469 - RF/Microwave and Fiber Optics Systems Laboratory (0-4-2)
Corequisite: ECE 462. Laboratory work in characterization of RF/microwave transmission structures and optical fibers, sources and detectors, spectral and time domain (OTDR) measurements in micro-waves and optics. Experiments in microwave and fiber optic links. Usage of CAD software tools for RF/microwave simulations. **Effective From: Fall 2003**

ECE 471 - Active Network Design (3-0-3)
Prerequisite: ECE 373. Topics include the basic theorems of network synthesis; the design of LC and RC networks; the design of second-order active RC low-pass, high-pass, band-pass and notch filters; and the design of high-order filters with Butterworth, Chebyshev, Elliptic, and Bessel response. Also, switched-capacitor circuit designs and other selected topics. **Effective From: Fall 2003**

ECE 472 - Pulse Techniques (3-0-3)
Prerequisite: ECE 373. Topics in electronics including linear and non-linear operational-amplifier circuits, the frequency compensation of operational-amplifiers, higher-order active filters including switched-capacitor designs, waveform generators, multi-vibrators, timers, waveshapers, converters, and other selected topics. **Effective From: Fall 2003**

ECE 475 - VLSI Circuits (3-0-3)

Prerequisite: ECE 372. Topics include MOSFETs, their characteristics and use in analog and digital circuit design, static and dynamic circuits; memory cells; differential stages; symbolic layout of NMOS and CMOS circuits; fundamentals of silicon processing technology and associated design rules and methodology; calculation of chip performance including power, speed and area; logic arrays.

ECE 476 - Electronic Device II (3-0-3)
Prerequisite: ECE 374. Thorough study of basic principles of semiconductor electrical behavior (particularly as applied to junction, the MOS field effect, and optoelectronic devices) in order to understand their operation and characteristics. Devices include Schottky barrier and PN junction diodes, bipolar and FET transistors, solar cells, photoconductive and photovoltaic detectors, LEDs, and semiconductor lasers. Emphasis on characteristics important for circuit design, e.g., dynamic switching behavior. **Effective From: Fall 2007**

ECE 477 - Semiconductor Sensors and Bio Electronics (3-0-3)
Prerequisite: ECE 374. The course outlines electronic systems geared for bio-sensors from fabrication to realization point of view. Topics include MEMS, device fabrication, BioMEMS and detection methods, Signal Conditioning Circuits, Signal Amplification, Microarrays & Nanoscale Arrays, Nanotechnology. **Effective From: Fall 2007**

ECE 478 - VLSI Circuits (3-0-3)
Prerequisite: ECE 372. Topics include MOSFETs, their characteristics and use in analog and digital circuit design, static and dynamic circuits; memory cells; differential stages; symbolic layout of NMOS and CMOS circuits; fundamentals of silicon processing technology and associated design rules and methodology; calculation of chip performance including power, speed and area; logic arrays. **Effective Until: Summer 2003**

ECE 479 - Optoelectronics and Electronic Laboratory (0-4-2)
Co-requisites: ECE 463 and ECE 476. The Laboratory course outlines experiments on electronic and optoelectronics device concepts. Topics include Optical waveguide, Solar Cell, LED Modulation of Light, capacitance-voltage of MOS structure. **Effective From: Fall 2007**

ECE 481 - Digital Communications Systems (3-0-3)
Prerequisites: ECE 321. An introduction to digital communications systems and modulation and techniques, along with simulation experiments of communications systems and techniques in Matlab/Simulink. Description of AM and FM modulations, sampling and digitalization of signals, baseband and carrier-modulated digital transmission, signal detection in noise, inter-symbol interference and equalization, channel capacity, data compression techniques, error detection and correction methods. **Effective From: Spring 2013**

ECE 482 - Communications Systems Elective (3-0-3)
Prerequisites: ECE 481. A continuation of the study of communications systems with selected topics from different areas of communications theory such as sampled-data communications, information theory and noise. **Effective From: Fall 2003**

ECE 489 - Communications Systems Laboratory (0-4-2)
Prerequisites: ECE 481. The laboratory experiments include time and frequency domain analysis of AM and FM signals, generation and detection of digitally modulated waveforms (ASK, FSK,BPSK), line coding and synchronization. Through the experiments, students learn how to assess and combat the impairments due to noise, and become familiar with instruments such as spectrum analyzers, audio analyzers and noise generators. **Effective From: Fall 2003**

ECE 494 - Electrical Engineering Laboratory III (1-2-2)
Prerequisites: ECE 341, ECE 374, ECE 392. A senior laboratory with experiments in two distinct areas: A) power and energy conversion, and B)semiconductor devices. Part A involves experiments with full size ac and dc electric motors, generators, and transformers. In part B characteristics of diodes, transistors and solar cells are measured using computer controlled instrumentation. **Effective From: Spring 2013**

ECE 495 - Computer Engineering Design Lab (1-4-3)
Prerequisites: ECE 353, ECE 394. Preparation for putting into practice the concepts learned in ECE 353. Emphasizes hardware design and debugging. Topics include combinational and sequential logic design using CAD tools, design based upon PLA/PLD devices, computer interface design using hardware and software, and an open-ended design project such as a central processing unit design. **Effective From: Fall 2003**

ECE 497 - Computer Systems Laboratory (0-4-2)
Prerequisite: ECE 494. Corequisite: ECE 487. Laboratory work in the design and synthesis of computer systems, closely coordinated with the computer systems elective.

ECE 498 - Special Topics in Electrical and Computer Engineering (3-0-3)

The study of new and/or advanced topics in an area of electrical and computer engineering not regularly covered in any other ECE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. **Effective From: Fall 2007**

GRADUATE COURSES:

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. **Effective Until: Fall 2004**

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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. **Effective Until: Fall 2011**

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)
Prerequisite: ECE 610 or equivalent Coils, condensers, and resistors as protective devices; fundamental principles of protective relaying; relay operating characteristics; power and current directional relays; differential relays; distance and wire pilot relays; heating and harmonic effects; and Computer-based protective device coordination. **Effective From: Fall 2009**

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. **Effective Until: Fall 2004**

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. **Effective Until: Fall 2000**

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 617 - Economic Control of Interconnected Power Systems (3 credits)
Economic Control of Interconnected Power Systems: Advanced techniques for operating power systems in the most economic manner while meeting various network constraints; economic dispatch, penalty factors, optimal power flow, short-term electricity markets and locational marginal prices will be studied. **Effective From: Fall 2009**

ECE 618 - Renewable Energy Systems (3 credits)
This course introduces renewable energy systems. It covers the fundamental concepts of energy and radiation with specific solar energy applications and photovoltaics, electrical energy storage systems, and thermal energy and storage. The second part covers the basic science of wind energy systems and their electrical sytem designs. The third part covers the bioenergy systems from resources to final products and conversion technologies. It finally introduces other promising energy sources. **Effective From: Spring 2009**

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 637 or CS 656. This course provides students with hands on training regarding the design, troubleshooting, modeling and evaluation of computer networks. In this course, students are going to experiment in a real test-bed networking environment, and learn about network design and troubleshooting topics and tools such as: network addressing, Address Resolution Protocol (ARP), basic troubleshooting tools (e.g. ping, ICMP), IP routing (e,g, RIP), route discovery (e.g. traceroute), TCP and UDP, IP fragmentation and many others. Student will also be introduced to the network modeling and simulation, and they will have the opportunity to build some simple networking models using the OPNET modeling tool and perform simulations that will help them evaluate their design approaches and expected network performance.

ECE 637 - Internet and Higher-Layer Protocols (3 credits)
The course introduces the protocols and standards of the TCP/IP suite that govern the functioning of the Internet. The material covered in class is a top-down approach on introduction, discussion, and analysis of protocols from the data-link layer to the application layer. Alternative protocols to the TCP/IP suite and new protocols adopted by this suite are discussed. Numerical examples related to network planning and proocol functioning are analyzed. **Effective From: Spring 2010**

ECE 638 - Network Management and Security (3 credits)
Prerequisites: ECE 683 or CIS 652, and ECE 637 or 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 Networks (3 credits)
Prerequisites: ECE 673, 683 or CS 652 or equivalent. This course covers fundamental concepts of broadband networks. Topics include Broadband ISDN, Switching Techniques, ATM, SONET/SDH, Congestion Control, High-Speed Switching Architectures, Traffic Modeling of Broadband Services, Admission Control, Traffic Scheduling, IP/ATM Convergence, QoS Provisioning in IP Networks, and Optical Networks.

ECE 640 - Digital Signal Processing (3 credits)

Prerequisite: ECE 601 or equivalent. The theory of digital signals and basic processing techniques: Discrete Fourier Series, Discrete Fourier Transform and FFT, Linear and Circular Convolution, Digital Filter Design Techniques, Discrete Hilbert Transforms, Discrete Random Signals, Chirp-Z and other advanced transforms. Introduction to multivariate signal processing. The typical applications of signal processing tools are discussed and connected to the theoretical foundations.

ECE 641 - Laboratory for High Performance Digital Signal Processing (3 credits)
This course first introduces today's FPGA and GPU technology, the design tools for the state-of-the-art DSP algorithms and systems. It focuses on computer arithmetic including possible number representations for DSP with FPGA like distributed arithmetic (DA) and CORDIC algorithm. Then, it introduces CUDA development tools for GPUS. Finally, there is a set of DSP implementations spanning from finite impulse response and infinite impulse response filters to wavelet processors with two-channel filter banks and others. Each student is also assigned a term project for the course to be implemented on FPGA or GPU. **Effective From: Fall 2011**

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 - Wireless Communication (3 credits)
Prerequisites ECE 321 or MATH 333. This course is focused on the technical challenges and solutions to physical and link layer design of wireless communication systems. Course topics include characterization of the wireless channel, the cellular concept, digital modulation techniques, spread spectrum, multiple access techniques including CDMA and OFDMA, diversity techniques. Advanced techniques such as MIMO, 3G and 4G wireless technologies are introduced. Matlab is used for examples and assignments. Team projects based on advanced wireless technologies. **Effective From: Fall 2013**

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 653 - Micro/Nanotechnologies for Interacing Live Cells (3 credits)
In this course, we will study technologies and tools available for interfacing live cells from a sub-cellular, single-cell, and multi-cellular (tissue models) approach. We will introduce key concepts of the biology of cells and tissues and will explore the technologies (micro-/nanotechnologies) and tools (sensors and actuators) available for the investigation of cell and tissue biology. Same as BME 653. **Effective From: Spring 2010**

ECE 655 - Modeling of Biological Neural Systems (3 credits)
This course introduces biological neural networks and systems as the essential parts of the autonomous, peripheral and central nervous systems in human body to perform physiological functions and determine behavior. The difference in neural architecture and function in different nervous systems will be discussed. Approaches for modeling of neural circuits with examples of simulation of small and large neural networks in human nervous systems for pattern generation, recall and recognition are discussed and studied. **Effective From: Spring 2010**

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 - Bio-Control Systems (3 credits)
The course provides an introduction to dynamic and control in biological systems, with particular emphasis on engineering aspects of biological oscillators/waves which govern the basic operations of all living organisms and especially higher order life forms. A combination of theoretical and simulation tools will be applied to analyze the qualitative and quantitative properties of selected biological systems. Feedback and control mechanisms in selected biological systems will be introduced. Same as BME 667. **Effective From: Spring 2010**

ECE 668 - Mecial Imaging Systems (3 credits)
This course provides a detailed introduction to medical imaging physics, instrumentation, data acquisition and image processing systems for reconstruction of multi-dimensional anatomical and functional medical images. Three-Dimensional medical imaging modalities including X-ray, Computer Tomography, Magnetic Resonance Imaging, Single Photon Emission Computer Tomography, Positron Emission Tomography, Ultrasound and optical imaging modalities are included. Same as BME 668. **Effective From: Spring 2010**

ECE 669 - Engineering Physiology (3 credits)
To enable students to apply basic tools in engineering analysis, mathematics, computer science, general physics and chemistry courses so that they can develop models that quantitatively predict the functioning of physiological systems in the human body. To enable students to apply engineering systems analysis to systematic physiology and employ the ideas of feedback control, signal procession, mathematical modeling and numerical simulation. Same as BME 669. **Effective From: Spring 2010**

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 - High Performance Routers and Switches (3 credits)
The course introduces the different system comprising and Internet routing including the processors for networking function and protocol compliance, switching functions and packet classification for deep-layer inspection capable routers or network appliances. This course material describe the different functions that Internet routers perform and discusses the different approaches used for improving performance of high-end routers. The content includes a discussion on switch architectures. **Effective From: Spring 2010**

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 - Computer Arithmetic Algorithms (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. **Effective From: Fall 2012**

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 692 - Embedded Computing Systems (3)
Pre-requisites: ECE 353 (CoE) or ECE 684 (EE) and CS 105 (or equivalents). Introduction of the methodology for the design and implementation of embedded computing systems, and its application to real-world problems. Topics include Embedded System Design Process, UML, ARM Instruct Set Architectures, CPU's Hardware Platforms, Software Design and Analysis, Embedded Operating Systems, Real-Time Scheduling, Hardware Accelerators, Distributed Embedded Systems, and Design Methodology and Quality Assurance. **Effective From: Fall 2006**

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 744 - Optimization for Communication Networks (3-0-3)
Modern communication are required to provide optimal performance in terms of quality-of-service under strict constrains on the utilization of resources, such as spectrum of power. In addition, the emerging paradigm of decentralized communication systems, such as ad hoc and sensor networks, calls for distributed, and possibly competitive, optimization techniques. This course covers the basic analytical and algorithmic tools that enable such centralized and decentralized optimization. **Effective From: Fall 2013**

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 - Advanced 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 782 - Advanced Data Security and Privacy (3 credits)
Prerequisites: CS 608, CS 696, or instructor approval. In-depth study of the security and privacy issues associated with the massive amount of data that is collected, stored, shared and distributed in today's society. New paradigms are needed to address the security/privacy challenges when data is outsourced at untrusted servers (such as in cloud computing), when data is anonymized in order to be shared among untrusted parties, or when copyrighted data needs to be protected from unauthorized use. **Effective From: Fall 2010**

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)
All master's and doctoral students must register for two semesters and six semesters of ECE 791 Graduate Seminar, respectively. To receive a satisfactory grade, students must attend at least five seminars during the semester, as approved by the seminar supervisor. **Effective From: Spring 2006**

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

GRADUATE COURSES:

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. See Humanities course list for faculty.

UNDERGRADUATE COURSES:

Eng 095 - General Skills in English as a Second Language (4.5-1-5)
Pre-requisite: None. Intended for students in need of extensive practice in speaking, listening, reading, and writing in English prior to enrolling in HSS 099S. **Effective From: Spring 2009**

Eng 200 - Communicating in Organizations (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Allows students to understand the need for writing in an information-based corporate culture. Students write intensively in a variety of forms for a variety of audiences. Attention is given to editing, graphic design, communications ethics, and desktop publishing. At the conclusion of the course, students prepare a portfolio of their work. **Effective From: Spring 2009**

Eng 301 - Advocacy and the Law (3-0-3)
Prerequisite: Eng 300, SS 300, HUM 101 and two from among HUM 102, HUM 211, HUM 212 and Hist 213 or their equivalents. Offers opportunities to explore the retrieval and use of legal and law-related materials while developing skills in oral advocacy and in writing persuasive legal documents, such as motion memoranda and briefs. Includes learning to listen to participants in the legal process as well as developing effective styles and forms of speech in the classroom. **Effective Until: Fall 2004**

Eng 302 - Communication Theory (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. This course will introduce students to communication theory and practice. The course begins with a review of contemporary communication theory. After covering five selected theories--semiotic, visual, cultural, social, and reception--students will be required to apply a selected theory to a computer-mediated case study. Students will also be required to perform a collaborative field study. Through the course, students will be expected to read critically, to research peer-reviewed sources thoroughly, to present effective oral briefings, and to write analytic reports. **Effective From: Spring 2009**

Eng 333 - Cybertext (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Through theoretical readings and electronic research, students explore and compare information structuring in print and digital media, particularly how digital technology influences the dynamics of text. Interactivity, visual communication and developments in the realm of cybernetics are addressed in the course. Materials presented in creative, technical and commercial areas were studied. **Effective From: Spring 2009**

Eng 336 - Advanced Composition (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Involves composing in-depth, persuasive research essays designed to address the aims of discourse (expressive, referential, literary, and persuasive), using current media tools (text, graphics, audio, animaation and video) and venues (print and electronic), in several iterations. **Effective From: Spring 2009**

Eng 339 - Practical Journalism (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. A descriptive and analytic survey of news systems. Assignments include practice in writing straight news items, sports writing, feature writing, science writing, interviewing, and editing?with emphasis on understanding methods. The survey of printed and broadcast news systems includes the influence of technological, economic, legal, ethical, and historical factors. **Effective From: Spring 2009**

Eng 340 - Oral Presentations (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Instruction and practice in effective oral presentations. Students deliver a wide range of presentations adapted to the needs of a variety of audiences. Topics include voice and diction, presentation skills, the effective use of visual aids, reporting technical

mate-rial and audience analysis. **Effective From: Spring 2009**

Eng 346 - Journalism in American History (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Explores how the media - defined as print as well as electronic media (television, radio and online modes of communication)have influenced different events and social movements at various points in time. Topics will include the role of William Randolph Hearst's newspapers in creating support for the Spanish-American War; press coverage of the women's suffrage movement; the role of television in ending the Vietnam war. **Effective From: Spring 2011**

Eng 347 - Technical, Professional and Scientific Writing for Publication (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. The purpose of this course is to acquaint students with samples from significant technical, professional and scientific writing, sharpen skills in identifying theses and the major supporting elements in these works, while making judgments on their contributions. In addition, students will be required to demonstrate their ability to do the necessary research to integrate related sources other than the assigned texts. **Effective From: Fall 2010**

Eng 348 - Literary Journalism (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Students will read and analyze the works of literary journalists from the 18th century to the present day. Close reading and analytical writing as well as some journalistic writing. **Effective From: Fall 2009**

Eng 349 - Advanced Journalism Skills (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Through hands-on writing and reporting supervised by the instructor, students learn competencies needed in various journalistic specialties. Special focus on how to cover science and technology, social issues, culture and the arts, sports, business and consumer news. Particular emphasis on copy-editing. **Effective From: Spring 2009**

Eng 350 - The Newsroom (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Students will work closely with the university's newspaper advisor in order to write news and feature stories, commentaries and critiques for publication in the university newspaper, The Vector. Students will finish the course with a portfolio of work that they can present to prospective employers or graduate schools. This is an advanced journalism course. **Effective From: Fall 2009**

Eng 351 - Online Journalism (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. A study of how news is covered on the World Wide Web, and the impact of online news on society and politics. History of news online. Differences between print, broadcast and online-what are the strengths and weaknesses inherent to each medium? Analysis of the websites of different news organizations-from the New York Times to CNN to special interest e-zines to blogs. **Effective From: Spring 2009**

Eng 352 - Technical Writing (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. An advanced writing course. Combines current theory with actual practice to prepare students as technical writers. Analyze complex communication situations and design appropriate responses through tasks that involve problem solving, rhetorical theory, document design, oral presentations, writing teams, audience awareness, ethical considerations, and gender equity issues. **Effective From: Spring 2009**

Eng 353 - Composing Documents for Print (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Explores information structuring via print and digital media; how computer technology has influenced the ways in which information is presented in modern culture. Focuses on the optimal ways to prepare and present information for technical and commercial use. Important concepts such as visual literacy and effective design are discussed and addressed. **Effective From: Spring 2009**

Eng 353A - Electronic Publishing Lab (0-3-2)
Prerequisites: HUM 101, and two from among HUM 102, HUM 211, HUM 212 and Hist 213 or their equivalents; Eng 352 and Eng 353. Seminar and laboratory-based course designed for PTC majors; open to others with appropriate backgrounds and interests and permission of instructor. Follow up of Eng 353, explores information structuring via digital media, and how computer technology has influenced the ways in which information is presented in contemporary culture. Through guided interactive research, present information for technical and commercial use. Projects involve use of html editors, graphical software, and NJIT networks. **Effective Until: Fall 2005**

Eng 354 - Composing Documents for the Web (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Seminar and laboratory-based course designed for BA/BS majors; open to others with appropriate backgrounds and interests and permission of instructor. Follow up of Eng 353, explores information structuring via digital media, and how computer technology has influenced the ways in which information is presented in contemporary culture. Through guided interactive research, presents information for technical, commercial, and artistic use. Projects involve use of HTML editors, NJIT networks, and graphical and animation software. **Effective From: Spring 2009**

Eng 355 - Television News Writing and Production (3-1-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. This course consists of lectures and hands-on practice with the basics of television news writing and production and a field trip to a television station. After learning the fundamentals, the class will then begin its own news production by refining the video taped "packages" and integrating them into a studio newscast they will write and produce while guided by the instructor and with technical support from the staff of Instructional Technology and Media Services. The semester culminates in a final program that can be delivered to the campus community through ITMS's cable network. **Effective From: Spring 2009**

Eng 356 - Technical Writing in Distributed Environments (3-0-3)
Prerequisites: HUM 101 and two from among HUM 102, HUM 211, HUM 212 and Hist 213 or their equivalents. Prepare distance-learning students to communicate technical information in collaborative computer systems. Uses both real-time and asynchronous communication tools in tasks that involve problem solving, rhetoric, information design, writing teams, audience awareness, and ethical considerations. ENG 356 will satisfy the ENG 352 Technical Writing requirement for distance learning students whose academic majors require ENG 352. **Effective From: Fall 2003 Until: Summer1 2004**

Eng 360 - Collaborative Communication: Community and Global Perspectives (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. The central focus is on the challenge for cooperative communication to solve local and global problems. Examines how technological advances have altered the way we gather resources to solve problems. Today's information is too vast, too diverse, and changes too rapidly to be used to solve social dynamics problems in traditional ways. Using the resources of all available technology--e-mail, video conferencing, satellite communications, etc.--the goal is to bring all stakeholders together in order to build consensus and/or solve problems. **Effective From: Spring 2009**

Eng 364 - Theory of Rhetoric (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Examines theories of rhetoric from ancient to contemporary times. Special attention is paid to Aristotle, Peter Ramus, James Kinneavy, Walter Ong, and -Jurgen Habermas. Focuses on the ways in which theories inform the practice of communication. In the course project, students design and conduct field research based on rhetorical theory. **Effective From: Spring 2009**

Eng 369 - Creative Writing (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Focuses on the complexities of creating literary texts. Analyzes student writing in genres such as fiction, creative non-fiction, poetry, and drama. Considers these genres from theoretical perspectives. Topics include character development, plot, dia-logue; meter, rhyme, figurative language; audience analysis, ethos, and narrative theory. Students write, edit and critique their own work with the aim of publication. **Effective From: Spring 2009**

Eng 490 - Co-op Work Experience I (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Eng 491 - Co-op Work Experience II (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Eng 496 - Senior Project-Communication and Media (3-0-3)
Prerequisites: HUM 102 and one from among HUM 211, HUM 212 and Hist 213 or their equivalents, all with a grade of C or better. Intended for Communication and Media majors only. For professional and technical communication majors only. Provides

students with a capstone experience. Offers PTC students the opportunity to enhance their understanding of communication through their integration of skills and knowledge gained in prior courses. The resultant research thesis or field project, of substantial length and originality, represents the culmination of the undergraduate disciplinary experience. Utilizing both a seminar and workshop approach, entails intense and sustained collaboration between student and instructor, and cooperation among students. **Effective From: Spring 2009**

R350:254 - Literature and Politics in the Third World (3)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

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 **Effective Until: Fall 2011**

Eng 502 - English for International Graduate Students (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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

Eng 605 - Elements of Visual Design (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. **Effective Until: Fall 2005**

Eng 606 - Advanced Online Design (3 credits)
Prerequisites: Eng 605 Elements of Visual Design. This course will focus on online visual communication strategies and community building. The course will cover: multimedia, usability heuristics, navigation theory, contemporary design practices and online community building. Students will be required to create a multidimensional online community and to participate in team-building by collaborating on the MSPTC newsletter. **Effective Until: Summer 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

Eng 632 - Content Management, Manuals and On-Line Help (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. **Effective Until: Fall 2005**

Eng 640 - Health Communication (3-0-3)
This course will focus on the use of communication strategies to inform and influence individual and community decisions regarding health. The course will cover: the multidimensional nature of health communication, research in health communication, behavioral theories in health communication, rhetorical theories in health communication, legal and ethical concerns in health communication, the communication of risk and uncertainty, and the design of health campaigns. Students will be required to (a) research and prepare a health communication strategy for use in a specific context and (b) to design an accompanying print or hypertext document to be used in that context. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

Eng 698 - Selected Topics in Professional and Technical Communication (3 credits)
Prerequisite or corequisite: ENG 601 **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

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. **Effective Until: Fall 2005**

Enviromental Engineering: Offered by the Department of Civil and Environmental Engineering. See Civil Engineering course list for faculty.

UNDERGRADUATE COURSES:

EnE 262 - Introduction to Environmental Engineering (3-1-3)
Prerequisites: Chem 126, Math 112, and Phys 121. To introduce students to the integrated science, engineering, design and management concepts of engineered environmental systems. The course will cover environmental regulations and standards, environmental parameters, mass balance and natural systems, water quality management, water and wastewater treatment, air pollution control, noise pollution, and solid and hazardous waste management. Background material and laboratories in the environmental sciences and management areas will be covered. Group term papers and presentations will be required. **Effective From: Fall 2006**

EnE 360 - Water and Waste Water Engineering (3-0-3)
Prerequisites: EnE 262 and junior standing. Training in the methods used for water pollution control. Topics include the chemical, physical, and biological processes that occur in waste treatment design and in receiving waters; modeling schemes to determine allowable loadings in various bodies of water; and waste treatment processes used for water pollution control.

EnE 361 - Solid and Hazardous Waste Engineering (3-0-3)
Prerequisites: EnE 262 and junior standing. Exposure to the area of air pollution control, solid waste disposal, and radioactive waste disposal. Topics include the chemistry of contaminated atmospheres; the influence on meteorological conditions of dispersion of pollutants; abatement processes used in the control of emissions; classification and nature of solid waste, and solid waste disposal techniques; sources and methods for the disposal of radioactive contaminants; and related health effects.

EnE 485 - Special Topics in Environmental Engineering (3-0-3)
The study of new and/or advanced topics in an area of environmental engineering not regularly covered in any other EnE course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. **Effective From: Spring 2010**

EnE 491H - Honors Research Experience in Environmental Engineering (3-0-3)
Prerequisites: Junior standing, agreement of a department faculty advisor, and approval of the associate chairperson for undergraduate studies. This course provides the student with an opportunity to work on a research project under the individual guidance of a member of the department. A written report is required for course completion. Open to students with a GPA of 3.0 or higher.

GRADUATE COURSES:

EnE 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2004**

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. **Effective Until: Fall 2011**

EnE 662 - Site Remediation (3 credits)
Prerequisite: EM 631. Can be taken concurrently with EM 631. Examines site remediation from start to finish. Includes regulations, cleanup standards, remedial investigations, feasibility studies, risk assessment, and safety. Examines established and innovative cleanup technologies such as incineration, containment, bioremediation, vapor extraction and ground water recovery.

EnE 663 - Water Chemistry (3 credits)
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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

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 672 - Stormwater Management (3 credits)
This course provides a comprehensive study of stormwater management with emphasis on design practices. Topics include regulatory framework, an overview of structural and non-structural BMPs, groundwater recharge analysis, estimate of runoff, and design of detention basin and drainage systems. **Effective From: Spring 2006**

EnE 673 - Sustainability and Life Cycle Analysis (3-0-3)
The course provides a systematic foundation for the connection between evolving technology and human activity impacts on

natural systems by emphasizing the sources of environmental degradation and energy use and strategies to reduce risk and promote sustainability. The course provides hands-on experience with life cycle assessment computer tools and approaches. The course emphasizes relationships between industrial activities and regional and global natural systems-physical, chemical and biological-focusing on the importance of sustainability goals and practices. **Effective From: Spring 2009**

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 720 - Environmental Chemodynamics (3)
Introduction to concepts, mechanisms and models used to describe the transport of chemicals in the environment. Concepts and models are applied to air-water, sediment-water and soil-air interfaces. **Effective From: Spring 2005**

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. **Effective Until: Fall 2011**

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 Chemistry and Environmental Science

UNDERGRADUATE COURSES:

EPS 202 - Society, Technology, and the Environment (3-0-3)
Prerequisite: HUM 101. Uses case studies to examine the relationships between the creation and use of technologies, the human and natural environment, and the development of social and cultural institutions. Its central theme is the manner in which human society structures the environment in which it lives: nature and culture, city and country, civilization and development. This course satisfies 3 credits of the Basic Social Sciences GUR. Honors Note: See HSS 101. **Effective From: Spring 2007**

EPS 312 - Technology and Policy in Contemporary America (3-0-3)
Prerequisites: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, Hist 213 or their equivalents. A study of technology and politics in recent America. Focuses on the role of the federal government in shaping technology, especially through funding technological innovations and applications. Topics will include the origins of technology policy in World War II, the influence of the Cold War, the science and technology policy advisory system, and political and cultural influences on technology policy. Honors Note: See HSS 101. **Effective From: Fall 2008**

EPS 313 - Environmental History and Policy (3-0-3)
Prerequisites: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, Hist 213 or their equivalents. Covers the rise of the modern environmental debate, and examines its current priorities and values, politics and economics, and impacts on industry and society. Students review the role of regulatory agencies, private industry, public interest groups, and the media. Current major issues in New Jersey are considered, as well as environmental debate on a national and global level. Honors Note: See HSS 101. **Effective From: Fall 2008**

EPS 360 - Ethics and the Environment (3-0-3)
Prerequisites: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, Hist 213 or their equivalents. An examination of contemporary environmental problems from the perspective of ethics or moral philosophy. An analysis of the ethical presuppositions and value principles underlying environmental policy. The study of ethical theories and their application to the environmental crisis. Honors Note: See HSS 101. **Effective From: Fall 2008**

EPS 362 - Environmental Economics (3-0-3)
Prerequisites: HUM 101, HSS 202, SS 201 or their equivalents. Presents a detailed overview of the relationship between political economy and the environment. Draws on diverse case studies including global warming, harvesting of minerals on the ocean's floor, destruction of old growth forests, and contamination of the -nation's water, air, and soils. Explores the economic remedies to the fast-changing relationship between society and nature. Honors Note: See HSS 101. **Effective From: Fall 2008**

EPS 380 - Policy Issues in the Coastal Environment (3-0-3)
Prerequisites: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, Hist 213 or their equivalents. An examination of coastal environments from the standpoint of the scientist, the engineer, and the resource manager. Topics include beach and shoreline characteristics, technological innovations to address coastal erosion problems, and current debates in coastal policy and resource management. Case studies are used to illustrate coastal management practices and the scientific, technical, and social constraint to policy formulation. **Effective From: Fall 2008**

EPS 381 - Field Techniques and Research (3-0-3)
Prerequisites: HUM 101, HSS 202 or their equivalents; two from HSS 211, HSS 212, Hist 213 or their equivalents.; STS 307. An introduction to research methods. The objectives of the course are to provide opportunity to pursue specialized, in-depth research in a subfield of science, technology and society of the student's choice; to develop skills in problem identification, research design and problem solving; to increase familiarity with methods of data analysis; to strengthen library research skills; to provide an opportunity to gather original field data in a team-oriented environment; and to improve oral and written communication skills. **Effective From: Fall 2008**

GRADUATE COURSES:

EPS 601 - Research Methods for Environment & Sustainability Policy (3 credits)
Introduces the research methods necessary to conduct studies in environmental and sustainability policy. Topics covered include literature review, problem identification, hypothesis testing, and quantitative methods of data analysis and problem solving. Students are required to implement and present their independently designed projects.

EPS 602 - Research Analysis for the Social and Policy Sciences (3 credits)
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. **Effective Until: Fall 2011**

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 & Management (3 credits)
Overviews the complex and dynamic interactions between the economy and the environment from biological, economic, and institutional perspectives and investigates various strategies for resolving conflicts in resource management and pollution control. Topics include the basic principles of risk assessment, cost benefit analysis, and cost-effectiveness analysis in environment management and assessment of contemporary environment politics in air and water pollution control and waste and toxics management. **Effective From: Fall 2012**

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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

EPS 622 - Sustainable Politics & Policy (3 credits)
Identifies the origins of the concept of sustainability development and institutional efforts to implement strategies at various geopolitical scales: international, national, regional, and local. The course introduces tools to measure progress toward sustainability through the use of metrics such as ecological footprint analysis and life-cycle analysis. Other topics include steady-state economics, sustainable systems of production and consumption, and sustainability transitions.

EPS 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. **Effective Until: Fall 2011**

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. **Effective Until: Fall 2011**

EPS 638 - Physical Geography (3)
Understanding the interaction between humans and the physical environment is important to the formulation of sound environmental policy. The course examines processes that shape the physical environment, the influence of human activities on these processes and the physical environment, and the application of this information to solving environmental problems.

EPS 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. **Effective Until: Fall 2011**

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 & Sustainability (3 credits each)
Course considers advanced topics of special or current interest related to environmental and sustainability policy. **Effective From: Fall 2012**

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 702 - Special Topics (3-0-3)
Prerequisite: Approval of graduate advisor in Environmental Science. Topics of current interest in the field of environmental policy. Doctoral level course. **Effective From: Spring 2006**

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. **Effective Until: Fall 2011**

EPS 712 - Advanced Studies in Environmental & Sustainability Policy (3 credits)
Evaluates strategies to reduce energy and material throughput including eco-efficiency relocalization of production and consumption, and green consumerism. Also considered are debates surrounding innovative policies to foster work-time reduction, to develop alternative measures of well-being, and to include societal values shifts. **Effective From: Fall 2012**

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. **Effective Until: Fall 2011**

Environmetal Science : Offered by the Department of Chemistry and Environmental Science

UNDERGRADUATE COURSES:

EvSc 125 - Fundamentals of Environmental Sciences (3-0-3)
Prerequisites: Chem 125 with grade C or better, R120:101 with grade C or better. An introductory course that will present freshman EvSc students with general concepts and topics on Environment, including chemistry, ecosystems, geological and soil resources, water quality, agricultural and Environment, atmosphere, noise and ionizing radiation. **Effective From: Fall 2013**

EvSc 325 - Energy and Environment (3-0-3)
Prerequisites: Chem 125 with a grade C or better and Phy 111 with grade C or better. An advanced course to instruct EvSc students, topics on energy and environmental issues such as introduction to energy, natural energy conservation, environmental issues of energy production and consumption, regulation and legislation related to energy, public policy development in energy and environment. **Effective From: Spring 2012**

EvSc 335 - Environmental Law (3-0-3)
Prerequisite: Hum 102 with a grade of C or better. The prerequisite is a college ability to communicate competently in the English language including the ability to research and prepare essay compositions and to articulate the major points in a presentation format. The introduction to Environmental Law will cover the regulatory system developed over time that has forged a complex system of environmental rules influencing industrial and other private and public actions that impact the environment. The course will review these rules from the vantage point of the practicing technical environmental engineer and scientist. Students will become familiar with the background and derivation of these laws as well as the major operational features such as environmental permits and enforcement. Several major environmental cases will be analyzed that give definition to the key features of these laws. Each class module will direct itself to the practical application of these laws. **Effective From: Fall 2012**

EvSc 375 - Environmental Biology (3-0-3)
An introductory ecological approach to understanding man's impact and dependence on the natural environment. Broad topics include ecosystems, nutrient cycles, pollution, pest management, conservation of natural resources, energy, and human population. **Effective From: Spring 2006**

EvSc 381 - Geomorphology (3-0-3)
This is a course in geomorphology, the study of landforms and the contemporary processes that create and modify them. The course will emphasize earth surface processes and quantitative analysis of landform change. Lectures will stress geomorphic principles and two field-based problems will enable students to apply these principles to contemporary geomorphic problems in engineering and management with a focus on the natural environment. **Effective From: Fall 2010**

EvSc 385 - Environmental Microbiology (3-0-3)
The main goals of this course are to present an overview of the important microbes involved in environmental microbiology, to discuss the environments where they are found, to learn how they are detected and monitored, and to describe their effects on humans. Traditional lectures and exams will be supplemented with discussions of experimental design and data interpretation by reading current research articles. **Effective From: Spring 2006**

EvSc 391 - Research and Independent Study (3-0-3)
Provides an opportunity to work on a research project under the individual guidance of a member of the department. **Effective From: Fall 2008**

EvSc 416 - Environmental Toxicology (3-0-3)
The course is intended to explore the general principles of toxicology and apply them to the assessment of acute, subacute and chronic effects of hazardous and toxic chemicals. Qualitative and quantitative measures of toxicity and testing protocols are addressed. The role of toxicology in risk assessment and risk management is discussed. **Effective From: Spring 2006**

EvSc 484 - Environmental Analysis (2-2-3)

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. **Effective From: Fall 2006**

EvSc 492H - Honors Research and Independent Study II (3-0-3)
Provides an opportunity to work on a research project under the individual guidance of a member of the department. **Effective From: Fall 2008**

GRADUATE COURSES:

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 624 - Environmental Analysis Methods and Laboratory (3 credits)
Basic theory, methods, instruments, and data interpretation for chemical analysis of environmental samples are described in lectures and used in the laboratory; sampling; sample preparation; quality assurance, chain of custody. Instrument methods and uses include: UV-VIS, FTIR, AA, HPLC, GC, Ion Chromatography, and Mass Spectrometry as applied to environmental samples.

EvSc 625 - Social Dimensions of Risk (3 credits)
Low-probability/high consequence events involving terrorism, food safety, and extreme weather offer ample evidence the prevalent approaches of economics and statistics are not able to deal with the complex ways that risk permeates modern societies. This course treats risk analysis as a broad interdisciplinary activity and draws on the full range of the social sciences to explore the multifaceted way that risk infuses itself into the fabric of contemporary affairs. **Effective From: Spring 2007**

EvSc 626 - Hydrogeology (3 credits)
This course covers the principles of ground water flow, advanced water cycle properties, aquifer flow and aquifer recharge. Contaminant migration and remediation methods are discussed. Basic groundwater chemistry and quality is covered. **Effective From: Spring 2008**

EvSc 627 - Environmental Microbiology (3 credits)
Prerequisites: R120:101, R120:102, (General Biology I and II) or permission of instructor. This course offers an overview of 1) basic microbiology: biochemical principles, cell structure organization, microbial nutrition and growth, 2) the important microbes involved in environmental microbiology and address the environments where they are found, and 3) how they are detected and monitored, and their effects on humans, and the environment. Traditional lectures and exams are supplemented with discussions of current research articles. **Effective From: Fall 2010**

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 712 - Hazardous Substance Management (3-0-3)
Prerequisites: Graduate standing. The course material comprises an overview of hazardous materials and hazardous waste management and control in an industrial setting. The course examines the technical approaches utilized in the control,

remediation, and prevention of hazardous substances and waste. It also includes the major technical elements of federal regulations that govern operations involving the handling of hazardous materials. **Effective From: Fall 2012**

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

GRADUATE COURSES:

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

UNDERGRADUATE COURSES:

Fin 218 - Financial Markets and Institutions (3-0-3)
This course provides an overview of the main features of financial markets and institutions in the United States, including interest rates and rates of return and how they are determined. It also covers securities traded on the U.S. financial markets including bonds, stocks, and derivatives and discusses how financial institutions, especially commercial banks work, along with the role of government in regulating financial markets and institutions. **Effective From: Fall 2009**

Fin 315 - Fundamentals of Corporate Finance (3-0-3)
Prerequisites: Acct 115, or Acct 117. This course focuses on how companies invest in real assets and how they raise the money to pay for those investments. Topics covered include the firm and the financial manager, time value of money, bonds, stocks, and net present value. International finance, risk management, capital structure strategy and case studies of technology-based companies will be introduced. **Effective From: Fall 2010**

Fin 401 - Securities in Financial Markets (3-0-3)
This course offers a quantitative approach to evaluating fixed income securities and to managing bond portfolios. Specific topics include: modern theory of bond pricing, pricing of high risk bonds, derivatives, and risk management. **Effective From: Fall 2005**

Fin 402 - Financial Risk Measurement and Management (3-0-3)
This course offers an in-depth analysis of the measurement and management of risk in financial markets. Topics include: assessing overall market risk, credit risk, liquidity risk, settlement risk, volatility risk, measuring portfolio risk, and extreme value risk. **Effective From: Fall 2005**

Fin 403 - Financial Statement Analysis (3-0-3)
This course offers comprehensive coverage of analysis of financial statements so that students can: a) evaluate the financial position of a firm; b) assess the firm's inherent value and the value of its securities; c) assess the firm's obligations and its ability to meet them; and d) analyze sources and uses of cash. **Effective From: Fall 2005**

Fin 404 - Financial Management Using ERP Systems (3-0-3)
Enterprise Resource Planning (ERP) systems are covered in-depth as tools for increasing a firm's profitability, reducing its costs, and for improving its competitiveness. ERP platforms from PeopleSoft and Microsoft as used throughout the course to demonstrate financial management using integrated, firm wide information systems. **Effective From: Fall 2005**

Fin 416 - Advanced Corporate Finance (3-0-3)
Prerequisite: Fin 315. Advanced corporate finance with an emphasis on the financial management of technology-based organizations. Case studies are used for comparative analysis. Emphasis is on organizational productivity and profitability. **Effective From: Summer 2008**

Fin 422 - International Finance (3-0-3)
Prerequisite: Fin 315. Introduction to the international financial management of the firm with an emphasis on technology-based organizations. Topics covered include hedging currency risk, capital budgeting internationally, raising funds internationally. Global competitiveness is addressed with comparative analysis of the financial management practices of American, European and Japanese firms.

Fin 423 - Risk Analysis (3-0-3)
Prerequisite: Fin 315. The management of risk in the business enterprise. Topics include meas-urement of risk and hedging strategies, sources of liability, property and liability insurance, and insurance administration.

Fin 430 - Options and Futures Markets (3-0-3)
Prerequisites: Fin 315 and Math 135 (or Math 138, Math 111, Math 113). This course covers options, forward contracts, futures

contracts and swaps, and will give students a working knowledge of how these contracts work, how they are used, and how they are priced. Students will learn how corporations and portfolio managers can hedge different kinds of risks or alter the distribution of returns on their portfolios using various techniques. **Effective From: Fall 2009**

Fin 485 - Special Topics in Finance (3-0-3)
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. **Effective From: Fall 2009**

R390:315 - Investments (3)
For more details go to Rutgers Catalog.

R390:329 - Finance (3)
For more details go to Rutgers Catalog.

R390:386 - Futures and Options (3)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

Fin 516 - Principles of Financial Management (3 credits)
Fundamentals of financial management divided into two segments: investment and corporation finance.

Fin 600 - Corporate Finance I (3 credits)
This course introduces concepts and analytical tools to identify and solve Financial Management problems. After introducing the corporation, the course focuses on how firms invest in real assets (capital budgeting) and how they raise money to pay for assets (financing). Practical problems in valuing bonds, stocks and other investments will be based on the time value of money. The trade-off between risk and return will be introduced with the Capital Asset Pricing Model. **Effective From: Fall 2009**

Fin 610 - Global Macro Economics (3 credits)
Fin 610 is an introductory graduate course for entering master's students that will also be taking other core Master's courses such as accounting. The course introduces various concepts relating to macroenomics and the financial environment from both a theoretical and institutional perspective. Thus fiscal and monetary policy and actions are covered but are taught using a macroeconomic model that helps identify how particular actions affect the money and goods economies as well as specific financial institutions. **Effective From: Spring 2010**

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 - Corporate Finance II (3 credits)
Fin 600 is a prerequisite. The trade-off between risk and return will be examined in the context of historical analysis, portfolio optimization, the Capital Asset Pricing Model and other alternative models. The course will begin with the understanding of the Modigliani and Miller results and introduce bankruptcy, taxes, information asymmetries and other market imperfections. Financial options, put-call parity and option pricing will be introduces. **Effective From: Fall 2009**

Fin 626 - Financial Investment Institutions (3 credits)
Prerequisite: Fin 600. Introduces the role of banking institutions and investment banks in the domestic and international money market and capital environment to the financial managers. Covers instruments and services of financial intermediaries that are crucial to business management. Discussions range from the financial services and facilities of regional banks to money-center banking institutions. Alternatives of project financing, lending requirements and regulations, project financing, and role of intermediaries in local and international transactions. Focuses on the private placement procedures of all types of securities in the capital market and the unique role undertaken by the investment banking firms. Provides an insight about the public offering process for existing and venture capitalized firms.

Fin 627 - International Finance (3 credits)
Prerequisite: Fin 600. Examines financing of exports and imports, managing multicurrency working capital, international aspects of capital budgeting, cost of capital and their relationship with political, economic, and financial risk. Explores financial innovations and their impact on the firm's financial strategy and performance of overall productivity. Discusses the tax consequences and principal-subsidiary relationship of the multinational enterprise. Introduces international money and capital markets, instruments, derivatives, and institutions.

Fin 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 600. Focuses on identifying and evaluating potential and international companies for mergers and acquisitions as well as structuring of deals. The financial, social and managerial implications of these changes in corporate ownership will be examined. Topics are: financing M&As, deal structuring, tax implications, valuation, broker/finder agreements, merger negotiations, and post-merger integration.

Fin 641 - Derivatives Markets (3 credits)
Prerequisites: FIN 600. This course introduces students to futures, options, and other derivative securities. Topics include option valuation models, principles of forward and futures pricing, structure of markets for derivative securities, and strategies for hedging and speculation. **Effective From: Spring 2011**

Fin 642 - Derivatives and Structured Finance (3 credits)
Prerequisites: Finance 641. This is a second course in the instruments created by modern financial engineering. It continues the study of derivatives from Fin 641 (Derivatives Markets), covering additional types of options and of underlying assets. The second part of the course is devoted to structured finance, including securities backed by mortgages and other types of assets. **Effective From: Spring 2010**

Fin 643 - Term Structure of Interest Rates (3-0-3)
Prerequisites: FIN 642(Derivatives and Structure Finance), Math 605 (Stochastic Calculus). This course provides the student with a basic understanding of models of the term-structure of interest rates and the pricing of derivatives on bonds and other interest-rate-based securities. Topics covered include arbitrage-free pricing principles, continuous-time interest-rate models, no-arbitrage term structure models, multifactor models, forward measure approach, market models and model calibration. **Effective From: Spring 2010**

Fin 644 - Credit Risk Modeling (3-0-3)
Prerequisites: FIN 643 (Term Structure of Interest Rates), Math 605 (Stochastic Calculus). This course covers types of credit risk, measurement of credit risk, and methods for changing exposure to credit risk using credit derivatives. Current models for pricing credit derivatives will be analyzed and applied. **Effective From: Fall 2011**

Fin 650 - Investment Analysis and Portfolio Theory (3 credits)
Prerequisite: FIN 600. This is a basic course in the theory and practice of investing. We will study in depth why and how to form portfolios of securities. A significant amount of mathematical and statistical analysis will be used in answering these questions. Theories of asset pricing based on the relationship between risk and return will be included. We will also discuss criteria for selecting specific securities in different asset classes, such as, stocks, bonds, and derivatives. **Effective From: Spring 2011**

Fin 655 - Financial Innovations and Market Failures (3-0-3)
Prerequisites: Fin 600. This reading intensive course introduces concepts and problems from derivative markets, entrepreneurial finance, and financial market failures (including financial bubbles). The course focuses on valuation of futures and options (including real options), strategy and incentives for new finance, and information asymmetry and market failures, especially financial market bubbles. **Effective From: Spring 2013**

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

UNDERGRADUATE COURSES:

R460:103 - Planet Earth (3)
For more details go to Rutgers Catalog.

R460:104 - Planet Earth Laboratory (1)
For more details go to Rutgers Catalog.

R460:106 - Environmental Geology (3-0-3)
For more details go to Rutgers Catalog.

R460:206 - Environmental Geology (3)
For more details go to Rutgers Catalog.

R460:207 - Environmental Geology Laboratory (1)
For more details go to Rutgers Catalog.

R460:309 - Geomorphology (3)
For more details go to Rutgers Catalog.

R460:311 - Geologic Field Problems (3)
For more details go to Rutgers Catalog.

R460:320 - Structural Geology (4)
For more details go to Rutgers Catalog.

R460:321 - Mineralogy (4)
For more details go to Rutgers Catalog.

R460:406 - Applied Geophysics (3)
For more details go to Rutgers Catalog.

R460:427 - Hydrogeology (3)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

R460:577 - Seminar in Environmental Geology (3 credits)
For more details go to Rutgers Catalog.

History: Offered by the Federated History Department of NJIT and Rutgers-Newark

UNDERGRADUATE COURSES:

Hist 125 - Mapping Human History (3-0-3)
An introduction to the relationship of time and space in human history, using selected case studies drawn from a wide range of historical periods and places. Students learn to read and use maps, with a particular emphasis on the critical examination of evidence.

Hist 213 - The Twentieth-Century World (3-0-3)
Prerequisite: HUM 101 and HUM 102 with a grade C or better. Uses case studies to provide an interdisciplinary view of the 20th-century world. Selected literary, philosophical, and artistic movements are discussed in the context of the major historical developments of the century. This course satisfies three credits of the GUR in Cultural History. **Effective From: Fall 2011**

Hist 310 - Co-op in Law, Technology, Culture & History I (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Students gain work experience related to their major in Law, Technology and Culture. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. **Effective From: Spring 2013**

Hist 311 - Co-op in Law, Technology, Culture & History II (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Students gain work experience related to their major in Law, Technology and Culture. Work assignments are facilitated and approved by the co-op office. Requires mandatory participation in seminars and completion of a report. **Effective From: Spring 2013**

Hist 334 - Environmental History of North America (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. The history of interactions between humans and their natural environment on the North American Continent. Considers perceptions of, use of, and alteration of the environment. Traces the cultural, intellectual, economic, political and technological transformations from early colonial times to the late 20th century. Addresses the diverse environmentalisms that have emerged the last several decades. **Effective From: Spring 2013**

Hist 341 - The American Experience (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. American history from the colonies to the 20th century, with concentration on several selected themes basic to an understanding of the changing cultural patterns and social values of American civilization. **Effective From: Spring 2013**

Hist 343 - African-American History I (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Introduction to African-American history from pre-colonial West Africa to emancipation in the mid-19th century. Topics include the African slave trade, the economics and politics of slavery, gender and culture in the slave community, and the free black experience in both the north and south. **Effective From: Spring 2013**

Hist 344 - African-American History II (3-0-3)
HUM 102 and one from among HUM 211, HUM 212, HIST 213, R510:200-- 299, R512:200--299 or their equivalents with a grade of C or better. Introduction to African-American history from the mid-19th century to the present. Covers race relations and the civil rights movement, as well as migration, black social and political thought, gender roles, and class formation. **Effective From: Spring 2013**

Hist 345 - Communication through the Ages (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Modes of communication, ancient and modern, in their social and cultural context?from cave painting to computers. Topics include literacy and economic development in the West; the technological revolution in media beginning with Daguerre, Samuel Morse, and Alexander Graham Bell; the institutional development of mass media and popular culture; and contemporary trends in world communication and interaction. **Effective From: Spring 2013**

Hist 351 - Ancient Greece and the Persian Empire (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. The political, institutional, and cultural developments of Ancient Greece and the Persian Empire from the Mycenaean period to the King's Peace (386 B.C.). **Effective From: Spring 2013**

Hist 352 - The Hellenistic States and the Roman Republic (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. The political and cultural developments of the Hellenistic states and their influence on the Republic of Rome to 30 B.C. **Effective From: Spring 2013**

Hist 359 - History of the Middle East I (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better The political, cultural, and institutional developments in the Middle East from the Parthians to the capture of Constantinople by the Ottoman Turks. Four periods will be analyzed: the Parthian, the Sassanid Persian, the Caliphate, and the Seljuk and Ottoman Turks. **Effective From: Spring 2013**

Hist 360 - History of the Middle East II (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. The political, cultural, and institutional developments in the Middle East from the capture of Constantinople by the -Ottoman Turks to the impact of the Arab-Israeli conflict on the world today. **Effective From: Spring 2013**

Hist 361 - The Founding of the American Nation (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. North America in the colonial and revolutionary periods, with emphasis on patterns of cultural and institutional development from early settlement through the ratification of the Constitution. **Effective From: Spring 2013**

Hist 362 - Sex, Gender, and the Law in American History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Examines how the US legal system has dealt with the problems of sex and gender. Surveys laws that dictated different roles for men and women as well as seemingly gender-neutral laws that affected men and women differently. Tracks the designation of sexual acts as legal or illegal and the ways that race, class, and nationality complicated these relationships. **Effective From: Spring 2013**

Hist 363 - The United States as a World Power (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. American domestic and foreign policy in the 20th century. Topics include imperialism, the Progressive Era, the Depression, the New Deal, World Wars I and II, the Cold War, America and the world today. **Effective From: Spring 2013**

Hist 364 - American Law in the World (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Concerns the history of American law as a product and catalyst of world politics by considering in global context the transformation of central doctrines of regulation, property rights, and civil liberties from the Declaration of Independence through the War on Terror. **Effective From: Spring 2013**

Hist 365 - Comparative Colonial History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. A comparative analysis of the relationship between expanding Western nations and selected regions of Africa, Asia, and South America, from 1500 to 1970. A case study approach illuminates key historical processes, with a special emphasis on economic development and cultural change in colonial settings. Topics include European perceptions of culturally different peoples, race relations in colonial societies, forms of rebellion and

resistance to European rule, nationalist movements. **Effective From: Spring 2013**

Hist 366 - Gender, Race and Identity in American History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Surveys the social construction of gender in America from the s17th century to the present. Examines the changing gender roles and relations that have characterized and structured the historical experiences of different racial and ethnic groups. In a multicultural framework, covers the impact that colonization, industrialization, slavery, immigration and migration, urbanization, war, and social movements have had on the ways that women and men think of themselves in terms of gender as well as their respective roles in families and larger social networks. **Effective From: Spring 2013**

Hist 367 - International Law and Diplomacy in History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Examines the origins, evolution, and application of diplomacy and international law from the 15th century to the present. Topics include the rise of modern diplomacy in Renaissance Italy; the emergence of international law and professionalization of diplomacy in early modern Europe; the development of international law and diplomatic theory in the 18th and 19th centuries; the codification of international law; and adaptation of international law to transnationalism and globalism in the 20th century. **Effective From: Spring 2013**

Hist 368 - Comparative Economic History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. A comparative analysis of the history of economic development, with particular attention to industrialization, shifting patterns of global trade, and changing labor markets. Topics include the Industrial Revolution, the rise of the world economy, the transformation of non-Western economies, labor migration, and newly industrializing countries. **Effective From: Spring 2013**

Hist 369 - Law and Society in History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Uses historical case studies to illustrate and evaluate various approaches to the study of law and society. Topics include criminality and the rise of incarceration as a legal penalty in the 19th century; the comparative law of slavery; and the evolution of American Indian law. **Effective From: Spring 2013**

Hist 370 - Legal issues in the History of Media (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better.Investigates the development and impact of media law and policy in the United States. Examines how media law and policy affect media content, industry behavior, and consumer rights. Analyzes the values and ideas, as well as political and cultural contexts, that have guided continuities and transformations in media law and policy. Topics include indecency and obscenity, copyright and intellectual property, legal protections for children, and media ownership regulation. **Effective From: Spring 2013**

Hist 372 - Contemporary Europe (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. European society in the 20th century, Nationalism, imperialism, totalitarianism, movements toward European unity, and prominent cultural developments. **Effective From: Spring 2013**

Hist 373 - The Rise of Modern Science (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Examines the development of modern science in the western world from the origins of the Scientific Revolution to 1900. Explores how science challenged the revealed universe of Christianity, changed the curriculum in schools and universities, and altered the world view of philosophers. This course covers the achievements of Copernicus, Galileo, Newton, Darwin, Einstein, and other leading scientific innovators, but it also weaves the expansion of scientific knowledge into the larger fabric of European intellectual history. **Effective From: Spring 2013**

Hist 374 - Modern Russian Civilization (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Russia under the last tsars, the 1917 upheavals, rise of the Soviet state to world power under Lenin, Stalin, and others, until the collapse of the communist dictatorship. **Effective From: Spring 2013**

Hist 375 - Legal Issues in Environmental History (3-0-3)

Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better.Examines the role of law in the formation of human relationships with the natural world. The course will focus on the management and regulation of the human use of natural resources in a variety of historical contexts, but particularly in the United States from colonial times to the present. Through readings and class discussion, students will explore a number of recurring themes, including the transformation from customary rules governing access to local resources to state enforced laws. **Effective From: Spring 2013**

Hist 377 - Cities in History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Examines social, cultural and economic changes in urban areas. Regions and themes vary and may include urbanization in Europe, the rise of cities in Latin America, and urban change in contemporary America. **Effective From: Spring 2013**

Hist 378 - Medicine and Health Law in Modern America (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Examines the legal and ethical aspects of medical and public health practice in the United States from 1900 to the present. Topics include the rights and responsibilities of physicians and patients, the roles of government in promoting health, the rise of health law and bioethics, the tensions between civil liberties and public health, as well as evolving notions of harm, liability, uncertainty, and proof as they relate to the history of medical and public health practice. **Effective From: Spring 2013**

Hist 379 - History of Medicine (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better.Focuses on the evolving institutions, values, concepts, and techniques through which doctors attempted to control the impact of disease and preserve the health of Americans, beginning with the shaman and colonial physician through post-World War II changes in the system of medical care. **Effective From: Spring 2013**

Hist 380 - History of Public Health (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Attempts to protect the health of human populations from the Black Death in medieval Europe to recent threats from epidemics and chemical and biological terrorism. Shiftings patterns of disease and the emergence and growth of public health as a domain of expert knowledge and policy. Topics include: epidemiology and statistical modes of inquiry; the tension between civil liberties and public health; the economics of health and disease; and the relationship between medicine and public health. **Effective From: Spring 2013**

Hist 381 - Germs Genes & Body: Sci. & Tech. in Modern Medicine (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Examines how science and technology came to play critical roles in the rise of modern medicine. Readings, lectures, and discussion focus on the specific innovations in ideas, practices, and technologies that helped transform Western medicine in the 19th and 20th centuries. The course also considers how medicine and the biomedical sciences both inform and reflect attitudes about the human body in Western society. **Effective From: Spring 2013**

Hist 382 - War and Society (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. The evolution of warfare and the impact of war on political, economic, cultural, and social institutions, including the two World Wars and post-1945 conflicts. **Effective From: Spring 2013**

Hist 383 - The Making of Modern Thought (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. The formation of contemporary images of human nature since the mid-19th century. Emphasis on Marx, Darwin, and Freud and their legacy to 20th century thought. Theories of the family, sexuality, and the changing role of women in society are explored. **Effective From: Spring 2013**

Hist 385 - Technology and Society in European and World History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. An introduction to the social history of European and global tech-nology from the Middle Ages to the second Industrial Revolution of the late 19th century. Emphasis on such themes as the process of tech-nological innovation, the nature of technological systems, the diffusion of technology, the interaction of Western and non-Western technology, the changing relations of science and technology, and the role of technology in broader

historical movements. **Effective From: Spring 2013**

Hist 386 - Technology in American History (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. Survey of the history of American technology emphasizing the social and economic environments of technological change. Topics include the transfer of technology in building canals and cities, the rise of the factory system, the emergence of the American system of manufacture, and the development of major technological systems such as the railroad, telegraph, electric light and power, and automobile production and use. Focus on the professionalization of engineering practice, the industrialization of invention, and the growing links between engineers and corporate capitalism in the 20th century. **Effective From: Spring 2013**

Hist 388 - Britain in the 20th Century (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. A survey of British history from the death of Queen Victoria to 1964 with emphasis on the social and political trans-formation resulting from Britain's declining economy and world position. Topics include: the causes and impact of the two World Wars, the transition from liberal democracy to welfare state, the turn from Empire to Europe, social and economic trends as well as foreign -relations. **Effective From: Spring 2013**

Hist 390 - Historical Problems of the 20th Century through Film (3-0-3)
Prerequisites: Hum 101, Hum 102 and one from among Hum 211, Hum 212, and Hist 213 or their equivalents R510:200 through 299 or R512:200 through 299 or their equivalents with a grade of C or better. A study of selected problems in the 20th century using film as a window into history. Such topics as the rise of Nazi Germany, America in the thirties, World War II and American society, the development of cities, and the emergence of the Third World will be considered. In any one semester only two topics will be selected for study. The material for the course will include documentary films, newsreels, TV news films, and theatrical feature films as well as selected readings. **Effective From: Spring 2013**

Hist 401, 402 - Independent Studies in History (1-0-1, or 2-0-2, or 3-0-3)
Prerequisites: HUM 101, HUM 102 and one from among HUM 211, HUM 212 and HIST 213 or their equivalents with a grade of C or better in addition to a junior or senior standing; and before registering, permission from one of the following: NJIT history department chairperson, associate chairperson or history minor advisor. Pursuit of special interests in history not covered in a regular elective course. A history faculty member provides guidance and assigns readings and papers. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Hist 489 - Seminar-Readings (3-0-3)
prerequisites: Completion of the GUR in English (3 credits), CUltural History (6 credits), Basic Social Sciences (6 credits) an upper level History course (3 credits) and senior standing. Intended to combine study of specific topics, which vary each year, with attention to the methods for researching and writing history, these small classes for history majors in their senior year prepare students for the following semester's research project and culminate in a brief paper describing a proposed topic and the historical documents and sources to be used. **Effective From: Fall 2012**

Hist 489H - Senior History Honors Seminar: Readings (3-0-3)
Prerequisites: HUM 101, HUM 102 and one from among HUM 211, HUM 212 and HIST 213 or their equivalents with a grade of C or better. Limited to senior history majors who are enrolled in the Albert Dorman Honors College or who receive permission from the undergraduate history advisor. Meets with 510:489 but includes more advanced readings. **Effective Until: Fall 2007**

Hist 490 - Seminar Research (3-0-3)
Prerequisites: Hist 489. In this continuation of the two-semester seminar sequence, students research, outline, and write a substantial paper they design in conjunction with the professor. **Effective From: Fall 2012**

Hist 490H - Senior History Honors Seminar: Research (3-0-3)
Prerequisites: HUM 101, HUM 102 and one from among HUM 211, HUM 212 and HIST 213 or their equivalents with a grade of C or better. Limited to senior history majors who are enrolled in the Albert Dorman Honors College or who receive permission from the undergraduate history advisor. Meets with 510:490 but includes more rigorous research and writing requirements. **Effective Until: Fall 2007**

R510:201-202 - History of Western Civilization (3,3)
For more details go to Rutgers Catalog. **Effective Until: Fall 2007**

R510:249 - An Introduction to China (3)
For more details go to Rutgers Catalog.

R510:317 - History of the Caribbean (3)

For more details go to Rutgers Catalog.

R510:321 - Military History of the Western World (3)
For more details go to Rutgers Catalog.

R510:325 - History of Mexico and Central America (3)
For more details go to Rutgers Catalog.

R510:333 - History of Imperialism (3)
For more details go to Rutgers Catalog.

R510:334 - 20th-Century Fascism (3)
For more details go to Rutgers Catalog.

R510:337 - The History of Iran (3)
For more details go to Rutgers Catalog.

R510:338 - The Ottoman Empire (3)
For more details go to Rutgers Catalog.

R510:340 - Women in European History (3)
For more details go to Rutgers Catalog.

R510:346 - Medieval Legal History (3)
For more details go to Rutgers Catalog.

R510:355 - Traditional China: Institutions and Society (3)
For more details go to Rutgers Catalog.

R510:356 - History of the People's Republic of China (3)
For more details go to Rutgers Catalog.

R510:361 - The Near and Middle East (3)
For more details go to Rutgers Catalog.

R510:364 - Contemporary Issues in Puerto Rican History (3)
For more details go to Rutgers Catalog.

R510:366 - History of Poland (3)
For more details go to Rutgers Catalog.

R510:369 - Modern Eastern Europe (3)
For more details go to Rutgers Catalog.

R510:370 - History of Modern Ukraine (3)
For more details go to Rutgers Catalog.

R510:373 - The English Novel in History (3)
For more details go to Rutgers Catalog.

R510:379 - Colonialism and Decolonization (3)
For more details go to Rutgers Catalog.

R510:380 - History of the Mass Media in Europe (3)
For more details go to Rutgers Catalog.

R510:394 - The Peoples and Cultures of Central Asia (3)
For more details go to Rutgers Catalog.

R510:399 - Tudor-Stuart England (3)
For more details go to Rutgers Catalog.

R510:401 - Topics in European History (3)
For more details go to Rutgers Catalog.

R510:402 - History of Spain and Portugal (3)
For more details go to Rutgers Catalog.

R510:403 - Topics on Social History (3)
For more details go to Rutgers Catalog.

R510:404 - Topics in Intellectual History (3)
For more details go to Rutgers Catalog.

R510:433 - Topics in Islamic History (3)
For more details go to Rutgers Catalog.

R510:435 - Topics in Medieval and Early Modern History (3)
For more details go to Rutgers Catalog.

R510:458 - Topics in Women's History (3)
For more details go to Rutgers Catalog.

R510:461 - Topics in Comparative History (3)
For more details go to Rutgers Catalog.

R510:497 - Honors Project: History (3)
For more details go to Rutgers Catalog.

R510:499 - Individual Study in Historical Research, Non-American(BA) (null)
For more details go to Rutgers Catalog.

R512:201-202 - Development of the United States (3,3)
For more details go to Rutgers Catalog. **Effective Until: Fall 2007**

R512:303 - Topics in the History of Newark (3)
For more details go to Rutgers Catalog.

R512:311 - Colonial America (3)
For more details go to Rutgers Catalog.

R512:318 - Labor History (3)
For more details go to Rutgers Catalog.

R512:330 - History of American Immigration (3)
For more details go to Rutgers Catalog.

R512:337 - History of the Family in the United States (3)
For more details go to Rutgers Catalog.

R512:343 - The Creation of the American Republic (3)
For more details go to Rutgers Catalog.

R512:344 - The Democratic Age in American History: 1820 - 1880 (3)
For more details go to Rutgers Catalog.

R512:349 - Antebellum Reform Movements (3)
For more details go to Rutgers Catalog.

R512:367 - The Age of the Corporation: 1880?1920 (3)
For more details go to Rutgers Catalog.

R512:368 - Modern America (3)
For more details go to Rutgers Catalog.

R512:369 - America in World War II and the Postwar Period (3)
For more details go to Rutgers Catalog.

R512:371 - Contemporary America (3)

For more details go to Rutgers Catalog.

R512:383 - United States Foreign Policy in the Era of the Cold War (3)
For more details go to Rutgers Catalog.

R512:402 - Topics in American Intellectual History (3)
For more details go to Rutgers Catalog.

R512:403 - Topics in American Political History (3)
For more details go to Rutgers Catalog.

R512:404 - Topics in American Business and Economic History (3)
For more details go to Rutgers Catalog.

R512:405 - Topics in the History of Science (3)
For more details go to Rutgers Catalog.

R512:408 - Topics in American Social and Cultural History (3)
For more details go to Rutgers Catalog.

R512:410 - Topics in the History of American Foreign Policy and Diplomacy (3)
For more details go to Rutgers Catalog.

R512:438 - Internship: Administration of Historical Manuscripts (3)
For more details go to Rutgers Catalog.

R512:452 - Topics in Legal History (3)
For more details go to Rutgers Catalog.

R512:462 - Topics in Recent American History (3)
For more details go to Rutgers Catalog.

R512:472 - Topics in Afro-American History (3)
For more details go to Rutgers Catalog.

R512:473 - Topics in Women's History (3)
For more details go to Rutgers Catalog.

R512:499 - Readings in American History (3)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

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 637 - Global Environmental History (3 credits)
This course takes a global view of human interaction with the natural world, mixing broad themes such as colonialism and industrialization with detailed case studies in an effort ot understand the ways that people and the environment have mutually shaped one another. Because environmental change often transcends national boundaries, this course places important subjects in environmental history such as disease, agriculture, pollution, and environmentalism into a global and transnational context.
Effective From: Fall 2010

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 645 - American Legal History to 1860 (3 credits)
Readings and discussion on the legacy of common law after the Revolution; the emergence of legal instrumentalism; and the evolution of tort, contract, and damages in the context of industrialism and economic growth. **Effective From: Fall 2010**

Hist 650 - History of American Conservatism (3 credits)
This course examines postwar American conservatism through classic works and contemporary studies. Topics include the rise of conservatism, groups under the conservative umbrella, and the rise of the right as related to key events in postwar history (Cold War, McCarthysim, the '60s, the suburbs and urban change). Course interrogates postwar conservatism with respect to American political and intellectual history and in relation to histories of gender, race, class, sexuality, place and religion. **Effective From: Fall 2010**

Hist 652 - Topics in the History of Technology (3 credits)
Selected topics in the history of technology. **Effective From: Fall 2010**

Hist 653 - Topics in European Intellectual & Cultural History (3 credits)
Examination of issues and methods in European intellectual and cultural history, with a consideration of some leading problems in the field. **Effective From: Fall 2010**

Hist 654 - Topics in American Intellectual & Cultural History (3 credits)
Examination of issues and methods in American intellectual and cultural history, with a consideration of some leading problems in the field **Effective From: Fall 2010**

Hist 655 - Topics in American Urban and Ethnic History (3 credits)
Examination of issues and methods in American urban and ethnic history, with a consideration of some leading problems in the field. **Effective From: Fall 2010**

Hist 656 - Topics in the History of Health (3 credits)
Selected topics in the history of Health. **Effective From: Fall 2010**

Hist 657 - Topics in Environmental History (3 credits)
Selected topics in environmental history. **Effective From: Fall 2010**

Hist 658 - Topics in American Legal History (3 credits)
Readings and discussion on the growth of legal formalism, the evolution of substantive due process, changes in legal education and the legal profession, and the evolution of private law. **Effective From: Fall 2010**

Hist 660 - The Enlightenment in Britain (3 credits)
The 18th century was the age of the Enlightenment. Great Britain became a unified polity and the most powerful imperial force in the world. We examine the Enlightenment in Britain against the backdrop of war and empire, imperial consumer culture, the growth and significance of sociability and politeness, representations of gender, the writing of cultural history, social uses of science/technology, print culture, and competition among varying notions of ethnic identity. **Effective From: Fall 2010**

Hist 661 - Problems & Readings in European History since 1850 (3 credits)
Introduction to the major historiographical problems and recent literature in European history since 1850. **Effective From: Fall 2010**

Hist 662 - Prob. & Read: Hist/US Foreighn Policy and Diplomacy (3 credits)
Examination of issues and methods in American diplomatic history, with a consideration of some leading problems in the field. **Effective From: Fall 2010**

Hist 663 - Problems & Readings in American History, 1492-1789 (3 credits)
Introduction to the major historiographical problems and recent literature in American history rom 1492 to 1789. **Effective From: Fall 2010**

Hist 664 - Problems and Readings in American History, 1789-1865 (3 credits)
Introduction to the major historiographical problems and recent literature in American history from 1789 to 1865. **Effective From: Fall 2010**

Hist 665 - Problems & Readings in American History, 1865-1914 (3 credits)
Introduction to the major historiographical problems and recent literature in American history from 1865 to 1914. **Effective From: Fall 2010**

Hist 666 - Problems & Readings in American History, 1890-1945 (3 credits)
Introduction to the major historiographical problems and recent literatue in American history from 1890 to 1945. **Effective From: Fall 2010**

Hist 667 - Problems & Readings in American History, 1945-Present (3 credits)
Introduction to the major historiographical problems and recent literature in American history since 1945. **Effective From: Fall 2010**

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 702 - Master's Essay (3 credits)
For those who don't write a 6 credit thesis, the 3 credit Master's Essay caps the M.A./M.A.T. A substantial work done with an advisor, may be: 1. Interpretive historical essay based on primary source research. 2. Narrative history based on primary source research. Prereq: R510:504, R510:505, or R510:506. 3. Historiographical essay. 4. Content-focused curriculum design, either a course or significant portion thereof. 5. Design for an historical museum exhibition/other work in public history. Prereq: R510:565 **Effective From: Fall 2010**

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.

R510:520 - Topics in the History of Technology (3 credits)
For more details go to Rutgers Catalog.

R510:525 - Colloquium in the History of Women (3 credits)
For more details go to Rutgers Catalog.

R510:526 - Problems and Readings in Afro-American History (3 credits)
For more details go to Rutgers Catalog.

R510:547 - Comparative World Colonialism (3 credits)
For more details go to Rutgers Catalog.

R510:548 - Topics in the History of the American Environment (3 credits)
For more details go to Rutgers Catalog.

R510:559 - Cities in Change I (3 credits)
For more details go to Rutgers Catalog.

R510:560 - Cities in Change II (3 credits)
For more details go to Rutgers Catalog.

R510:566 - American Historiography (3 credits)
For more details go to Rutgers Catalog.

R510:569 - American Legal History to 1860 (3 credits)
For more details go to Rutgers Catalog.

R510:570 - Topics in American Legal History (3 credits)
For more details go to Rutgers Catalog.

R510:571 - Introduction to Historical Method (3 credits)
For more details go to Rutgers Catalog.

R510:572 - Philosophy of History (3 credits)
For more details go to Rutgers Catalog.

R510:576 - Problems and Readings in American History, 1492-1789 (3 credits)
For more details go to Rutgers Catalog.

R510:577 - Problems and Readings in American History, 1789-1865 (3 credits)
For more details go to Rutgers Catalog.

R510:581 - Problems and Readings in American History, 1865-1912 (3 credits)
For more details go to Rutgers Catalog.

R510:583 - Problems and Readings in American History, 1912-1945 (3 credits)
For more details go to Rutgers Catalog.

R510:585 - Problems and Readings in American History, 1945 to Present (3 credits)
For more details go to Rutgers Catalog.

R510:618 - Seminar: Teaching of History (3 credits)
For more details go to Rutgers Catalog.

R510:669 - Business and Government in the Twentieth Century I (3 credits)
For more details go to Rutgers Catalog.

R510:670 - Business and Government in the Twentieth Century II (3 credits)
For more details go to Rutgers Catalog.

R510:695 - Individual Studies in History (3 credits)
For more details go to Rutgers Catalog.

R510:696 - Advanced Individual Studies in History (3 credits)
For more details go to Rutgers Catalog.

Human Resource Management : Offered by the School of Management. See Management course list for faculty.

UNDERGRADUATE COURSES:

HRM 301 - Organizational Behavior (3-0-3)
Prerequisite: upper division standing. A foundation course in individual and group behavior in organizations. Processes such as perception, motivation and leadership are examined with a focus on issues central to technology-based organizations (innovation, creativity, managing technical professionals).

HRM 303 - Human Resources Management (3-0-3)
Covers basic human resources concepts including recruitment, selection, EEO, training, labor relations, and human resources information systems. Human resources management practices in technology-based firms are studied in detail.

HRM 305 - Supervision and Employee Relations (3-0-3)
The nature of supervision, particularly at the first line. Qualifications, duties, and responsibilities of supervisors. Planning the job, making work assignments, progressing, and controlling employees. Techniques of employee relations, such as conducting job instruction, maintaining discipline, appraising performance, and handling grievances. The supervisor's interrelationships with upper management and labor union representatives. The conference method and case study techniques are utilized.

HRM 310 - Managing Diversity in Organizations (3-0-3)
Analyzes issues that arise in managing a diverse work force. After examining the demographic environment of contemporary organizations, significant attention is paid to developing strategies to recruit, train, motivate, and retain employees with diverse personal characteristics. While the emphasis is on developing broad-based interpersonal skills, the impact of federal and state laws and regulations is also studied. In addition, students examine the implications of technological developments for managing a diverse population (e.g., the use of new technologies in retaining the differently abled).

HRM 311 - Job and Work Environments (3-0-3)
Prerequisite: HRM 301. The effect of job and work environments on the individual and on the organization. Covers fit between the worker and the workplace including issues such as: the micro environment of job layout and design, physical conditions of the workplace, the social environment of work, and macro environments of the workplace within a regional context.

HRM 407 - Social Insurance and Employee Benefits (3-0-3)
Prerequisites: Econ 265 and Econ 266, or SS 201. The causes of economic insecurity in an urban, industrial society and the personal and social consequences. Social Security, unemployment insurance, workers compensation, public assistance, and other government programs. Private programs of employee benefits. Analysis of trends in coverage, benefits, and benefit levels, and the impact of demographic, economic, and technological developments on the viability of present and proposed programs.

HRM 411 - Employee Training and Development (3-0-3)
Prerequisite: HRM 303. Training and development is studied from the standpoint of employee contributions to gaining competitive advantage, with an emphasis on firms in technology-intensive industries. Topics include needs analysis, skills utilization, design and delivery of training programs, manpower planning, and employee development.

HRM 415 - Organizational Design and Development (3-0-3)
Prerequisite: HRM 301. Focuses on the design of modern organizations with an emphasis on effectively responding to environmental and technological change. Design issues include analyzing organizational structures, understanding the process of organizational learning, and evaluating organizational cultures. Development issues focus on employee empowerment, vertical and horizontal communication in organizations, and self-managed work teams.

HRM 485 - Special Topics in Human Resource Management (3-0-3)
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of

the course. **Effective From: Fall 2009**

GRADUATE COURSES:

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 605 - Managing High Performance Work Teams (3 credits)
Developing and managing high performance is central to fostering the innovation and process improvements that are necessary to respond to competitive pressures. This course covers all aspects of building and managing high performance work teams. Case studies and experimental learning are used to reinforce theory and established best practices.

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)
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. **Effective From: Spring 2011**

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.

Urban Systems: Urban Systems

GRADUATE COURSES:

Usys 702 - Evolution American Metropolis (3-0-3)
This course introduces the morphological and cultural evolution of the US metropolis, historical and economic, political, geographic, contemporary perspectives. The emphasis is on the intersection of social, and environmental conditions that gave rise to distinct urban areas and that have influenced urban populations for over three centuries. A chronological overview of the settlement, growth, decline and revitalization of American cities is combined with detailed case studies. **Effective From: Fall 2011**

Usys 725 - Independent Study I (0-0-3)
Prerequisites: Permission of Track Director. This designation covers courses for Urban Systems students prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Student may not register for this course more than once with the same supervising faculty member. **Effective From: Fall 2011**

Usys 726 - Independent Study II (0-0-3)
Prerequisites: Permission of Track Director. This designation covers courses for Urban Systems students prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Student may not register for this course more than once with the same supervising faculty member. **Effective From: Fall 2011**

Usys 788 - Special Topics in Urban Systems (0-0-3)
Special-area given when suitable interest develops. Advance notice of forthcoming topics in Urban Systems will be given. **Effective From: Fall 2011**

Usys 790B - Dissertation Research (0-0-3)
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester until a written dissertation is approved. **Effective From: Fall 2011**

Usys 790C - Dissertation Research (0-0-6)
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved. **Effective From: Fall 2011**

Usys 790D - Dissertation Research (0-0-9)
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved. **Effective From: Fall 2011**

Usys 790E - Dissertation Research (0-012)
Required of all students for the degree of Doctor of Philosophy. A minimum of 24 credits is required. Approval of dissertation advisor is necessary for registration. Students must register for at least 3 credits of dissertation per semester until 24 credits are reached and then for 3 credits each semester thereafter until a written dissertation is approved. **Effective From: Fall 2011**

Usys 792 - Dissertation Research (0-0-3)
Prerequisites: Permission of Track Director. For students admitted to the Doctor of Philosophy Program in Urban Systems who have not yet passed the qualifying examination. Research is carried out under the supervision of designed Urban Systems faculty. If the student's research activity culminates in doctoral research in the same area, up to a maximum of 6 credits may be applied to the 24 credits required under USYS 790. **Effective From: Fall 2011**

Industrial Engineering: Offered by the Department of Industrial and Manufacturing Engineering

UNDERGRADUATE COURSES:

IE 101 - Introduction to Industrial Engineering (1-1-1)
An Introduction to the field of Industrial Engineering, the functions performed by industrial engineers, career paths and opportunities in the field, introduction to the student and senior professional societies, and initiation of a mentoring program.

IE 203 - Applications of Computer Graphics in Industrial Engineering (1-2-2)
Prerequisites: CIS 101, FED 101C and FED 101D. Areas of graphical communication germane to manufacturing and production are stressed. Provides mathematical and practical knowledge of graphical standards necessary to meet the requirements of today's industrial engineering practices. Introduction to the use of up-to-date software for computer-aided graphics, databases, spreadsheet, general programming, statistical analysis. Also, ProEngineer, Database, Lotus, Fortran/C/ Pascal, and SAS.

IE 224 - Production Process Design (2-2-3)
Prerequisite: sophomore standing. Introduction to the theory and practice of manufacturing processes. Study covers the fabrication of metallic, plastic, and electrical products, operation of NC and other automatic equipment, and economics of the design and production process.

IE 310 - Co-op Work Experience I (zero credits)
Prerequisites: junior standing, approval of co-op faculty advisor, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their aca-demic program. Work assignments facilitated by the co-op office and approved by the co-op faculty advisor. Mandatory participation in seminars and completion of a report.

IE 331 - Applied Statistical Methods (3-0-3)
Prerequisite: Math 211. A presentation of statistical analysis techniques and their applications. Topics include the statistical measures describing data, frequency distributions, probability distributions, sampling parameter estimation, hypothesis testings, regression analyses, and analyses of variance. Special emphasis on their application to industrial fields.

IE 334 - Engineering Economy and Capital Investment (3-0-3)
Prerequisite: junior standing. Introduction to the principles of engineering economics for utilization and evaluation of capital investments, including time value of money, depreciation, cost of capital, life cycle cost, net present value, and payback. Consideration of decisions involving multiple choice replacement, uncertainty, and risk.

IE 335 - Engineering Cost Analysis and Control (3-0-3)
Prerequisite: junior standing. The tools and techniques applicable for cost analysis and control including standard costs, variance analysis, cost volume relationships, cost estimation, and utilization of accounting data for control of operations.

IE 339 - Work Measurement and Standards (2-2-3)
Prerequisites: IE 203, IE 224. Emphasizes the measurement and evaluation of existing work methods and how improvement can be achieved. Topics include visual and micro-motion study techniques, motion economy, time study, and work sampling. The development and use of standard data and computerized techniques. Also, hands-on experience through a series of laboratory experiments.

IE 355 - Human Factors (3-0-3)
Prerequisite: junior standing. Human-machine systems analysis including study of workplace layout, measurement of employee efficiency and productivity, criteria for tool and fixture design or selection, industrial fatigue, environmental influences on performance including the effects of illumination, noise, vibration, thermal, and other atmospheric factors. Basic ideas of industrial hygiene; the impact of OSHA; and special techniques for experimenting with human subjects, via demonstrations and supervised experiments.

IE 411 - Co-op Work Experience II (3 degree credits)
Prerequisites: IE 310, approval of co-op faculty advisor, and permission of the Office of Cooperative Education and Internships. Full-time work experience of approximately one semester's duration. Provides major-related work experience as a co-op/intern. Mandatory participation in seminars and completion of requirements that include a report and an oral presentation to IE faculty. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

IE 436 - Cost Analysis and Engineering Economics (3-0-3)
Prerequisite: junior or senior standing. Not open to industrial engineering majors. Focuses on the economic factors of concern to manufacturing engineers. Major topics include justification of proposed capital expenditures, equipment retirement and replacement decisions, cost determination, profitability studies, and manufacturing budget construction and utilization for cost control.

IE 439 - Deterministic Models in Operations Research (3-0-3)
Prerequisite: Math 222 or equivalent. The deterministic techniques of operations research. Topics include the applications of linear, nonlinear, integer, and dynamic programming methods and network flows analysis to solve industrial and systems engineering problems.

IE 440 - Stochastic Models in Operations Research (3-0-3)
Prerequisites: IE 331, Math 222 or their equivalent. Probabilistic techniques of operations research. Topics include the applications of Markov chains, queueing and inventory control models to analyze and evaluate systems performance.

IE 441 - Information and Knowledge Engineering (3-0-3)
Prerequisite: junior or senior standing. Introduction to recent advances in the application of computers in industrial engineering and database structures, both sequential and random. Description of methods for organizing data, database modeling, information storage and retrieval. Also, applications of expert systems concepts and techniques.

IE 443 - Senior Project I (1-3-2)
Prerequisite: senior standing. Introduction to senior design project. Selection of specific system design for the project, establishment of initial contacts, preliminary collection and analysis of system data. Concepts of system design analysis emphasizing simulation modeling and analysis, model verification, and model validation.

IE 444 - Senior Project II (2-2-3)
Prerequisite: IE 443. Senior design project, in which the concepts of industrial engineering systems, principles, and procedures are integrated and applied in industrial projects or case studies.

IE 445 - Idustrial Simulation (2-2-3)
Prerequisites: CIS 101, IE 331 or equivalent. Introduction to the application of simulation modeling for the analysis of complex industrial and manufacturing service systems. Examples are chosen from real-life situations such as warehousing, material handling, robotics, transportation, and hospital emergency rooms. Verification/validation as well as statistical analysis of both input/output data are introduced.

IE 447 - Legal Aspects of Engineering (3-0-3)
Prerequisite: junior or senior standing. Familiarization with the U.S. system of case law, statutes and regulations applicable to professional relationships involving the engineer. Includes contracts, property, product liability and other torts, governmental regulatory bodies such as OSHA, EPA, and NRC, professional liability, and role of codes and standards.

IE 449 - Industrial Robotics (2-2-3)
Prerequisites: CIS 101, Phys 121, junior or senior standing. Robotics in manufacturing systems. The field of robotics is studied with emphasis given to the role of programmable robots in manufacturing. Hands-on experience with hardware and software necessary for various industrial robot systems through laboratory experience.

IE 450 - Product Engineering Standards (3-0-3)
Prerequisite: senior standing. Developing and using standards in the design, manufacturing, and use of products. Topics include economics of parts standardization, drawing and assembly techniques, and use of national and international standards. Review of the role of standards-setting bodies and methods for the development of product testing standards used in industry and commerce.

IE 451 - Industrial Measuring Systems (2-2-3)
Prerequisite: IE 331. Reviews contemporary measuring systems and provides a basic under-standing of the various methods, their accuracy, reliability, and relative costs to perform. Includes measuring methods needed for compliance evaluation in accordance with occupational and safety legislation, industrial processes, and product design.

IE 453 - Computer Integrated Manufacturing (2-2-3)

Prerequisite: junior or senior standing. Examines the components of computer integrated manufacturing (CIM) including the design of information frameworks and network protocols required to orchestrate full manufacturing automation. Study of CAD, CAPP, robotics, NC, CNC, computer interfacing, and database systems in the context of a CIM environment. Exposure to state-of-the-art CIM software and hardware.

IE 455 - Robotics and Programmable Logic Controllers (2-2-3)
Prerequisites: junior or senior standing. Introduction to the design and implementation of programmable logic controllers for use in industry in the areas of automotive assembly, pharmaceutical manufacturers, the chemical industry, and others. Includes ladder logic, input/output ports, continuous process control, timing and counting functions, chaining sequences, and digital gate logic. **Effective From: Spring 2009**

IE 456 - Introduction to Industrial Hygiene (3-0-3)
Prerequisite: IE 355. Analysis of the effects of various environmental stressors on people at work, including their interference with performance and the development of acute and chronic health problems. Study of how numerous airborne contaminants, noise, thermal extremes, ionizing and nonionizing radiation, etc., affect workers alone and in combination. Topics include measurement and evaluation techniques, TLVs, control methodologies, legal requirements for employers.

IE 459 - Production Planning and Control (3-0-3)
Prerequisites: IE 221, IE 439, junior or senior standing. A study of the components and functioning of integrated production, planning, and control systems. Forecasting, aggregate planning, scheduling, and recent models of production and inventory control for optimizing continuous and intermittent manufacturing operations. MRP basics. Introduction to using a computer to apply scheduling models.

IE 460 - Measuring Techiniques and Quality Control (3-0-3)
Prerequisite: understanding of basic probability. Not open to industrial engineering majors; intended for other engineers, inspection supervisors, and management. Various types of control charts and acceptance sampling systems and procedures. These techniques are used widely in industry to improve product quality and reduce costs.

IE 461 - Product Quality Assurance (3-0-3)
Prerequisite: IE 331. Methods used to achieve higher product quality, to prevent defects, to locate chronic sources of trouble, to measure process capability, and to use inspection data to regulate manufacturing processes are emphasized. Preparation of statistical control charts and selection of suitable sampling plans

IE 463 - Invention and Entrepreneurship (2-1-3)
Prerequisite: Junior or Senior standing or permission of instructor. This course will teach students the process of developing new products. It takes students from the art of creativity through product design and concludes with the formulation of a business plan for marking and production. If the new product satisfies the requirements of novelty, usefulness and nonobviousness, a patent application may be filed. **Effective From: Spring 2010**

IE 466 - Material Handling and Facilities Layout (3-0-3)
Prerequisite: IE 439. Analysis of organized human activities typified by industrial and office operations. Recent methods are applied to optimize location and layout of facilities. Introduction to modern material handling systems, expert systems in plant layout, logistics of motion of people and materials, flow analysis, plant layout, and material handling techniques.

IE 469 - Reliability in Engineering Systems (3-0-3)
Prerequisites: IE 331 or equivalent, senior standing. Emphasizes the determination of systems reliability from a knowledge of characteristics and reliability of individual system components. Topics include reliability concepts, failure rates, systems analysis, optimization, maintenance, etc. Covers techniques for the formulation and evaluation of reliability models.

IE 472 - Product Liability Engineering (3-0-3)
Prerequisite: junior or senior standing. The techniques available to the engineer to minimize the hazards of design and manufacturing that result in product liability cases. The effect of legal precedents on design, manufacturing, advertising, marketing, and using a product within developing technical disciplines such as: reliability prediction and analysis methods, assuring the quality of manufactured products, loss control systems, safety engineering precepts, human factors principles and design review. Review of government regulations for safety and protection.

IE 473 - Safety Engineering (3-0-3)
Prerequisite: junior or senior standing. The principles and practices of safety engineering in product and facilities design. Safe practices and hazard control, safety standards and codes, inspection procedures, the role of insurance, governmental regulations, and safety statistics. Participation in current safety engineering research studies. The Occupational Safety and Health Act and related legislation.

IE 480 - Special Studies in Industrial Engineering for Non-Majors (3-0-3)
Prerequisite: permission of the IE faculty advisor. Not open to industrial engineering majors. Individual investigations under faculty guidance through consultation, readings, and visits with recognized authorities and institutions, dealing with specialized industrial engineering problems. Explore in depth an area of interest and give a report in a seminar setting, and submit a written project report.

IE 481 - Investigations in Industrial Engineering I (3-0-3)
Prerequisites: junior or senior standing, per-mission of the IE faculty advisor. Individual investigation under faculty guidance through consultation, readings, and visits with recognized authorities and institutions, dealing with specialized industrial engineering design problems. Explore in depth an area of interest and give a report in a seminar setting, and submit a written project report.

IE 481H - Investigations in Industrail Engineering I (3-0-3)
Prerequisites: junior or senior standing, permission of the IE faculty advisor, enrolled in Honors College. Same as IE 481, but investigation is in more comprehensive and in greater depth.

IE 482 - Investigations in Industrial Engineering II (3-0-3)
Prerequisites: IE 481, permission of the IE faculty advisor. Further individual investigations, a continuation of IE 481.

IE 482H - Investigations in Industrial Engineering II (3-0-3)
Prerequisites: IE 481, permission of the IE faculty advisor. Further individual investigations, a continuation of IE 481H.

IE 492 - Engineering Management (3-0-3)
Prerequisite: junior or senior standing. An introduction for engineering majors to the fundamentals of engineering economics and the management process for engineering and development. Major topics include capital investment justification methods, project organization, scheduling and control techniques, legal, quality, and staffing issues.

IE 492H - Engineering Management (3-0-3)
Prerequisite: junior or senior standing and enrolled in Honors College. Same as IE 492, but topics are treated more comprehensively and in greater depth.

GRADUATE COURSES:

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 - Facility Maintenance (3 credits)
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 659 - Supply Chain Engineering (3 credits)
Coordination of product manufacturing and logistic activities across the global supply chain is studied. Focus is on supply chain design, implementation, and control. Topics include transportation and distribution networks, inventory control, demand planning, materials handling and warehousing, supply chain contracts, manufacturing flexibility, product design for responsiveness, and ERP systems. Supply chain analytics concepts and relevant case studies are introduced. **Effective From: Fall 2007**

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 662 - Cognitive Engineering (3 credits)
Prerequisite: IE 355 or equivalent. The purpose of this course will be to introduce the application of human factors and cognitive psychology principles to the user interface design of information technology, including computer systems, groupware and communications, handheld devices and Internet applications, and automatic speech recognition interfaces. The course will provide grounding in the engineering design processes used to enhance the usability of products and services, and usability testing methods used by user interface designers. Secondly, major areas and design problems in human-computer interaction and Information Technology will be covered, with real world examples. The course would be appropriate for advanced undergraduates in engineering, computer science, and psychology.

IE 664 - Advanced Ergonomics (3 credits)
Prerequisite: IE 355 or equivalent. The course covers important topics for ergonomics, including functional anatomy of the human body, work physiology and body energy expenditure, and biomechanics for people at work. Commonly used analytical tools for ergonomics will be introduced in the course.

IE 665 - Applied Industrial Ergonomics (3 credits)
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 681 - Interdisciplinary Seminar in Occupational Safety and Health (1 credit)
Prerequisite: OSHE students, or permission of instructor. This is a required course for students who receive the trainee scholarship from the Occupational Safety and Health Engineering Program sponsored by the National Institute for Occupational Safety and Health (NIOSH). Other graduate students are also welcome and encouraged to take the interdisciplinary seminar course. Students and residents in the ERC programs will be able to participate in an interdisciplinary course with students in industrial hygiene, occupational medicine and occupational safety.

IE 682 - Industrial Safety and Health Evaluation (3 credits)
Prerequisite: OSHE students, or permission of instructor. This is a required course for students who receive the trainee scholarship from the Occupational Safety and Health Engineering Program sponsored by the National Institute for Occupational Safety and Health (NIOSH). Other graduate students are also welcome and encouraged to take this site visit course. Upon completion of this course, students will be able to plan and conduct a walk-through evaluation of health and safety hazards in a workplace. Students will also understand the role of occupational health and safety disciplines in the recognition and prevention of occupational injury and illness.

IE 685 - Systems Safety (3 credits)
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. **Effective From: Fall 2005**

Infrastructure Planning: Offered by the School of Architecture

GRADUATE COURSES:

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.

Information Systems: Information Systems

UNDERGRADUATE COURSES:

IS 117 - Introduction to Website Development (3-0-3)
This course discusses the concepts and skills required to plan, design and build websites. It will be taught in a lab to ensure hands-on experience with each of these tasks. The course begins with an overview of web technologies. Students learn to plan websites, which includes determining the business and end-user requirements for the site. Design includes learning to develop "mockups" of how the site will look and how people will use it. The major tools for building websites will be industry standard HTML and XHTML to describe webpage content, and Cascading Style Sheets (CSS) for flexibly formatting the content. Using entire site, as well as "future-proofs" a website, allowing it to be viewed on every major web browser (such as Firefox or Chrome) and easily adapt to changes in future browser technology. The course features substantial hands-on projects comprising websites of several interlinked pages and images, enabling students to thoroughly learn the course's important concepts and skills. **Effective From: Spring 2012**

IS 118 - Introduction to Software Application Tools (3-0-3)
This hands-on taught in a computer lab, introduces the general area of application development, including web and other software applications. This course will teach you about these tools through the use of the development of several applications. During this process you will learn about the general software development process, including the software development life cycle (SDLC), which covers gathering requirements, designing the application, application testing and implementation. **Effective From: Fall 2011**

IS 127 - Introduction to Web Systems Design (3-0-0)
This course provides a critical, hands-on introduction to Web-based Information Systems and Web systems design. Students will research and discuss emerging trends, capabilities, and limitations of web technologies used to capture, store, access, and disseminate information for both businesses and online communities. Students will design and develop different types of websites and web applications which will then be analyzed as to their usability in real public and private settings. **Effective From: Fall 2008 Until: Summer 2009**

IS 217 - Advanced Website Development (3-0-3)
Pre-requisites: IS 117 or equivalent. This course discusses the concepts and skills required to plan, design and build advanced websites, with a focus on sophisticated user interaction enabled by programming the web browser (such as Internet Explorer or Chrome). Such programming is known as client-side scripting. These interactive websites utilize forms to gather user inputs, and vary both the content and display of the webpages based on the current user tasks and preferences. This includes designing and dynamically changing tabs and menus, as well as expanding and contracting sections of pages. Students will develop a thorough understanding of website usability (designing effective sites that people like, security and user privacy, browser capability (ensuring websites work on every major web browser), and the tools and skills that web developers use to add interactive features to websites. These skills include Javascript (for programming interactive features), the Document Object Model or DOM (specifying the internal structure of web pages), JQuery (to access information utilizing this internal structure, create animations and generally streamline Javascript), browser variables (providing information about the browser characteristics), HTML input forms, form validation (ensuring correctness of user input), securing user input (to ensure user privacy), cookies (tracking user information), basic communication with the web server (which processes the information users input into forms), and AJAX (which integrates many of these technologies). The course will be taught in a lab to ensure hands-on experience and will include substantial design and development projects. **Effective From: Spring 2012**

IS 218 - Building Web Applications (3-0-3)
Prerequisites: CS 113 or 115, or other computing GUR. This course provides a critical, hands-on introduction to the design of Web-based Information Systems. We will explore and discuss emerging trends, capabilities, and limitations of web technologies used to capture, store, access, and disseminate information for both businesses and online communities. Students, working in groups, will design and develop different types of web applications, which will then be analyzed and critiqued by the students as to their usability in actual public and private settings. An open-source web content management system will be utilized throughout the course. **Effective From: Spring 2012**

IS 245 - Information Technology Systems: Hardware/Software (3-0-3)
This course reviews hardware/software technologies in order to enable system developers to understand tradeoffs in the design of computer architectures for effective computer systems. Also covered are operating systems and systems architecture for networked computing systems. Topics include Hardware (CPU architecture, memory, registers, addressing modes, busses, instruction sets, multi processors versus single processors, and peripheral devices), Operating systems (processes, process management, memory and file system management), and Telecommunications (basic network components, switches, multiplexers and media, installation and configuration of multi-user operating systems). **Effective From: Fall 2006**

IS 247 - Designing the User Experience (3-0-3)
This course covers the design and evaluation of the human-computer interface in interactive computer systems. Among the topics covered are approaches to interface design such as menus, commands, direct manipulation; screen layout strategies; metaphor models; models of human information processes; evaluation approaches such as protocol for analysis, interactive monitoring, use of surveys; and requirements for documentation and help. Students are expected to design interface mockups and evaluate them. **Effective From: Spring 2012**

IS 265 - Introduction to Information Systems (3-0-3)
Information systems is the study of how organizations use information technology. This course is an overview of the information systems discipline, the role of information systems in organizations, and the changing nature of information technology. Computer tools for analysis and presentation are used. **Effective From: Spring 2012**

IS 270 - Designing the Multimedia Experience (3-0-3)
Prerequisite: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. Multimedia combines text, graphics, sound, video, and animation in a single application. Preparation for creating multimedia information systems, and understanding the crucial issues involving technology, design and effectiveness of multimedia applications. Programming techniques for integrating video, sound, animation, and graphics, and design strategies for multimedia information systems. **Effective From: Fall 2010**

IS 305 - Community Service Internship (0-2-1)
Prerequisite: IS 350. Increasingly, computer professionals are recognizing their ethical responsibility to provide advice and assistance that will improve the ability of government and social service agencies to use computers to serve the public. This course involves approximately 40 hours of internship in a community agency, arranged through the NJIT Cares Program. The interns will use their skills to improve the effectiveness of the use of computers at the agency. Bi-weekly progress reports will be submitted, with required meetings with the course supervisor, and a final report. **Effective From: Fall 2006**

IS 310 - Co-op Work Experience I (3)
Prerequisites: completion of the sophomore year, approval of the department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

IS 322 - Mobile Applications: Design, Interface, Implementation (3-0-3)
Prerequisites: CS 113 or CS 115 or equivalent. This course is a practical introduction to building applications for mobile devices. The course combines hands on design and development experience, with a conceptual overview and discussion of design and practical development issues. Taken into account will be constraints and requirements of devices with small screen sizes, limited battery power, limited computational power, etc. Tools used for building an application in the context of a specific device such as iPhone or an Android based device will be discussed. Students build a mobile application to demonstrate their understanding of mobile web constraints and tools. **Effective From: Spring 2012**

IS 331 - Database Design Management and Applications (3-0-3)
Prerequisite: completion of 100 level courses in the computing: CS 101 or CS 111 or CS 113 or CS 115 or IS 118 or BNFO 135. Businesses use databases extensively for analysis and decision-making because they provide efficient, large-scale information storage and rapid retrieval. Databases support the "back end functionality" of most large web systems. This course gives students extensive, pragmatic experience in designing, building, querying, updating, maintaining and managing relational databases, using the Structured Query Language (SQL). Proper database design principles are emphasized throughout the course, beginning with high level descriptions of relational databases using data modeling tools(such as entity-relationship or ER diagrams)and progressing to relational database design principles based on higher order normalizations. We will examine some poorly designed and show how theses can be transformed into well designed databases. SQL will be extensively covered, and students will design implement sophisticated SQL queries invoking self-joins, outer joins, correlated subqueries and related concepts. Students will explore and utilize design methodologies for input data validation and maintaining database integrity, and study issues of database privacy and security. Advanced topics to be discussed include the role of the Database Administrator (DBA), database life cycle activities, database denormalization, read-only database and data warehouses. Hands-on experience will be gained by with actual database using industry-standard database management systems such as Oracle. **Effective From: Spring 2011**

IS 333 - Social Networking: Application and Interface Design (3-0-3)
Prerequisite: Completion of computing GUR, such as, IS 118, CS 101, CS 113, CS 115 or BNFO 135. In this intensely hands-on course, you will analyze existing social networking sites (Facebook, MySpace, LinkedIn, LISTSERV, etc.) in terms of usage and security implications, and identify design considerations for new application use. Working in teams, you will design and execute an implementation plan for add-on applications to an existing social networking site, manage the security settings and other aspects of these applications. This involves combining existing reusable components and developing the interface to these from the social networking sites. The team project will design solutions for an existing organization. **Effective From: Spring 2011**

IS 335 - Introduction to .NET Framework (3-0-3)
This course introduces students to .NET Framework, a new computational environment that supports more than 25 programming languages and is platform and device independent. Problem solving and system development topics are integrated into the course by using C# languages as a vehicle to illustrate the concepts. **Effective From: Spring 2007 Until: Spring 2012** **(Archived Versions)**

IS 344 - Computing Applications in Business (3-0-3)
Prerequisites: Acct 115 or Acct 117, and either CS 100, CS 113 or CS 115 or Department permission. A comprehensive overview of the various types of computing applications used by businesses in order to run effectively and efficiently. All the major functional departments within organizations are examined and evaluated to see how applications are integrated to implement "business processes" that flow across department boundaries, and from suppliers to customers. The modeling of business situations and the design of applicable software solutions. A full-semester hands-on student project will provide experience in designing solutions to changes in the business environment. **Effective From: Spring 2011**

IS 347 - Designing the User Experience (3-0-3)
Prerequisite: None. This course covers the design and evaluation of the human-computer interface in interactive computer systems. Among the topics covered are approaches to interface design such as menus, commands, direct manipulation; screen layout strategies; metaphor models; models of human information processes; evaluation approaches such as protocol for analysis, interactive monitoring, use of surveys; and requirements for documentation and help. Students are expected to design interface mockups and evaluate them. **Effective From: Spring 2011 Until: Fall 2011**

IS 350 - Computers, Society and Ethics (3-0-3)
Prerequisites: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118 and one basic SS course, and HUM 101. Examines the historical evolution of computer and information systems and explores their implications in the home, business, government, medicine and education. Topics include automation and job impact, privacy, and legal and ethical issues. Co-listed as STS 350.

IS 365 - Computer Applications to Commercial Problems (3-0-3)
Prerequisite: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. Covers design and implementation of commercial application software systems. Concepts of organization and management of data and files including file operations and organization of sequential access, relative access, indexed sequential access, virtual storage access and multi-key access methods. The COBOL language is used to illustrate these concepts and to implement application systems. The design and implementation of commercially oriented computer systems. Emphasis is placed on modern computers as a tool for solving business problems. The COBOL programming language will be extensively studied and utilized in developing the programming techniques for the solution of these problems. **Effective From: Fall 2006 Until: Fall 2011**

IS 373 - Web Standards (3-0-3)
Prerequisites: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. This course covers the standards that are emerging for formatting, accessing, displaying, transmitting and structuring information, including the standards and protocols existing and under development today. Topics include: Standards, Rationale, Pros and Cons, the Standards Process; Standards Bodies & Participating on Standards Bodies; How Companies Influence Standards; How Developers Incorporate Standards in their Programs; Planning for Emerging Standards; Company Policies Regarding Web Standards; Standards and Legal Issues. **Effective From: Fall 2010**

IS 375 - Evaluating the User Experience (3-0-3)
Prerequisites: Math 105, Math 333 or another course in statistics or social science research methods. Methods for identifying usability problems and for testing the relative merits of alternative designs for interactive systems. Following a review of usability heuristics, students read journal articles about and practice five different methods: semi-structured interviews, protocol analysis, cognitive walkthroughs, user surveys, and controlled experiments. **Effective From: Spring 2011**

IS 385 - Special Topics in IS (3-0-3)
The study of new and/or advanced topics in an area of information systems and the computing sciences not regularly covered in any other IS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester

prior to the offering of the course. **Effective From: Fall 2011**

IS 390 - Requirements Analysis and Systems Design (3-0-3)
Prerequisite: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. A study of the information systems development life-cycle, from the initial stages of information requirements analysis and determination to the ultimate activities involving systems design. Theory, methodologies and strategies for information requirements analysis, including the assessment of transactions and decisions, fact-finding methodologies, structured analysis development tools, strategies of prototype development, and an overview of computer-aided software engineering (CASE) tools. Theory, methodologies and strategies for systems design, including design of user-interfaces, particularly menu-driven and keyword dialogue strategies, and issues in the proper design of computer output. **Effective From: Fall 2006**

IS 392 - Web Mining and Information Retrieval (3-0-3)
Prerequisites: Completion of 100 level course in computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. This course introduces the design, implementation and evaluation of search engines and web mining applications. Topics include: automatic indexing, natural language processing, retrieval algorithms, web page classification and clustering, information extraction, summarization, search engine optimization, and web analytics. Students will gain hands-on experience applying theories in case studies. **Effective From: Spring 2010**

IS 405 - Internship in Community Service (1-0-1)
Prerequisite: IS 305 or its equivalent, approval of the department, and permission of the Office of Service Learning and Career Development Services. This course involves approximately 40 hours of internship in a community agency, arranged through the NJIT Cares Program. The interns will use their skills to improve the effectiveness of the use of computers at the agency. Bi-weekly progress reports will be submitted, with required meetings with the course supervisor, and a final report. **Effective From: Fall 2006**

IS 410 - Co-op Work Experience II (3 additive credits)
Prerequisites: IS 310 or its equivalent, approval of the department, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

IS 413 - Requirements for Emergency Management Information Systems (3)
Requirements analysis, interface design, and supporting functionality of information systems related to the complete preparedness lifecycle for emergency, disaster, and crisis situations for government bodies and/or private organizations. Components of the lifecycle-planning, mitigation, training, alerting, response, recovery, and assessment, are studied. Human and organizational behavior in this environment and how it influences system functionality and design of the user interface. Integration and coordination issues across the phases of the process. **Effective From: Fall 2006**

IS 421 - Advanced Web Applications (3-0-3)
Prerequisite: IS 118 or IT 202, or instructor permission. This course introduces the next generation of web application platform and web applications - Web 2.0 and Rich Internet Applications (RIAs). The course covers key attributes of RIA development, defines Service Oriented Architecture (SOA) and introduces different application development platform, design and development tools and languages supporting development and deployment of RIAs. The in-depth study of Microsoft.NET Framework and Silverlight will provide hands-on experience to develop and deploy RIAs. **Effective From: Spring 2012**

IS 431 - Database Design, Management and Applications (3-0-3)
Prerequisite: completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118. Database system components; data modeling using the Entity-Relationship model, Semantic Object model, UML and other data models; Relational Database Management Systems-functionality and design concepts and applications; querying a database; Structured Query Language; functional dependencies and higher order normalization for relational database design; relation decomposition; overview of concurrency control and transaction management; database application design and management issues. Student projects involve the use of DBMS packages, including Oracle and Microsoft Access. **Effective From: Fall 2006 Until: Fall 2010**

IS 433 - Electronic Commerce Requirements and Design (3-0-3)
Prerequisites: IS 431 or CS 431 and IS 390 or CS 490. Introduces critical concepts emerging in the field of electronic commerce, such as business to consumer (B2C), business to business (B2B), supply chain management (SCM) systems, and peer to peer (P2P). The course provides concepts and practical skills for building effective, usable, and secure electronic commerce systems, offering a conceptual framework for the study of electronic commerce, as well as hands-on skills for building systems for electronic commerce. **Effective From: Fall 2006 Until: Fall 2011**

IS 441 - Geographic Information Systems (3-0-3)

Prerequisite: IS 431 or CS 431. Geographic Information Systems (GIS) allow individuals and organizations to pose, explore and answer a variety of public- and private-sector questions using spatial data. In this course the student will learn to identify, manipulate and analyze spatial data using state-of-the-art software. The course is project-driven and hands-on: students will define and address real problems using real data. The course will also cover selected topics in information visualization as they relate to the use of GIS. **Effective From: Fall 2006 Until: Fall 2011**

IS 447 - Designing the User Experience (3-0-3)
Prerequisite: IS 390. This course covers the design and evaluation of the human-computer interface in interactive computer systems. Among the topics covered are approaches to interface design such as menus, commands, direct manipulation; screen layout strategies; metaphor models; models of human information processes; evaluation approaches such as protocol for analysis, interactive monitoring, use of surveys; and requirements for documentation and help. Students are expected to design interface mockups and evaluate them. **Effective From: Spring 2010 Until: Fall 2010**

IS 448 - Design Studio for Ubiquitous Computing (3-0-3)
Handheld devices, mobile and wireless technologies, 'smart spaces', wearables and other technologies are creating a ubiquitous computing environment that is moving application development off the desktop. This course explores recent developments in both the technical and Human Computer Interaction (HCI) side of ubiquitous computing. To put into practice what is being learned, the class will use scenario based usability engineering techniques to design various aspects of a ubiquitous computing application to be deployed at NJIT. **Effective From: Summer 2010**

IS 455 - Information Systems Management (3-0-3)
Prerequisite: Completion of 100 level course in the computing sciences: CS 101 or CS 111 or CS 113 or CS 115 or IS 118 or BNFO 135. The information systems function in an organization has a broad responsibility to plan, develop or acquire, implement, and manage an infrastructure of information technology, data, and enterprise-wide information processing systems. This course will emphasize how information systems enable core and supportive business processes, as well as those that interface with suppliers, partners and customers. It will discuss basic administrative, management, and policy issues associated with the impact of information systems on the user and organization. Topics include the strategic uses of IS, enterprise computing architecture and infrastructure, software development management, organizational change, outsourcing, governance, risk management, and performance measurement. **Effective From: Spring 2011**

IS 461 - Systems Simulation (3-0-3)
Prerequisites: completion of a 100-level GUR course in computing; Math 333. This course introduces computer simulation as an algorithmic problem solving technique. Includes discrete simulation models, elementary theory, stochastic processes, use of simulation languages, random number generators, simulation of probabilistic processes, design of simulation experiments, validation of models, queueing systems, and applications to the design and analysis of operational systems. The GPSS language is covered in detail. **Effective From: Fall 2006**

IS 465 - Advanced Information Systems (3-0-3)
Prerequisites: IS 265, and either (IS 331 or CS 431) and either (Math 105 or Math 333). Design and programming concepts are presented for automation of management information systems. Includes the organization of files and techniques for processing information based upon organizational requirements and available hardware and software. Some case studies are presented. **Effective From: Fall 2011**

IS 475 - Evaluating the User Experience (3-0-3)
Prerequisite: a course in probability and statistics, or social science research methods. Methods for identifying usability problems and for testing the relative merits of alternative designs for interactive systems. Following a review of usability heuristics, students read journal articles about and practice five different methods: semi-structured interviews, protocol analysis, cognitive walkthroughs, user surveys, and controlled experiments. **Effective From: Fall 2006 Until: Fall 2010**

IS 485 - Special Topics in Information Systems (3-0-3)
Prerequisites: junior standing and/or department approval. The study of new and/or advanced topics in an area of IS not regularly covered in any other IS course. The precise topics to be covered in the course, along with prerequisites, will be announced in the semester prior to the offering of the course. A student may register for no more than two semesters of Special Topics. **Effective From: Fall 2006**

IS 486 - Topics in Information Systems (3-0-3)
Prerequisites: Same as for IS 485. A continuation of IS 485. **Effective From: Fall 2006**

IS 488 - Independent Study in Information Systems (3-0-3)
Prerequisites: open only to students in the Honors Program who are IS majors and who have the prior approval of the department and the IS faculty member who will guide the independent study. Independent studies, investigations, research, and reports on advanced topics in IS. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in

this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the department and the faculty mentor. A student may register for no more than one semester of Independent Study. **Effective From: Fall 2006**

IS 491 - Senior Project (3-0-3)
Prerequisites: IS 331, IS 431, or CS 431, and senior standing. Integration of knowledge and skills gained in previous information systems courses into an individual research project. The project entails investigation of current literature and the design, implementation and evaluation of an information system. **Effective From: Spring 2011**

IS 491H - Honors Senior Project (3-0-3)
Prerequisites: IS 465 and senior standing in the Honors College. A course similar to IS 491, with a project of greater depth and scope. **Effective From: Fall 2006**

GRADUATE COURSES:

IS 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. **Effective From: Fall 2006 Until: Fall 2008**

IS 565 - Aspects of Information Systems (3 credits)
Co-requisite: CS 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. **Effective From: Fall 2006 Until: Fall 2008**

IS 590 - Graduate Co-op Work Experience I (3 additive credits)
Prerequisite: students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of each semester's work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS. **Effective From: Fall 2006**

IS 591 - Graduate Co-op Work Experience II (3 additive credits)
Prerequisite: students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS. **Effective From: Fall 2006**

IS 592 - Graduate Co-op Work Experience III (3 additive credits)
Prerequisites: graduate standing, and acceptance by the IS department and the Division of Career Development Services. Students must have the approval of the co-op advisor for the IS department. Provides on-the-job reinforcement and application of concepts presented in the graduate IS curriculum. Work assignments are identified by the co-op office and developed and approved by the IS department in conjunction with the student and employer. Students must submit, for IS department approval, a proposal detailing the nature of the intended work. A report at the conclusion of the semester work experience is required. Credits for this course may not be applied toward degree requirements for either the bachelor's or master's in IS. **Effective From: Fall 2006**

IS 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

IS 612 - Emergency Management Informatics (3 credits)
This course covers core aspects of Emergency Management (EM) as they relate to information systems and usage of associated

technologies. EM theory identifies four critical areas: 1) understanding & mitigating risk, 2) planning & preparedness, 3) reaction & response, 4) recovery & normalization. The role of informatics for each critical area will vary and is the basis for discussions and assignments. This course also focuses on innovative information systems approaches to EM in each area. Within the EM domain, business continuity (information processing and sharing during crisis situations), cyberterrorism, and international response are covered. **Effective From: Spring 2011**

IS 613 - Design of Emergency Management Information Systems (3 credits)
This course is concerned with the development of requirements, the design of the human interaction, and the supporting functionality of any Information System related to the complete preparedness lifecycle for emergency, disaster, and crisis situations for government bodies, non-profit, and/or private organizations that are concerned with business continuity. It also focuses on organizational behavior and its effects on the functionality of the system and the design of the human interface. **Effective From: Fall 2006**

IS 614 - Command and Control Systems (3 credits)
This course investigates the relevance and applicability of using of Command and Control (C2) models in organizational responses to both normal emergencies and catastrophic events. C2 refers to how leadership, authority, decision-making and coordination are assured within an organization, including distributed and virtual organizations. The course examines the functionality and properties of C2 systems in terms of matching requirements for these systems to the behavior of individuals, groups, and organizations during emergency conditions. It will address integrating systems and technologies within organizational emergency operations functions and processes to include business continuity and disaster response. **Effective From: Summer 2010**

IS 615 - Improvisation in Emergency Management (3 credits)
This course explores the continuum between planned and improvised behavior in emergency management. It introduces tools and techniques useful for understanding and supporting decision-making in emergencies, and enables learners to apply them in simulated emergency response scenarios. The focus is on decision making under time pressure, the influence of cognitive, policy and organizational factors, and the design and use of technologies to support planned and improvised decision making. **Effective From: Fall 2006 Until: Fall 2011**

IS 616 - Learning Methodologies and Training Technologies (3 credits)
This course provides an overview of learning methodologies and training technologies, with an emphasis on emergency management. It reviews theories and develops skills for the planning, evaluation and selection of traditional and new technology-driven learning and training methods. Course participants will review relevant research and learn how to choose the most effective training methodologies, technologies and content resources appropriate to the needs of different audiences. **Effective From: Fall 2007**

IS 617 - Social Dimensions of Risk (3 credits)
Low-probability/high consequence events involving terrorism, food safety, and extreme weather offer ample evidence the prevalent approaches of economics and statistics are not able to deal with the complex ways that risk permeates modern societies. This course treats risk analysis as a broad interdisciplinary activity and draws on the full range of the social sciences to explore the multifaceted way that risk infuses itself into the fabric of contemporary affairs. **Effective From: Spring 2007 Until: Fall 2008**

IS 623 - Qualitative Research on Information Systems (3 credits)
Prerequisites: IS 350 (or equivalent covering basics of research in IS) or IS 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. **Effective From: Fall 2006 Until: Fall 2011**

IS 631 - Enterprise Database Management (3 credits)
Prerequisites: Undergraduate course in database or design and management, or permission of instructor. This course provides an understanding of the issues as well as hands-on experience in managing database systems as an essential organizational resource. Students will obtain a conceptual foundation of database design and explore the implications for organizational database usage. Students also will gain experience with enterprise database management systems, such as Oracle. This course introduces the design and management of enterprise-wide database systems. Topics include: (1) data modeling and database design; (2) database implementation with SQL; (3) database access standards for enterprise database systems; (4) multidimensional databases, online analytic processing (OLAP) and data warehousing, customer relationship management (CRM); and (5) web-based enterprise database systems. **Effective From: Fall 2011**

IS 634 - Information Retrieval (3 credits)
Prerequisites: IS 631 or CS 631; working knowledge of an object-oriented programming language. Modern information retrieval systems, such as web search engines, empower users to easily access information on the web. The course covers the concepts and principles of information retrieval systems design, including web crawling, automatic indexing, vector space modeling, retrieval algorithms, digital libraries, text mining, information extraction, and document warehousing. These techniques are essential for

building web systems, text databases, document processing systems, and other advanced information management systems. **Effective From: Fall 2006**

IS 658 - Multimedia Systems (3 credits)
Prerequisite: CS 601 or CS 602 or experience in an object-oriented programming language. 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. Students will also develop familiarity with one multimedia authoring package. **Effective From: Summer 2010**

IS 663 - System Analysis and Design (3 credits)
This course develops the skills necessary to analyze, design and manage the development of effective enterprise-scale information systems solutions incorporating contemporary methods and effective organizational and global project management practices. It focuses on technical business systems analysis and design techniques, and covers key software engineering principles, methods and frameworks, including process models, agile and lean principles, project and risk management, estimation, requirements elicitation and analysis, modeling, system and software architecture, design patterns, and quality systems. Students will actively participate in discussions, review selected articles, participate in team exercises and collaborate on projects involving analysis and prototyping of applications addressing real-world problems and integrating current and emerging technologies. **Effective From: Summer 2010**

IS 675 - Information System Evaluation (3 credits)
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. **Effective From: Fall 2006 Until: Fall 2008**

IS 676 - Requirements Engineering (3 credits)
Corequisites: IS 663 or CS 673 or equivalent project experience in the field. Requirements engineering is one of the all-important beginning stages of the systems development life cycle. Revealing and understanding the system's requirements is a crucial component of success for developing new computing systems or adjusting existing applications. This course covers the theory, principles, and practical application of the methodologies and tools for requirements engineering. The focus is development of large software systems and the integration of multiple systems into a comprehensive, domain dependent solution. All aspects of requirements engineering including the knowledge and skills needed to elicit and analyze requirements, translate these requirements into technical specifications, verify that the requirements accurately capture the system requirements, and manage software requirements through the system development cycle will be covered. Students will actively participate in discussions, labs and exercises, and prepare operational requirements and technical specifications for real-world problems. We will spend a considerable amount of time interacting and learning through discussion of assigned readings and other material. **Effective From: Summer 2010**

IS 677 - Information System Principles (3 credits)
This course introduces the field of Information Systems; the study of how people and organizations should use information technologies effectively. We examine the major areas in the field, analyzing the major issues, trends and problems. We survey the role of information systems in organizations and how these systems support organizational objectives and organizational structure, as well as providing competitive business advantages. We discuss basic concepts such as the systems point of view, the organization of a system, the nature of information and information flows, as well as how people process information and related cognitive concepts. We also examine various types of information system applications such as e-commerce, supply chain, decision support, and enterprise systems. And, finally, we also consider critical ethics issues including privacy, personalization and security. **Effective From: Summer 2010**

IS 678 - IT Service Management (3 credits)
Prerequisites: Prior coursework or industry experience in Information Systems, or permission of instructor, otherwise we do not recommend taking IS 678 in the first semester. This course introduces the Information Technology Infrastructure Library (ITIL) fundamentals of the service management life cycle-service strategy, service design, service transition, service operation, and continual service improvement. ITIL provides a comprehensive, consistent, and coherent framework of best practices for IT Service Management (ITSM), which promotes a quality approach for achieving business effectiveness and efficiency in the use of information systems. This course presents the basic terminology and an overview of the functions and processes for each of the life cycle phases as they apply to IT Management. Although ITIL is originally presented as an approach for designing IT processes, we can expand this view and apply it to the design of other business services. Possible semester-long contexts are

the processes of an educational services provider or health care services provider. **Effective From: Spring 2013**

IS 679 - Information Systems Strategy (3 credits)
Prerequisites: IS 677 or MIS 645. This course explores issues and approaches in managing information systems in organizations and how they integrate, support, and enable various types of organizational capabilities. It takes a management perspective in exploring the acquisition, development and implementation of efficient and effective information systems. The course also addresses issues relating to defining a high-level technology infrastructure and the systems that support the operational, administrative and strategic needs of the organization. The course is focused on developing an intellectual framework that will allow leaders of organizations to critically assess existing infrastructures and emerging technologies as well as how these enabling technologies might affect organizational strategy. The ideas developed and cultivated in this course are intended to provide an enduring perspective that can help leaders make sense of an increasingly global and technology intensive business environment. **Effective From: Summer 2010**

IS 680 - Information Systems Auditing (3 credits)
Due to the dynamic nature of information technology, the need arises continually to redefine audit, control and security requirements and processes. Topics include the IS audit process, IT infrastructure and operations, information protection, disaster recovery and business continuity, IT service delivery and support, business application systems, and project management. Students gain practical experience with each by working through a series of sample Certified Information Systems Audit (CISA) exam questions. **Effective From: Summer 2010**

IS 681 - Computer Security Auditing (3 credits)
This course reflects the current emphasis on information security and security management in Fortune 500 corporations. Students will delve into information protection concepts, privacy impact analysis, computer crime, legal issues, controls and auditing systems, and firewall configuration. Students will have the opportunity to learn and perform evaluations on security infrastructures in a controlled environment in class labs by completing realistic security auditing projects and using vulnerability assessment tools to assess risks and evaluate security controls on networked infrastructures. **Effective From: Summer 2010**

IS 682 - Forensic Auditing for Computing Security (3 credits)
A computer forensics audit is the proper identification and collection of computer evidence. Computers are involved in security violations through crime or violations of policy, or being targeted by an attack. This course deals with the preservation, identification, extraction, documentation, reporting, acquisition, analysis and interpretation of computer data. Topics covered include evidence handling, chain of custody, collection, preservation, identification and recovery of computer data. In this hands-on course, you will conduct several labs where you will be taught to analyze, review and extract information from computer hard drives, and determine what and how the information could have been compromised. Computer Forensics Audit professionals become experts in e-discovery and preserving sensitive evidential matter. **Effective From: Summer 2010**

IS 683 - Web Systems Web Development (3 credits)
Students will gain experience in open source web development through an intensive hands-on project, applying real-world problem-solving skills to meeting information systems requirements. Students will learn Web development principles, as well as professionally relevant skills including industry standards, conventions, and procedures within large-scale programming projects. Also covered are the communication tools, technologies, and practices that individuals use to coordinate and collaborate within the open source software development community. **Effective From: Spring 2013**

IS 684 - Business Process Innovation (3 credits)
Prerequisites: Prior coursework or industry experience in Information Systems, or permission of instructor, otherwise we do not recommend taking IS 684 in the first semester. This course adopts a balanced approach to business process innovation (BPI) that includes both incremental improvement and re-engineering. It specifically examines the concept of a service-oriented architecture (SOA) and the use of web services as a way to enable scalable and adaptive business processes. Students will learn how to develop process maps using the Business Process Modeling Notation (BPMN) and design process improvements to achieve efficiency, effectiveness, compliance and agility objectives. The focus of the course is on ways in which information technology can be used to manage, transform and improve business processes. **Effective From: Spring 2013**

IS 685 - Enterprise Architecture and Integration (3 credits)
Prerequisites: None, but recommend completion of IS 663 or CS 673. The Enterprise Architecture (EA) describes an organization's IT strategy and operational structure. IS and IT professionals utilize the EA to analyze, design and integrate the (often heterogeneous) IT infrastructure and applications to most effectively support the enterprise and respond to risks. Students learn to develop an EA analysis which reflects its business strategies, capabilities, processes, and systems, metrics, information resources, and networking infrastructure. This enables students to determine the impact of IT solutions, by learning to deconstruct, analyze and configure IT systems in alignment with enterprise-wide business strategies. The course covers the industry standard The Open Group Architecture Framework (TOGAF) enterprise architecture framework and focuses on Enterprise Application Integration (EAI). **Effective From: Summer 2009**

IS 686 - Pervasive Computing: An HCI Perspective (3 credits)
This course examines Pervasive/Ubiquitous Computing, the trend toward increasingly ubiquitous connected computing devices in the environment - a trend being brought about by a convergence of advanced electronic, and particularly, wireless technologies and the internet. We do this from a Human Computer Interaction perspective looking at the current and future design of various systems. **Effective From: Fall 2006**

IS 687 - Transaction Mining and Fraud Detection (3 credits)
Pre-requisite: An undergraduate course in probability and statistics. Increasingly, all of our transactions are electronic. We use debit and credit cards (electronic transactions) instead of checks and cash at banks, restaurants, stores, and many other businesses. Evaluation of transactions to find risk includes detection of terrorists and money launderers. Every financial institution is legally required to monitor transactions to detect organized crime and terrorism. Mining transaction streams to find good or bad customers in a rapidly growing area of employment for IS graduates. This course will present methods that are being used to analyze and mine transactional data and the business applications of these methods. **Effective From: Summer 2010**

IS 688 - Web Mining (3 credits)
Web mining aims to discover useful information and knowledge from the Web hyperlink structure, page contents and usage logs. It has direct applications in e-commerce, Web analytics, information retrieval/filtering, personalization, and recommender systems. Employees knowledgeable about Web mining techniques and their applications are highly sought by major Web companies such as Google, Amazon, Yahoo, MSN and others who need to understand user behavior and utilize discovered patterns from terabytes of user profile data to design more intelligent applications. The primary focus of this course is on Web usage mining and its applications to business intelligence and biomedical domains. We learn techniques from machine learning, data mining, text mining, and databases to extract useful knowledge from the Web and other unstructured/semistructured, hypertextual, distributed information repositories. This data could be used for site management, automatic personalization, recommendation, and user profiling. Topics covered include crawling, indexing, ranking and filtering algorithms using text and link analysis, applications to search, classification, tracking, monitoring, and Web intelligence. Programming assignments give hands-on experience. A group project highlights class topics. **Effective From: Fall 2009**

IS 690 - Web Services and Middleware (3 credits)
Web services enable integration of web-based applications and feature sets to any other web-based system in a modular way. Middleware is a set of functionality positioned in between and enabling interoperability among different, distributed enterprise and other computing applications. This course provides an introduction to web services and middleware in the context of digital libraries - large scale multimedia information repositories. Students will gain hands on experience in developing their own web services managing a complex distributed computing platform. **Effective From: Spring 2010**

IS 698 - Special topics in Information Systems (3)
Special area course given when suitable interest develops. Advance notice of forthcoming topics will be given. **Effective From: Fall 2006**

IS 700 - Master's Project (3 credits)
An approved project involving design, implementation, and analysis, or theoretical investigation, under the guidance of a faculty member. Students are strongly advised to work with the faculty member to develop a project proposal during the semester prior to conducting the master's project. Approval to register for the project must be obtained from the faculty member advising the project.

IS 701 - Master's Thesis (6 credits)
An approved research-oriented project involving design, implementation, and analysis or theoretical investigation, carried out under the supervision of a faculty member who will be the thesis advisor. The thesis should be of such depth and caliber as to warrant publication in a technical or scientific journal. Approval to register for the thesis must be obtained from the thesis advisor. A student must register for a minimum of 3 credits per semester. Credit will be limited, however, to the 6 credits required for the thesis. Students are strongly advised to work with the thesis advisor to develop a thesis proposal during the semester prior to commencing the project.

IS 725 - Independent Study in Information Systems (3 credits)
Prerequisites: Graduate standing and department consent. **Effective From: Fall 2006**

IS 732 - Design of Interactive Systems (3 credits)
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. **Effective From: Fall 2006 Until: Fall 2008**

IS 735 - Social Media (3 credits)

Prerequisite: IS 675 or 764, or a graduate course in statistics (e.g., math 661) or quantitative research methods. Seminar style course that covers design and impact of computer-based systems for human communication, including email and IM, discussion boards, Computer-Supported Cooperative Work (CSCW), Group Decision Support Systems (GDSS), and Social Networking Systems. Topics include alternative design structures, impacts of primarily text-based group communication, and recent empirical studies of virtual teams, online communities, and systems used for social networking, including 3-D worlds such as Second Life and "micro blogging" systems such as Twitter. **Effective From: Spring 2013**

IS 754 - Measurement and Evaluation of Software Quality and Performance (3 credits)
Prerequisites: Ph.D. core courses, CS 630, CS 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. **Effective From: Fall 2006 Until: Fall 2008**

IS 762 - Computerized Information Systems for Planning and Forecasting (3 credits)
Prerequisite: IS 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. **Effective From: Fall 2006 Until: Fall 2008**

IS 763 - Qualitative Methods in IS Research (3)
Prerequisites: IS 675 or IS 350 (or an equivalent course) 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. **Effective From: Fall 2006 Until: Fall 2008**

IS 764 - Research Methods for Human-Centered Computing and Design (3 credits)
Prerequisites: None. This introductory seminar in human centered computing and design provides a survey of the methodological literature on qualitative research methods paired with appropriate article-length exemplars. We cover a variety of different research strategies including design science, action research, case study, qualitative data collection and analysis techniques, and scenario-based design. This course develops skills in designing and evaluating systems using qualitative methods. We also discuss writing and reviewing academic articles and research proposals. The course utilizes information systems as the primary domain but could be extended for students in other disciplines. **Effective From: Fall 2009**

IS 765 - Quantitative Methods in Information Systems Research (3 credits)
Prerequisite: Math 661 or equivalent. This course is a practical and project-oriented introduction to quantitative methods in information systems (IS) research. The focus of the course is on developing researchers' capability to select and implement appropriate statistical procedures for a variety of research questions and to interpret the results of these procedures. **Effective From: Fall 2010**

IS 766 - Philosophy of Information Science (3-0-3)
This seminar explores central issues in contemporary philosophy of science. We consider "scientific" progress in the computing sciences with a focus on information systems and human computer interaction theory. We discuss topics such as confirmation and disconfirmation of theories; falsifiability and pseudo-science; introduction; probability; and statistical inference, prediction, explanation and empirical equivalence. We read key works by philosophers such as Popper and Kuhn. We examine the notion of "design science" and contrast it with "natural science", and examine whether social science research should strive to emulate natural science methods. Readings will be tied into research within information systems and the computing sciences in general, looking at how scientific theories are tested or confirmed. **Effective From: Fall 2011**

IS 767 - Decision Support Systems (3 credits)
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. **Effective From: Fall 2006**

IS 776 - IS Research Proposition (3 credits)
Prerequisite: Restricted to students in the doctoral program in Information Systems. Students must have an approved program of study and approval of a faculty advisor to register for this course, which precedes the dissertation proposal. Students enrolled in

this course will, develop a grant proposal following the NSF Grant Proposal Guide. Students are required to present their work in the IS Research Seminar. The completed proposal will be evaluated by a reviewing panel for approval. **Effective From: Summer 2010**

IS 786 - Special Topics (3 credits)
These seminars examine a special interest area of Information Systems in depth. Each seminar emphasizes recent work in the area selected. **Effective From: Summer 2010**

IS 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. **Effective Until: Fall 2008**

IS 788 - Information Systems PhD Seminar (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). 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. **Effective From: Spring 2007**

IS 790 - Doctoral Dissertation and Research (Credits as designated)
For PhD students who have completed the qualifying exam. Research and writing are carried out under the supervision of a designed graduate faculty member. The completed dissertation should be a substantial contribution to the knowledge of the topic under research, and of sufficient merit to warrant publication in a leading scientific or technical journal. **Effective From: Fall 2011**

IS 791 - Graduate Seminar (Non-credit)
A seminar in which faculty, students, and invited speakers will present summaries of advanced topics in information systems. In the course students and faculty will discuss research procedures, dissertation organization, and content. Students engaged in research will present their own problems and research progress for discussion and criticism. **Effective From: Spring 2007**

IS 792 - Pre-Doctoral Research (3 credits)
Prerequisite: permission from department chairperson. For students admitted to the doctoral program in IS who have passed the field exam or the qualifying examination. Research is carried out under the supervision of a designated faculty member. Students identify a research problem and prepare a plan to solve the problem. A maximum of 6 credits of IS 792 may be applied to the IS 790 requirement. **Effective From: Fall 2006**

IS 794 - Computer Science/Information Systems 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. **Effective From: Fall 2006 Until: Fall 2008**

Information Technology: Offered by the Information Technology Committee

UNDERGRADUATE COURSES:

IT 101 - Introduction to Information Technology (3-0-3)
The foundations of information technology (IT), including basic computer architecture, various kinds of computer hardware, and networking technology, are introduced. Various data representation schemes, such as the binary number systems, are covered. Different levels of software are examined, including aspects of the operating systems from the perspective of the IT professional. The software development process is discussed. Database management software and SQL are dealt with, as are applications and languages developed around the internet and Web infrastructure. Overall, fundamental knowledge required of today's IT professional is obtained along with an appreciation of IT's impact on business and society. Hands-on experience with some important elements of the IT field is gained through various laboratory assignments. **Effective From: Fall 2013**

IT 102 - Advanced Programming for Information Technology (3-0-3)
Prerequisites CS 115. This course develops a broader and deeper understanding of the concepts and tools of IT providing a foundation for later work. It focuses on problem solving using object-oriented, event-driven, and networked programming. Topics include classes, objects, GUI's, events, sockets, client/server programming, multithreading, multimedia, exception handling and IO. A modern development environment and programming language are used to realize the concepts introduced. **Effective From: Summer 2011 Until: Fall 2011**

IT 114 - Advanced Programming for Information Technology (3-0-3)
Prerequisites CS 113 or CS 115. This course is a continuation of CS 113. Problem solving techniques and program design knowledge are expanded with an eye toward IT-related applications. Various kinds of data structures are introduced, including classic containers such as lists, stacks, queues, and tress. Sorting and searching techniques are examined. The fundamentals of client/server programming and the use of sockets are covered. Recursion and its various applications are studied. The built-in class features of an object-oriented programming language are exploited throughout. **Effective From: Fall 2013**

IT 120 - Introduction to Network Technology (3-3-3)
An introduction to the basics of networking in a modern operating system environment. Emphasis is placed on the application and management of networking technology. Topics to be covered include: the OSI model, network hardware and technologies, network protocols, wired and wireless networks, TCP/IP. Whenever possible, concepts will be explained through the use of hands-on exercises that reinforce the lecture material. **Effective From: Spring 2007**

IT 201 - Information Design Techniques (3-0-3)
Prerequisite: IT 101. This course presents an introduction to the theory and practice of information design. Topics covered include the theoretical foundations of information design, graphic design, content design, interaction design, usability, multimedia design, sound and video, animation, and an introduction to 3D modeling. **Effective From: Fall 2005**

IT 202 - Internet and Applications (3-0-3)
Prerequisites: CS 100 or CS 113 or CS 115 or a course in a high-level programming language as approved by department. This course presents the concepts and software technologies that underline web-oriented, three-tier software architectures and applications. The enabling software mechanism include the markup languages (HTML5 and CSS3) used by browsers, client-side scripting languages and libraries (Javascript and AJAX), web servers and server-side-scripting languages (Apache, PHP, HTTP protocol), and background databases (SQL, MySQL). The course uses a hands-on, guided development approach with substantial assignments to illustrate the fundamental computing concepts systems, and technologies considered and to provide direct experience in their use. **Effective From: Fall 2013**

IT 220 - Wireless Networks (3-0-3)
Prerequisite: IT 120. This course introduces the students to the applied topic of Wireless Networks, focusing on applied methods, tools and technologies, as well as practical experience in designing & implementing wireless networks. Topics include hardware, software, data, applications, communication, design & installation of wireless networks, together with the implementation,

performance, security and limitations of such systems.

IT 230 - Computer and Network Security (3-0-3)
Prerequisite: IT 120. This course introduces the applied topic of Computer Security, presenting the evolution of computer security, the main threats, attacks & mechanisms, applied computer operations & security protocols, main data transmission & storage protection methods via cryptography, ways of identifying, understanding & recovery from attacks against computer systems, various methods of security breach prevention, network systems availability, applications security, recovery & business continuation procedures and counter systems penetrations techniques and the role of the US Government in security of national computer infrastructure.

IT 240 - Scripting for System Administration (3-0-3)
Prerequisites: CS 113 or CS 111 or CS 115. This course will introduce task automation using shell scripting in a multi-OS environment using the Shell and the Perl programming languages. Topics covered will include scripting commands, control structures, functions, scalar data and lists, regular expressions, hashing, automating administration functions and debugging. Lessons will be enhanced through the use of hands-on exercises to strengthen comprehension. **Effective From: Fall 2010**

IT 265 - Game Architecture and Design (3-0-3)
Prerequisite: IT 201 or equivalent. Course introduces students to the core concepts and design methodologies integral to designing and developing games and other Entertainment Software. **Effective From: Spring 2007**

IT 266 - Game Modification Development (3-0-3)
Prerequisites: IT 102 or IT 114 or CS 116 or CS 114. This course introduces students to the basic concepts of game programming and development. Students will learn how to reprogram a professional game engine, or Modification (Mod) development as it is referred to in the industry. Students will work with C intensively. Students will work on their own game projects utilizing the professional game engine. **Effective From: Spring 2012**

IT 276 - Game Development (3-0-3)
Prerequisites: IT 265 and IT 266, or, CS 265 and CS 266. This course introduces students to the core concepts and skills necessary for the development of games utilizing 2D graphics. Students will learn how to set up and program their own 2D graphics based game engine. The engine will integrate 2D graphics, audio, input handling and network socket programming. Students will learn how to utilize their own custom 2D graphics and sounds into their projects. Once complete, students will have created two fully functional games. **Effective From: Spring 2007**

IT 286 - Foundations of Game Production (3-0-3)
Prerequisites: IT 202 and IT 265. This class introduces students to many of the tools and design methodologies needed for electronic game production. This class will focus heavily on scripting, level design and content control as applied to game development. Students will learn a few scripting languages that are used in the games industry such as Unreal Script and Python. Students will work on projects to develop the levels, controls and scripts in order to create a new game experience with a professional game. **Effective From: Fall 2009**

IT 287 - Advanced Game Production (3-0-3)
Prerequisite: IT 286 or Com 266. This course will build on tools and techniques presented in Foundations of Game Production and guide students through the development cycle of game levels. This will be a hands-on class that will teach students the development styles and revision techniques used in the professional game industry. Upon completion of the course, students will have first hand experience producing professional quality content for electronic games and a portfolio of work. **Effective From: Fall 2009**

IT 302 - Advanced Internet Applications (3-0-3)
Prerequisites: IT 202 or IS 217. This course covers Internet-related software technologies in a more comprehensive, in-depth manner than IT 202. Topics considered include: client-side technologies like HTML5 and jQuery, JQuery UI (user interface) library, jQuery Mobile, CSS3 (transitions, animations), feature detection and polyfills using jQuery UI and Modernizr, advanced Javascript DOM and JSON (Javascript Object Notation), basic web services applications, JSONP. Advanced PHP topics considered include: sessions, cookies, HTTP exchanges, encryption, graphics library (CAPTCHA?s), and as time permits regular expressions and remote file access. An introduction to the Model-View-Controller (MVC) paradigm is presented using Ruby-on-Rails environment. Programming assignments are required which provide experience with the concepts covered. **Effective From: Fall 2013**

IT 303 - Model View Controller Software Architecture (3-0-3)
Prerequisite: IT 202 or instructor approval. The Model View Controller(MVC) software architecture or pattern separates the concerns of application or domain logic, interface design, and the view of the system presented to the user, with the objective of more effective design, development and testing. This course covers environments and frameworks for modeling, developing and programming Internet Applications with emphasis on the Model View Controller paradigm. Design and development, applicability of principles, integrated test-driven development applicability of major external libraries like JQuery and Prototype, deployment,

scaling and security issues will be examined. Case studies will be used to illustrate the concepts and frameworks considered. A substantial development project will be required. **Effective From: Spring 2012**

IT 310 - E-commerce Technology (3-0-3)
An overview of the technologies relevant to electronic commerce. Communications and networking, web authoring tools, system security, databases and archiving, EDI, transaction processing, and factory/warehouse data networks. Provides competency to appraise tools such as HTTP servers, secure transaction software and firewalls, low and high-end database systems, heterogeneous networks, NNTP Servers, client software, procurement systems, and intelligent agents. Covers e-commerce models including agent-based and Java-based, electronic contracts and the electronic exchange of technical data, electronic cash systems and user security.

IT 311 - Co-op Work Experience I (3-0-3)
Prerequisite: Completion of the sophomore year, approval of the program coordinator, and permission of the Office of Cooperative Education and Internship. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

IT 320 - Virtual Instrumentation (3-0-3)
Cross-listed with OPSE 310. Prerequisite: CS 113 or CS 115. Covers the basics of virtual instrumentation including use of IEEE GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform such as National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisition and instrument control, instrument status, and acquisition speed.

IT 330 - Computer Forensic (3-0-3)
Prerequisites: IT 230. This course introduces students to the applied topic of Computer Forensic, the study of obtaining and analyzing digital information from computers that have been used to commit illegal actions (computer crime), for use as evidence in civil, criminal, or administrative cases. **Effective From: Spring 2012**

IT 331 - Privacy and Information Technology (3-0-3)
Prerequisite: Computing GUR. This course will introduce the legal, social and technical issues involving information privacy. Topics covered will include the historical development of information privacy law; law enforcement, technology and surveillance; government databases and records; privacy and business records and financial information; privacy and the media; health and genetic privacy and international privacy law. **Effective From: Fall 2009**

IT 332 - Digital Crime (3-0-3)
Prerequisite: Computing GUR. Comprehensive, multidisciplinary overview of the methods and means by which technology is used by the criminal in today's society. An examination of the historical, legal, technological and sociological aspects of cybercrime. The course covers the challenges of a new era of technology has brought to combating crime of all types, including terrorism. Topics covered will include: the sociology of the white collar criminal, the criminal justice system and law enforcement, computer security and deterrence/prevention. **Effective From: Fall 2009**

IT 335 - Introduction to .NET Framework (3-0-3)
Prerequisite: IT 202 or equivalent. This course introduces students to .NET Framework, a new computational environment that supports more than 25 programming languages and is platform and device independent. Problem solving and system development topics are integrated into the course by using C# languages as a vehicle to illustrate the concepts. **Effective From: Spring 2007**

IT 340 - Introduction to System Administration (3-0-3)
Prerequisite: IT 120. This course will introduce the tasks and techniques required to perform as a system administrator of Linux systems. Topics to be covered include: booting, process control, the file system, managing users and resources, backups, configuration management, networking, the network file system, email servers, security, hardware devices, interoperability and daemons. Whenever possible, lectures will be augmented with hands-on exercises. **Effective From: Fall 2011**

IT 360 - Programming for Computer Graphics (3-0-3)
Introduction to programming graphics and animation through the use of an appropriate application interface such as openGL. Topics include 2D and 3D graphics with mappings from the real world coordinates to graphics display. Perspective display will be provided by an interface. Basic vector and matrix operations which underlie the concepts of perspective will be covered.

IT 380 - Educational Software Design (3-0-3)
Prerequisite: IT 201. Educational Media Design employs the instructional principles of constructivist pedagogy as the process used to develop a solution to develope courseware for K-12 audience. The course builds on the participatory design model of software engineering in order to develop integrated learning environments that support visual and verbal literacy; enables student to be able

to plan, organize, and systematically develop instructional materials. This course implements instructional design theory and pedagogy in order to create an actual application for a computer-based environment. Same as STS 318. **Effective From: Fall 2009**

IT 386 - 3D Modeling and Animation (3-0-3)
Prerequisite: IT 201. This class introduces students to the concepts of 3D modeling and animation, and putting those concepts into action by working with software. This class will be a hands-on, project focused course, using 3D modeling packages, taking students from design to final render. **Effective From: Fall 2009**

IT 400 - Information Technology and the Law (3-3-3)
This course will provide an introduction to legal concepts, principles and terminology as applied to modern information technology. The historical background and foundations of the various principles of U.S. Statutory and Common Law will be considered and will be used to explore how such principles may be applied to encompass and govern modern legal interactions in the U.S. and internationally. Through assignments and class discussion, which will often involve the Socratic Method, students will be expected to spot potential legal issues and make logical arguments for and against various legal propositions. **Effective From: Spring 2007**

IT 411 - Co-op Work Experience (3-0-3)
Prerequisite: Completion of the sophomore year, approval of the program coordinator, and permission of the Office of Cooperative Education and Internship. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the Co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

IT 420 - Computer Systems and Networks (3-0-3)
Prerequisites: IT 120 and either CS 113 or CS 115. This course provides students with an understanding of methods, tools and technologies required to work with computer systems and networks. It includes a detailed discussion of Internet/intranet issues, including standards, connectivity, performance, protocols, network configurations, network design, wireless technology, management and simulation through practical cases, covering both hardware and software systems. **Effective From: Fall 2011**

IT 430 - Ethical Hacking for System Administrators (3-0-3)
Prerequisite: IT 420 or equivalent. This course will explore the various means that an intruder has available to gain access to computer resources. Traditional security analysis often falls short due to the rapidly evolving threats that exist. The course was developed to teach how system and network vulnerabilities are found and exploited and what steps can be taken to mitigate the risk. **Effective From: Fall 2010**

IT 485 - Special Topics in Information Technology I (3-0-3)
Prerequisites: junior standing and/or advisor approval. The study of new and/or advanced topics in an area of information technology and its application not regularly covered in any other IT course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. A student may register for no more than two semesters of special topics courses.

IT 486 - Special Topics in Information Technology II (3-0-3)
Prerequisites: same as for IT 485. A continuation of IT 485.

IT 488 - Independent Study in Information Technology (3-0-3)
Prerequisites: open only to Information Technology majors who have the prior approval of the program director and the IT faculty who will guide the independent study taking the form of investigations, research, and reports on advanced topics in information technology. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the program director and the faculty mentor. A student may register for no more than one semester of independent study.

IT 488H - Honors Independent Study in Information Technology (3-0-3)
Prerequisites: open only to Honors College Information Technology majors who have the prior approval of the program director and the IT faculty who will guide the independent study taking the form of investigations, research, and reports on advanced topics in information technology. Students must prepare, in collaboration with their faculty mentor and in the semester prior to enrolling in this course, a detailed plan of topics and expected accomplishments for their independent study. This must have the approval of both the program director and the faculty mentor. A student may register for no more than one semester of independent study.

IT 490 - Systems Integration (3-0-3)
Prerequisite: IT 420. The course will introduce the major design, implementation & distributed deployment issues regarding system integration, Network Operating Systems (NOS), cross platform database integration, e-commerce and e-business applications implementation, cross-servers & multiple locations e-sessions migration and the related communications security. **Effective From:**

Fall 2005

IT 491 - IT Capstone Project (3-0-3)
Prerequisites: senior standing. An opportunity for students to integrate the knowledge and skills gained in previous information technology work into a team research project. The project involves investigation of current literature as well as implementation of either a part of a large application or the whole of a small system.

IT 491H - Honors IT Capstone Project (3-0-3)
Prerequisites: senior standing in the Honors College and project proposal approval. Similar to IT 491, with a project of greater depth and scope.

GRADUATE COURSES:

IT 610 - System Administration (3 credits)
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course is an introduction to the skills needed for and tasks performed by a System Administrator. The course will cover administration of host and server systems in modern operating system environments. Topics to be covered include: user, configuration, and change management, shell scripting, monitoring and performance analysis, disaster mitigation and recovery, and auditing. **Effective From: Fall 2009**

IT 620 - Wireless Networks Security and Administration (3 credits)
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course introduces the fundamentals of wireless network security and administration. Topics include: wireless LAN vulnerabilities, passive and active wireless attacks, enterprise wireless hardware security, secure wireless authentication and communication, wireless intrusion detection and prevention systems, WiFi and cellular network management, location privacy, personal area network administration and security, mobile IP security, GSM, CDPD, 3G and 4G network security. The course provides both a theoretical foundation and hands-on experience in these areas. **Effective From: Fall 2009**

IT 635 - Database Administration (3 credits)
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course provides a broad overview of the tasks and techniques necessary to function as a Database Administrator (DBA)in a modern relational database environment. Students will learn the duties typically performed by a DBA, which include: user authorization, disaster planning and recovery, monitoring, performance analysis, database tuning, metadata maintenance as well as data modeling, analysis and database design. **Effective From: Fall 2009**

IT 640 - Network Services Administration (3 credits)
Prerequisite: Completion of the Bridge requirements for the MS in IT Administration and Security (or the equivalent). This course provides an introduction to the fundamentals of network services administration. It covers how web-based and domain-services operate, integrate and communicate. Topics include: fundamental technologies that underpin the web services paradigm, key standards necessary for their development, and how other critical domain services should be deployed. This course will enable students to gain skills necessary to plan, install, configure, secure and maintain web servers, DNS servers, email & print servers, resource sharing systems, and domain authentication systems. **Effective From: Fall 2009**

International Studies:

UNDERGRADUATE COURSES:

MR INTL - Study Abroad (12 maintenance-of-registrations 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 majors.

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Management: Offered by the School of Management.

UNDERGRADUATE COURSES:

Mgmt 190 - Introduction to Business (3-0-3)
Introduction to business enterprise, including organization structure, basis of authority and responsibility, financial systems, marketing, and the interaction of government and business. The interrelationships of the broad economic, political, psychological, and social influences upon business. **Effective From: Spring 2008**

Mgmt 216 - Business Statistics (3-0-3)
Prerequisite: Math 105 or Math 333. Introduction to business data analysis for application in management decision-making processes. Productivity measures, employment trends, national income data, and consumer price changes. Methods for collection of business and economic data, presentation of data and computer applications, index numbers, historical analysis trend projections, survey sampling, and planning for business research.

Mgmt 290 - Business Law I (3-0-3)
The basic principles of common and statutory law applicable to business and professional relationships, emphasizing contracts, negotiable instruments, sales of goods, agency and business organizations. **Effective From: Spring 2013**

Mgmt 310 - Co-op Work Experience I (3 credits)
Prerequisites: junior standing, approval of the school, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. **Effective From: Spring 2013**

Mgmt 316 - Business Research Methods (2-1-3)
Prerquisites: Mgmt 216, MIS 245. This course covers business research methodologies with an emphasis on data collection/mining and data analysis. It offers the knowledge skills to conduct research in all applicable fields from the traditional areas of business, such as, marketing, finance, human resources, operations and service management, as well as web-based e-commerce related research applications. Upon completion, students will be able to: (1) understand business research methodologies, (2) conduct business research studies, (3) present the results, analyses and recommendations to management. **Effective From: Fall 2009**

Mgmt 350 - Knowledge Management (3-0-3)
The purpose of this course is to introduce students to Knowledge Management. This term is used to refer to the ways in which organizations create, gather, manage and use the knowledge. Emphasis is placed on the information systems needed to capture and distribute knowledge and how knowledge can be used to gain competitive advantage.

Mgmt 360 - Business Law II (3-0-3)
The course will cover concepts required for the CPA Exam. Current cases will illustrate legal principles and how courts make decisions. Topics include corporate information and termination, agency and employment issues and forms of discrimination, comparisons of U.S. laws with those in other countries, the ethical context for business decisions, insider trading, online securities fraud, and disclosure of financial information on corporate blogs and tweets, including the tax consequences. **Effective From: Spring 2013**

Mgmt 380 - Principles of E-Commerce (3-0-3)
This course is designed to provide an overview of electronic commerce technologies, e-commerce strategies and their implications for work organizations. The course focuses on how the Internet has transformed business and the emergence of the digital firm. **Effective Until: Spring 2009**

Mgmt 390 - Principles of Management (3-0-3)
Prerequisite: junior or senior standing. The broad basic principles of the managerial process that are fundamental to the successful operation of various types of enterprises. Emphasizes the role of management at all levels of responsibility. Organization,

motivation and morale; scientific management and human relations; the functions of planning, directing, and controlling. A rational synthesis of research and concepts, which together constitute the subject matter of management.

Mgmt 390H - Honors Principles of Management (3-0-3)
Prerequisites: member of the Honors College or permission of the instructor

Mgmt 410 - Co-op Work Experience II (zero credits)
Prerequisites: Mgmt 310 or equivalent, approval of the school, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience as a co-op/intern. Mandatory participation in seminar and completion of requirements that include a report and/or project. **Effective From: Spring 2013**

Mgmt 460 - Management Strategies for E-Commerce (3-0-3)
Prerequisite: MIS 360. Learn about the Internet, intranets and extranets and incorporating them into business planning and operations

Mgmt 480 - Managing Technology and Innovation (3-0-3)
Prerequisite: Junior standing. Introduction to an array of technologies affecting management functions to provide an appreciation and understanding of the importance of new technologies as critical success factors for modern organizations. An integrative approach is taken in analyzing how changes in technology affect individual, group, and organizational effectiveness. **Effective From: Fall 2010**

Mgmt 485 - Special Topics in Management (3-0-3)
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. **Effective From: Fall 2009**

Mgmt 491 - International Business (3-0-3)
A basic understanding of the activities in international business providing a framework for understanding them from the perspective of a company manager. Covers international trade, multinational enterprises, foreign exchange, foreign direct investment, international financial institutions, barriers to international trade, accounting of taxation, industrial relations, multinational enterprise, and world order

Mgmt 492 - Business Policy (3-0-3)
Prerequisite: senior standing. A capstone course in the area of business administration focusing on the integration of concepts taught in various functional courses such as marketing, finance, operations management, accounting, organizational behavior. Issues related to corporate responsibilities and ethical behavior are also incorporated in this course. Emphasis on application of concepts to real life situation is achieved through case discussion and projects.

Mgmt 492H - Honors Business Policy (3-0-3)
Prerequisites: member of the Honors College, senior standing.

Mgmt 496* - Introduction to Transportation (3-0-3)
Prerequisite: upper division standing. Introduction to transportation systems and the transportation industry. Survey of the various modes of transportation, organizational structure and operation of private and public carriers. The role of government in the regulation of the U.S. transportation industry. Management of traffic and physical distribution operations. Cost and service comparisons of competing modes of transportation. Organized labor and associated costs.

Mgmt 499 - Senior Seminar: Career Planning and MFT (1-0-1)
A one credit, satisfactory/unsatisfactory course that will allow students to get the career training they need prior to entering work force, as well as review for the Major Fields Test and to actually take the Major Field Test in the course. Corequisite: MGMT 492. This course runs for the first 10 weeks of the semester. **Effective From: Fall 2012**

GRADUATE COURSES:

IM 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

Mgmt 501 - Management Foundations (3-0-3)
This course provides foundation knowledge for MSM and MBA students whose undergraduate coursework does not include coursework in accounting and finance. It therefore, serves as a pre-qualifier for the MSM and MBA programs. **Effective From:**

Fall 2004

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 612 - Principles of Emergency Management (3 credits)
This course covers core aspects of Emergency Management (EM). EM theory identifies four critical areas: 1) understanding & mitigating risk, 2) planning & preparedness, 3) reaction & response, 4)recovery/normalization. This course focuses on innovative approaches to EM in each area. Also: risk & cost assessment, entrepreneurial approaches to disaster prevention & response, self-organized response, new technologies for emergency management, terrorism & global issues, and after-action evaluations. **Effective From: Fall 2007**

Mgmt 616 - Learning Methodologies and Training Technologies (3 credits)
This course provides an overview of learning methodologies and training technologies, with an emphasis on emergency management. It reviews theories and develops skills for the planning, evaluation and selection of traditional and new technology-driven learning and training methods. Course participants will review relevant research and learn how to choose the most effective training methodologies, technologies and content resources appropriate to the needs of different audiences. **Effective From: Fall 2007**

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 (3 credits)
This course provides an introduction to data mining with an emphasis on large scale databases as a source of knowledge generation and competitive advantage. Specific topics include: framing research questions; data modeling; inferential data mining techniques; and evaluation and deployment of data mining systems.

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 641 - Global Project Management (3-0-3)
The course reviews key elements of project management frameworks with a particular focus on global projects, which include people from various organizations working in different countries across the world, both face-to-face and virtually. Such projects vary in complexity based on the number of organizations, locations, cultures, languages and time-zones involved. It discusses people, technology and processes relevant to managing global projects and virtual teamwork. **Effective From: Spring 2013**

Mgmt 642 - Corporate Communication (3 credits)
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. **Effective From: Fall 2007**

Mgmt 644 - Communication in Technology Transfer and Innovation (3 credits)
In order to help prepare students for careers in a market-oriented productive economy, this course builds on the understanding

that communication is essential to innovation development and technology transfer. Students first review the principles of successful technical communication and the models and literature of communication in technology transfer. Then, students apply this knowledge in team-based projects to develop Technology Transfer Communication Strategy (TTCS) for technology start-up companies as needed (business plans, documentation, technical reports, etc.) **Effective From: Fall 2007**

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 649 - Convention, Creativity and Innovation (3-0-3)
This course explores the role of creativity and disruptive thinking in relation to the development of new products, processes, technologies and industries. It begins with a focus on the behavioral aspects of creativity and disruptive thinking and includes exercises and tools to challenge conventional thinking. Disruption is them studies through a strategic lens with emphasis on understanding the conditions under which radical change is appropriate and when it is not. **Effective From: Spring 2013**

Mgmt 650 - Knowledge Management (3 credits)
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. **Effective From: Spring 2011**

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 656 - Public Policy and Business (3-0-3)
This course explores the relationship between business and government with a focus on regulatory policies and public?private partnerships. Areas of focus include sustainability and environmental regulations, trade policies and their influence on international commerce, public policy concerning the Internet and emerging digital technologies, patent rights, and opportunities for public?private partnerships with regard to fostering economic development **Effective From: Spring 2013**

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. Taken in the final semester only.

Mgmt 681 - Project-Based Enterprise Development (3 credits)
Enterprise development involves activities geared toward substantive renewal of established enterprises or industries. In this Course, students will work with enterprise development projects including corporate venturing, international expansion, or business development initiatives, as well as, identification and implementation of new, more ethical business models, or restructuring of established businesses, just to mention a few examples. **Effective From: Fall 2008**

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 686 - Corporate Governance (3 credits)
Presents inter-disciplinary perspectives on the rights, responsibilities and roles of the corporation in society. Focuses on the relationships among owners, managers, and other stakeholders. Analyzes corporate control mechanisms including ownership concentration, executive compensation, boards of directors, and the market for corporate control. Includes changes in political/legal/regulatory institutional environments over time, and develops a comparative international framework. **Effective From: Fall 2009**

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)
This course focuses on the Strategic Integration of the different functional areas in management providing a top management perspective to the role of chief executive in an organization. An integral part of this course is to understand the roles of both competitive environment and the organization's experience in developing corporate strategy to gain competitive advantage. We also emphasize 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.

R620:555 - Seminar in Organizational Behavior (3 Credits)
For more details go to Rutgers Catalog.

R620:556 - Seminar in Organizational Theory (3 credits)
For more details go to Rutgers Catalog.

R620:671 - Management of Innovation and Technology (3 credits by arrangement)
For more details go to Rutgers Catalog.

R620:677 - Culture and Organizations (3 credits by arrangement)
For more details go to Rutgers Catalog.

Management Information Systems: Offered by the School of Management

UNDERGRADUATE COURSES:

MIS 245 - Introduction to Management Information Systems (3-0-3)
Concepts of information systems, business process, hardware, software, systems analysis, e-commerce, enterprise systems and computer applications in organizations, techniques of systems analysis, systems designs, implementations, and information management (both technical and behavioral)are studied in the organizational context of management information needs. **Effective From: Spring 2005**

MIS 246 - Tools and Technologies for the Digital Firm (3-0-3)
This course is designed to provide students with an introduction to the applications being used by digital firms, companies that rely extensively on the use of information technology to support all their functions and processes. Although function specific systems (e.g. accounting information systems, financial information systems) are introduced the emphasis is on enterprise wide systems such as those offered by SAP, Oracle and Peoplesoft. A basic introduction to the technologies underlying the applications used in business is also provided.

MIS 345 - Management of Information Systems (3-0-3)
Prerequisites: CIS 103 or CIS 113, MIS 246. Training managers or entrepreneurs to use and manage information systems. The evolution of the computer as a management information tool and a demonstration of how this tool can be used to improve both the effectiveness and efficiency of managers.

MIS 360 - Survey of E-Commerce Tools & Technologies (3-0-3)
Prerequisite: MIS 246. Covers the current technologies behind e-commerce solutions such as dynamic Web sites, database integration, server-side scripting, client-side scripting, and XML.

MIS 363 - Project Management for Managers (3-0-3)
This course covers theories, tools, and techniques to manage projects in organizations. Students will learn how to put together a project charter, define project goals, and develop project teams, schedules, and budgets. The course will illustrate the key aspects of project lifecycles (initiation, planning, execution, monitor and control, and closing). It will also emphasize aspects of team, performance, risk, and quality management. **Effective From: Fall 2009**

MIS 376 - Information Systems and Operations Management (3-0-3)
This course will integrate information systems with operations management. The role information systems play in the operations management functions for both the goods and services sectors of a global economy. Topics to be covered are mission and strategy development, demand forcasting, capacity planning, facility location, process strategy, inventory management, project management and total quality management. The way information systems integrates these concepts with ERP, SCM, CRM and other business systems will be discussed. **Effective From: Spring 2005 Until: Spring 2009**

MIS 445 - Decision Support Systems and OLAP (3-1-4)
Prerequisites: MIS 345 and OM 375.Introduces students to the use of decision support systems (DSS) to support management decisions. Topics include: DSS software tools, model management, and DSS design and use.

MIS 463 - Systems Analysis and Design for Managers (3-0-3)
This course focuses on the analysis and development of systems to meet the increasing need for information within organizations. Topics include systems development life cycle, analysis and design techniques, information systems planning and project identification and selection, requirements collection and structuring, process modeling, data modeling, design of interface and data management, system implementation and operation, system maintenance, and change management implications of systems. **Effective From: Spring 2005**

MIS 485 - Special Topics in Management Information Systems (3-0-3)
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other

business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. **Effective From: Fall 2009**

GRADUATE COURSES:

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)
Intended to develop a basic understanding of the Internet and its underlying technologies as a foundation for e-commerce with an introduction to e-commerce applications. Addresses the technology for MIS managers to effectively manage the launching of e-commerce infrastructures. Covers data communication and networking, EDI, intranets and extranets, bandwidth and security issues.

MIS 625 - Management Strategies for E-Commerce (3 credits)
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 (null)
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 - Information Systems Principles (3 credits)
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. **Effective From: Spring 2011**

MIS 648 - Decision Support Systems for Managers (3 credits)
Prerequisites: MIS 645. Covers the use of decision support systems to support management decision making in a real world environment. Topics include: establishing and measuring decision support systems success criteria, software tools, model management, elements of artificial intelligence, and statistics. Justification, design, and use of decision support systems. **Effective From: Spring 2011**

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 - Management Science (3 credits)
Introduction to the methodology of decision making applying the techniques of operations research and system analysis to managerial problems. Introduction to the concept of objective functions and constraints, concepts of value and utilities, optimization algorithms, networks and game theories. Elementary mathematical model linear production systems, inventory systems, multi-criteria decision making, project management and transportation planning. Topics will be discussed from the deterministic as well as scholastic points of view.

MIS 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.

Manufacturing System Engineering: Offered by the Department of Industrial and Manufacturing Engineering

GRADUATE COURSES:

MnE 601 - Computerized Manufacturing Systems (3 credits)
Development of automated manufacturing systems with applications including Industrial Robotics, Programmable Logic Controller, Lean Manufacturing and other artificial intelligence technologies. Laboratory experimentation using hardware and software necessary for various industrial robots & PLC systems in the automotive assemble; pharmaceutical and chemical industries are included. **Effective From: Fall 2011**

MnE 602 - Flexible and Computer Integrated Manufacturing (3 credits)
Prerequisites: MNE 601. Flexible manufacturing systems are developed including Robotic applications, PLC & CNC programming as automated inspection and transportation systems. Laboratory experience with hardware and software needed for various industrial robots & other automated systems are included. **Effective From: Fall 2011**

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 - Industrial Ecology & Sustainability (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. **Effective From: Fall 2009**

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 Management: Offered by the School of Management

UNDERGRADUATE COURSES:

Mrkt 330 - Principles of Marketing (3-0-3)
Provides an understanding of how environmental factors (political, legal, economy, competition, socio-cultural, and technology) influence the design of product, pricing, promotion and distribution strategies. Topics discussed include strategies to satisfy target markets, market segmentation, buyer behavior, marketing ethics, and an introduction to global marketing issues. Fundamentals of marketing are integrated using cases, videos, and class projects. **Effective From: Spring 2008**

Mrkt 331 - Consumer and Buyer Behavior ((3-0-3))
Prerequisites: Math 105 and Mrkt 330. Psychological, social, and economic influences on consumer behavior. The application of consumer behavioral innovation to marketing decisions: research and measurement techniques, individual influences, environmental influences, and consumer information processing and decision making. A field research project will be undertaken. **Effective From: Fall 2005**

Mrkt 338 - Product Development and Management (3-0-3)
Prerequisite: Mrkt 330. The process of product development is studied in detail with specific emphasis on technology-driven innovation. Techniques for getting closer to customers including TQM principles are also covered.

Mrkt 339 - Professional Selling (3-0-3)
Prerequisite: Mrkt 330. Provides an understanding of multifaceted roles salespeople play and prepares students for sales careers in business-to-business firms. Discusses the personal selling process that include prospecting and qualifying, sales call planning, approaching prospects, giving sales demonstrations and presentations, negotiating sales resistance, confirming and closing "win-win" agreements. Places emphasis on building customer relationships and partnerships by providing customer service and to ensure satisfaction and build customer loyalty. Concepts are discussed and integrated using role-playing, experiential exercies, videos, cases and class projects. **Effective From: Spring 2008**

Mrkt 360 - Internet Marketing (3-0-3)
Prerequisite: Mrkt 330. Provides an overview of fundamental principles of Internet marketing for the contemporary business environment. Topics include Internet marketing strategies, Internet marketing plan, and development of Internet-based marketing programs. **Effective From: Spring 2008**

Mrkt 430 - Marketing Research (3-0-3)
Prerequisite: Mrkt 330. The process of marketing research is studied in detail from study design through report preparation. A hands-on, experiential approach is taken with an emphasis on secondary research and multivariate statistical methods. Data analysis is conducted using SAS and/or SPSS.

Mrkt 432 - Sales Management (3-0-3)
Prerequisite: Mrkt 330. This course helps the student to understand the various sales management activities that sales managers are responsible for in their important role as revenue generation managers. Key topics that are discussed within the realm of organizing, managing and controlling the sales force include sales forcasting, budgeting, sales force organization, time and territory management, recruitment, selection and training the salespeople, leadership, motivation, compensation, and sales force performance evaluation. Sales ethics and customer relationship management issues are also addressed. **Effective From: Fall 2008**

Mrkt 434 - Business to Business Marketing (3-0-3)
Prerequisite: Mrkt 330. Techniques for marketing industrial products to organizations in the manufacturing, service, government, and non-profit sectors are covered within the context of a global marketplace. Emphasis is on the marketing of high technology products using a customer-driven approach. **Effective From: Spring 2008**

Mrkt 435 - International Marketing (3-0-3)

Prerequisite: Mrkt 330. This course will help students understand how the product, pricing, promotion and distribution elements of the marketing mix are influenced by international forces (cultural, political-legal, economic, competitive, and technological environment). Topics discussed include global market segmentation, marketing ethics, standardization or adaptation of the marketing mix as well as global information systems and market research, segmentation, targeting, and foreign market entry strategies (importing, exporting, licensing, and strategic alliances). Course concepts are integrated using cases, videos, and class projects. **Effective From: Summer 2008**

Mrkt 485 - Special Topics in Marketing (3-0-3)
The study of new and/or advanced topics in the various fields of business and their application not regularly covered in any other business course. The precise topics to be covered, along with prerequisites, are announced in the semester prior to the offering of the course. **Effective From: Fall 2009**

GRADUATE COURSES:

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.

R630:576 - Quantitative Methods in Marketing Credits by arrangement (3 credits)
For more details go to Rutgers Catalog.

R630:625 - Clustering Analysis (3 Credits by arrangement)
For more details go to Rutgers Catalog.

R630:660 - Qualitative Research Methods (3 credits)
For more details go to Rutgers Catalog.

R630:668 - Causal Modeling (3 credits)
For more details go to Rutgers Catalog.

Material, Science and Engineering : Offered by the Materials Science and Engineering Committee

UNDERGRADUATE COURSES:

MtSE 301 - Principles of Material Science and Engineering (3-0-3)
Prerequisites: Phys 111 and Phys 121, Chem 125 and Chem 126, Math 111 and Math 112 or equivalent. Examines the interrelationships among structure, properties, and performance of engineering materials. Topics to be covered include atomic structure, crystallography, solid state imperfections and diffusion. The properties of metals, semiconductors, polymers, ceramics, and composites as well as their behavioral response to mechanical, chemical, optical, electrical, and magnetic stimuli are examined in light of their performance in service.

MtSE 311 - Properties of Materials (3-0-3)
Prerequisite: two semesters of college physics or equivalent. Intended for engineering technology students and is an introduction to the principal metallic and nonmetallic engineering materials, including their physical properties, response to heat treatment, and corrosion -resistance.

MtSE 318 - Engineering Materials (3-2-4)
Prerequisites: Physics III; Chem 126. Introduces the student to such engineering materials as metals, viscoelastic materials, ceramics, polymers, and semiconductors. The approach is interdisciplinary with stress upon the structure of materials. Various mechanical and thermal treatments are discussed and related to the stability of the resultant properties. The laboratory sessions implement and emphasize the effects of these mechanical and thermal treatments on the materials.

MtSE 319 - Engineering Materials (3-0-3)
Prerequisites: Physics III; Chem 126. This course is identical to MtSE 318, with the laboratory omitted.

MtSE 450 - Electron Microscopy (2-2-3)
Prerequisites: Physics III; Chem 126. Combines the lecture and laboratory in introducing the field of electron microscopy. Topics include magnetic electron lenses, electron optical systems, selected area diffraction, sample preparation, thin foil techniques, and photography.

MtSE 451 - X-Ray Diffraction (2-2-3)
Prerequisites: Physics III; Chem 126. Combines the lecture and laboratory in introducing the methods of X-ray diffraction. Topics include directions and intensities of diffracted beams, diffractometer methods, Laue methods, power photographs, reciprocal lattice constructions, and the rotating crystal method.

MtSE 452 - Materials Science I (3-0-3)
Prerequisites: Physics III; Chem 126; ME 435 or Phys 335. Emphasizes the structure and properties of materials and the relationships between them. The primary topics include the thermodynamics of solids, fracture mechanisms, diffusion, elasticity, plasticity, fatigue strength, viscosity, and creep.

MtSE 453 - Materials Science II (3-4-5)
Prerequisite: MtSE 452. Emphasizes the electronic properties of materials in conjunction with an introduction to ceramics. Topics include semiconductors, thermoelectricity, magnetism, conductivity, dielectric, optical properties, and an introduction to the properties and behavior of ceramics.

GRADUATE COURSES:

MtSE 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

MtSE 601 - Fundamentals of Engineering Materials (3 credits)
Prerequisite: graduate standing. Core course for students in Material Science and Engineering. 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. **Effective From: Fall 2005**

MtSE 602 - Thermodynamics of Materials (3 credits)
Prerequisite: undergraduate thermodyamics. Core course for students in Material Science and Engineering. 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. **Effective From: Fall 2005**

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)
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy, near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project. **Effective From: Fall 2007**

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. **Effective Until: Fall 2008**

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 681 - Composite Materials (3 credits)
Prerequisites: MtSE 601 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. **Effective From: Fall 2005**

MtSE 682 - Introduction to Ceramics (3 credits)
Prerequisite: MtSE 601. 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. **Effective From: Fall 2005**

MtSE 685 - Physical Metallurgy (3 credits)
Prerequisite: MtSE 601. 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. **Effective From: Fall 2005**

MtSE 687 - Glass Science and Engineering (3 credits)
Prerequisites: MtSE 601 and MtSE 602. 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. **Effective From: Fall 2005**

MtSE 688 - Mathematical and Statistical Methods in Materials Science (3 credits)
More emphasis on analytical methods and statistics. Course is required for Ph.D. students in Materials Science. **Effective From: Fall 2006**

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)
Core course for students in Material Science and Engineering, 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 722 - 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. **Effective From: Fall 2005**

MtSE 723 - Defects in Solids (3 credits)
Prerequisites: MtSE 601 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. **Effective From: Fall 2005**

MtSE 724 - 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. **Effective From: Fall 2005**

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: Mathematics

UNDERGRADUATE COURSES:

Math 098 - Introduction to College Math A (4-1-4 additive credits)
Intended for students whose major requires Math 113, Math 138, Math 135, or Math 116. Topics include: Elementary Algebra, Introduction to Graphs and Functions, Linear Functions, Equations, Inequalities, Systems of Linear Equations, Radicals and Complex Numbers, Quadratic Equations, Rational Expressions and Rational Functions, Functions and Relations, Exponential and Logarithmic Functions and Equations. Introduction to the logistics of applied calculus. Diverse applications will be emphasized throughout the course. This course may not be used to satisfy degree requirements in any program. **Effective From: Spring 2009 Until: Spring 2011**

Math 099 - Introduction to College Math B (4-1-4 additive credits)
Intended for students whose major requires Math 111. Topics include: Elementary Algebra, Introduction to Graphs and Functions, Linear Functions, Equations, Inequalities, Systems of Linear Equations, Radicals and Complex Numbers, Quadratic Equations, Rational Expressions and Rational Functions, Functions and Relations, Exponential and Logarithmic Functions and Equations. Introduction to the logistics of applied calculus. Diverse applications will be emphasized throughout the course. This course may not be used to satisfy degree requirements in any program. **Effective From: Spring 2009 Until: Spring 2011**

Math 101 - University Mathematics II-Trigonometry (4-1-4)
Intended for students whose major requires Math 113, Math 135, or Math 138. Prerequisite: Placement by performance on standardized entrance examinations. This course reviews the trigonometry needed for higher level mathematics courses. The following topics are covered: radian measure, conic sections, trigonmetric functions and identities, laws of sines and cosines, logarithmic equations, partial fraction decomposition, systems of linear and nonlinear equations, functions in polar coordinates, and hyperbolic functions. Degree credit awarded for the following majors only: Hist, PTC, MGMT, and STS. **Effective From: Spring 2009 Until: Summer 2011**

Math 101 - Foundations of Mathematics for the Liberal Arts (3-0-3)
Intended for students in degree programs offered by HSS and History. This course reviews principles of algebra and the foundations of mathematics. Degree credit awarded for degrees offered by HUM and History. **Effective From: Fall 2011**

Math 102 - Modern Pre-calculus (6 credits)
This course is an intensive non-traditional approach to pre-calculus employing curriculum innovations for the preparation of students for college calculus. The course infuses calculus techniques into the pre-calculus curriculum. The format includes both regular class and workshop environments with a focus on student problem solving. Course meets on Saturdays in the fall and spring terms and M, T, W, R in the summer, second session. This course is only available to high school students. **Effective From: Spring 2009**

Math 103 - University Mathematics I (4-1- 4 additive credits)
Prerequisite: Math 098 with a grade of C or better or placement by performance on standardized entrance examinations. Consists of a series of projects, many of which introduce and use elementary differentiation and/or integration in which the students perform sustained algebraic and trigonometric computations. The projects involve the following topics: polynomials, rational expressions, expressions involving radicals, exponential and logarithmic functions, right triangle trigonometry, and the solution of linear and quadratic equations. This course may not be used to satisfy degree requirements in any program. **Effective From: Spring 2009**

Math 104 - University Mathematics II (4-1- 4 additive credits)
Prerequisite: Math 103 with a grade of C or better or placement by performance on standardized entrance examinations. Consists of a series of projects, many of which introduce and use elementary differentiation and/or integration in which the students perform sustained algebraic and trigonometric computations. The projects involve the following topics: radian measure, conic sections, trigonometric functions and identities, law of sines and cosines, logarithmic equations, partial fraction decomposition, systems of linear and nonlinear equations, functions in polar coordinates, and hyperbolic functions. This course may not be used to satisfy degree requirements in any program. **Effective From: Spring 2009**

Math 105 - Elementary Probability and Statistics (3-0-3)
Consider notions of probability. Topics include the binomial and normal distributions, expected value, and variance. The notions of sampling, hypothesis testing, and confidence intervals are applied to elementary situations. **Effective From: Fall 2011**

Math 106 - University Mathematics I A (4-1-4)
Prerequisite: Math 098 with a grade of C or better or Math 099 with a grade of C or better or placement by performance on standardized entrance examinations. Intended for students whose major requires Math 113 or Math 138. Intended for students whose major requires Math 113, Math 135 or Math 138. Consists of a series of projects, many of which introduce and use elementary differentiation and/or integration in which the students perform sustained algebraic and trigonometric computations. The projects involve the following topics: polynomials, rational expressions, expressions involving radicals, exponential and logarithmic functions, right triangle trigonometry, and the solution of linear and quadratic equations. Degree credit awarded for the following majors only: Hist, PTC and STS. **Effective From: Spring 2009 Until: Spring 2011**

Math 107 - University Mathematics BI (3-0-3)
Linear functions, equations, inequalities, systems of linear equations, quadratic equations, elementary functions, graphing functions. **Effective From: Fall 2012**

Math 107(archived) - University Mathematics II A (4-1-4)
Intended for students whose major requires Math 113 or Math 138. Prerequisite: Math 106 with a grade of C or better. Consists of a series of projects, many of which introduce and use elementary differentiation and/or integration in which the students perform sustained algebraic and trigonometric computations. The projects involve the following topics: radian measure, conic sections, trigonometric functions and identities, laws of sines and cosines, logarithmic equations, partial fraction decomposition, systems of linear and nonlinear equations, functions in polar coordinates, and hyperbolic functions. Degree credit awarded for the following majors only: Hist, PTC and STS. **Effective From: Spring 2009 Until: Spring 2011**

Math 108 - University Mathematics I B (4-1-4)
Intended for students whose major requires Math 111. Linear functions, equations, inequalities, systems of linear equations, quadratic equations, polynomials, rational expressions, expressions involving radicals, partial fraction decomposition, conic sections, graphing functions. **Effective From: Spring 2009**

Math 109 - University Mathematics II B (4-1-4)
Intended for students whose major requires Math 111. Prerequisite: Math 108 with a grade of C or better. Consists of a series of projects, many of which introduce and use elementary differentiation and/or integration in which the students perform sustained algebraic and trigonometric computations. The projects involve the following topics: radian measure, conic sections, trigonometric functions and identities, laws of sines and cosines, logarithmic equations, partial fraction decomposition, systems of linear and nonlinear equations, functions in polar coordinates, and hyperbolic functions. Degree credit awarded for the following majors only: Hist, PTC and STS. **Effective From: Spring 2009 Until: Spring 2011**

Math 110 - University Mathematics B II - Trigonometry (4-1-4)
Intended for students whose major requires Math 111. Perequisite: Math 108 or placement by performance on standardized entrance examinations. Trigonometric functions and identities, laws of sines and cosines, logarithmic equations, systems of nonlinear equations, polar coodinates. **Effective From: Fall 2011**

Math 111 - Calculus I (4-1-4)
Prerequisite: Math 139 with a grade of B or better, or placement by performance on standardized entrance examinations. Topics include limits, differentiation, applications of differentiation, and integration. **Effective From: Spring 2013**

Math 111H - Honors Calculus I (4-1-4)
Admission to this course is by invitation, based on standardized entrance exams. Topics enhance those of Math 111 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 112 - Calculus II (4-1-4)
Prerequisite: Math 111 with a grade of C or better or Math 132 with a grade of C or better. Topics include integration, applications of integration, series, exponential and logarithmic functions, transcendental functions, polar coordinates, and conic sections. **Effective From: Spring 2012**

Math 112H - Honors Calculus II (4-1-4)
Prerequisite: Math 111H with a grade of B or better or Math 111 with a grade of A or Math 132 with a grade of A. Topics enhance those of Math 112 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Fall 2012**

Math 113 - Finite Mathematics and Calculus I (3-0-3)

Prerequisite: (Intended for Architecture students.) Math 107 with a grade of C or better, or Math 108 with a grade of C or better, or NJIT placement. An introduction to differential and integral calculus. Applications include area, volumes, curve lengths, surface area, centroids, and moments. Focus is on application throughout the course. **Effective From: Fall 2013**

Math 114 - Finite Mathematics and Calculus II (4-0-4)
Prerequisite: (Intended for Architecture students.) Math 113 with a grade of C or better. Topics include numerical methods, set theory and counting, series, descriptive statistics and basic probability, matrices, and optimization. **Effective From: Spring 2009**

Math 115 - Elements of Geometry (3-0-3)
A modern approach to the elements of geometry grounded in real-world applications. Topics included basic axiomatic, Euclidean geometry, non-Euclidean geometry, and transformational geometry. Applications and examples in architecture, engineering and science are integrated throughout the course. **Effective From: Fall 2011**

Math 116 - Mathematics of Design (3-0-3)
The course is project oriented, covering theories of proportion; tiling, symmetry, symmetry groups, and informal geometry; fractals; theory of graphs and knots; three-dimensional design and polyhedra. The mathematics is oriented towards carrying out designs rather than a systematic development of mathematical theory. **Effective From: Fall 2011**

Math 120 - Basic Concepts in Statistics (1-0-1)
The course offers an introduction to the basic concepts in statistics. Topics include the role of statistics, data summary, normal distribution, elements of probability, and computation of mean and variance. This course will also include an introduction to statistical estimation and inference. **Effective From: Spring 2012**

Math 131 - Calculus A (4-1-4)
Prerequisites: Math 139 with a grade of B or higher and permission of the major advisor or placement. The course covers limits, continuity, differentiation, and related rates, also reviewing the foundations of algebra, precalculus, and trigonometry. (4-1-4) Math 131, 132, and 133 are equivalent to math 111 and math 112. **Effective From: Spring 2013**

Math 132 - Calculus B (4-1-4)
Prerequisites: Math 131 with a grade of C or higher or Math 111 with a grade of C or higher. The course covers optimization, integration, calculation of arc length, area, volume, and hyperbolic functions (4-1-4) Math 131, 132, and 133 are equivalent to Math 111 and Math 112 **Effective From: Fall 2011**

Math 133 - Calculus C (4-1-4)
Prerequisites: Math 132 with a grade of C or higher. The course covers integration, applications of integration, numerical integration, series, and polar coordinates. (4-1-4)Math 131, 132 and 133 are equivalent to Math 111 and Math 112. **Effective From: Fall 2011**

Math 135 - Calculus for Business (3-0-3)
Intended for students with major offered by SOM. Prerequisite: Math 107 with a grade of C or better or Math 108 with a grade of C or better or NJIT placement. An introduction to mathematics of business, principles of differential and integral calculus, and optimization. **Effective From: Fall 2013**

Math 138 - General Calculus I (3-0-3)
Intended for students who are not in Science or in Engineering. Prerequisite: Math 107 with a grade of C or better, or Math 108 with a grade of C or better or NJIT placement. An introduction to differential and integral calculus of a single variable. **Effective From: Fall 2013**

Math 139 - Trigonometry and Principles of Differential Calculus (4-1-4)
Prerequisites: Grade A in Math 108 or NJIT placement. Comprehensive review of trigonometry and pre-calculus topics integrated into an introduction to differential calculus. Topics covered include: Exponential, logarithmic and trigonometric functions, analytics trigonometry, conic sections, limits, derivatives, applications of differentiation. **Effective From: Fall 2013**

Math 211 - Calculus III A (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Topics include vectors, curvature, partial derivatives, multiple integrals, line integrals, and Green's theorem. Students who are considering a major in Mathematical Sciences or who are undecided about their major should take Math 213. **Effective From: Fall 2012**

Math 211H - Honors Calculus IIIA (3-0-3)
Prerequisite: Math 112H with a grade of B or better or Math 112 with a grade of A or Math 133 with a grade of A. Topics enhance those of Math 211 and concepts are studied in detail. **Effective From: Fall 2012**

Math 213 - Calculus III B (4-0-4)

Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Topics include vectors, curvature, partial derivatives, multiple integrals, line integrals, and Green's, divergence, and Stokes' theorems. **Effective From: Fall 2012**

Math 213H - Honors Calculus III (4-0-4)
Prerequisite: Math 112H with a grade of B or better or Math 112 with a grade of A or Math 133 with a grade of A. Topics enhance those of Math 213 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Fall 2012**

Math 222 - Differential Equations (4-0-4)
Prerequisite: Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Methods for solving ordinary differential equations are studied together with physical applications, Laplace transforms, numerical solutions, and series solutions. **Effective From: Fall 2012**

Math 222H - Honors Differential Equations (4-0-4)
Prerequisite: Math 112H with a grade of B or better or Math 112 with a grade of A or Math 133 with a grade of A. Topics enhance those of Math 222 and concepts are studied in detail. Emphasizes science and engineering applications. Effective From: Spring 2009 **Effective From: Fall 2012**

Math 225 - Survey of Probability and Statistics (1-0-1)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Topics include descriptive statistics, elements of probability, random variables and distributions; mean and variance; introduction to estimation and inference. This course satisfies the Mathematics GUR in probability and statistics. However, degree credit will not be granted for both Math 225 and any other upper level course in probability and/or statistics. **Effective From: Fall 2012**

Math 226 - Discrete Analysis (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. An introduction to discrete mathematics. An introduction to discrete mathematics. Topics include elementary set theory, logic, combinatorics, relations, and selections from graphs and trees and algebraic systems. **Effective From: Fall 2012**

Math 226H - Honors Discrete Analysis (4-0-4)
Prerequisite: grade of B or better in Math 112H or grade of A in Math 112 or a grade of A in Math 133. An introduction to discrete mathematics. Topics enhance those of Math 226 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 227 - Mathematical Modeling (4-0-4)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better and CS 115 with a grade of C or better or CS 113 with a grade of C or better or CS 100 with a grade of C or better or CS 101 with a grade of C or better. An introduction to the theory and practice of mathematical modeling. Techniques include scaling and dimension, fitting of data, linear and exponential models, elementary dynamical systems, probability, optimization, Markov chain modeling. Models are drawn from applications including biology, physics, economics, finance, and chemistry. **Effective From: Spring 2013**

Math 238 - General Calculus II (3-0-3)
Prerequisite: Math 138 with a grade of C or better or math 139 with a grade of C or better or Math 111 with a grade of C or better or placement. A continuation of Math 138. Topics include applications of integral calculus and an introduction to ordinary differential equations. **Effective From: Spring 2013**

Math 240 - Numerical Mathematics Laboratory (3-0-3)
Prerequisite: Math 112 with a grade of C or better, and CS 113 or knowledge of FORTRAN, C, or C++. Introduction to basic concepts and processes of numerical mathematics with emphasis on practical issues of implementation, use of numerical algorithms and software, and interpretation of numerical data. Weekly projects involving writing computer programs, presenting numerical results in tables and graphs, evaluation and approximation of standard numerical functions, round-off errors and loss of significance, basic iterative processes, matrix arithmetic, random number generation, and Monte Carlo methods. Students gain experience using a programming language, such as C, and mathematical software, such as MATLAB. **Effective From: Spring 2009**

Math 244 - Introduction to Probability Theory (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Topics include basic probability theory in discrete and continuous sample space, conditional probability and independence, Bayes' theorem and event trees, random variables and their distributions, joint distribution and notion of dependence, expected values and variance, moment generating functions, useful parametric families of distributions including binomial, geometric, hypergeometric, negative binomial, exponential, gamma, normal and their applications, simple case of central limit theorem and its uses. **Effective From: Fall 2012**

Math 245 - Multivariate Probability and Stochastic Processes (3-0-3)
Prerequisite: Math 244 with a grade of C or better or Math 333 with a grade of C or better. Topics include discrete and continuous multivariate distributions and their moments, multivariate normal distributions, order statistics, discrete and continuous Markov chains, Poisson processes, and Brownian motion processes. **Effective From: Spring 2009**

Math 246 - Introduction to Financial Mathematics ((3-0-3))
Prerequisite: Math 135 with a grade of C or better or Math 138 with a grade of C or better or Math 111 with a grade of C or better. An introduction to the basics of simple interest and discount, compound interest and discount, and simple annuities. This course is primarily intended for students whose major only requires Calculus I. It cannot be used for credit towards major or minor degrees offered by the Department of Mathematical Sciences. **Effective From: Spring 2009**

Math 279 - Statistics and Probability for Engineers (2-0-2)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. This course introduces methods of summarizing and analyzing engineering data and the importance of observing processes over time such as control charts. Descriptive statistics, plots and diagrams are then used to summarize the data. Elements of probability and random variables with their distributions along with mean and variance are taught. All this knowledge is then used as a platform towards covering how to do basic estimation and inference, including confidence intervals and hypothesis testing based on a single sample. Students taking this course cannot receive degree credit for Math 225, 244, or 333. **Effective From: Fall 2012**

Math 305 - Statistics for Technology (3-0-3)
Prerequisite: (Intended for students in Engineering Technology.) Math 111 with a grade of C or better, or Math 132 with a grade of C or better, or Math 138 with a grade of C or better. An introduction to the modern concepts of statistics needed by engineering technologists. Topics include organization of data, descriptive statistics, discrete and continuous probability distributions, sampling distribution and designs, estimation -- one and two populations, tests of hypotheses. **Effective From: Fall 2012**

Math 309 - Mathematical Analysis for Technology (3-0-3)
Prerequisite: Math 112 with a grade of C or better, or Math 133 with a grade of C or better or Math 238 with a grade of C or better. Emphasis on partial derivatives; vector calculus, and multiple integrals. **Effective From: Fall 2012**

Math 310 - Co-op Work Experience I (3 Credits)
Prerequisites: Completion of the sophomore year, departmental approval, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated and approved by the co-op office. Mandatory participation in seminars and completion of a report. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Math 321 - Introduction to the Finite Element Method (3-0-3)
Prerequisite: Math 222 with a grade of C or better. An elementary introduction to the theory and practice of the finite element method (FEM) is given. The mathematical underpinnings covered in this course include the basics of Sobolev spaces, Galerkin's method and various other weak formulations. Mathematical modeling of different physical problems and their solution techniques are also discussed. Existing finite element programs will be introduced through a course project. **Effective From: Spring 2009**

Math 322 - Differential Equations for Applications (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better or Math 238 with a grade C or better. An applied science study using differential equations as the vehicle for comprehension of the unknown. Introduction to first-order differential equations and their applications to motion, cooling and electromechanical systems followed by higher order differential equations and their solutions. Study of methods of undetermined coefficients, variation of parameters, and many series and numerical methods. Includes Laplace transforms, matrix methods, and eigenvalue problems. **Effective From: Fall 2012**

Math 326 - Discrete Analysis for Computer Engineers (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. An introduction to mathematical logic, Boolean algebra, and Karnaugh maps. Other topics include functions, equivalence relations and partially ordered sets, counting, graph theory and finite state machines. The emphasis is on computation but proofs will be addressed. Students cannot receive credit for both Math 226 and Math 326. **Effective From: Fall 2012**

Math 328 - Mathematical Methods for Scientists and Engineers (3-0-3)
Prerequisites: Math 211 with a grade of C or better, or Math 213 with a grade of C or better. Corequisite: Math 222. The course exposes students to concepts of mathematics encountered throughout the physical science and engineering disciplines. Topics include matrix algebra, vector analysis, complex numbers, and boundary value problems in partial differential equations. **Effective From: Spring 2009**

Math 331 - Introduction to Partial Differential Equations (3-0-3)
Prerequisite: Math 211 or Math 213 and Math 222 all with a grade of C or better. Partial differential equations in science and

engineering. Topics include initial- and boundary-value problems for parabolic, hyperbolic, and elliptic second-order equations. Emphasis is placed on separation of variables, special functions, transform methods, and numerical techniques. **Effective From: Fall 2010**

Math 331H - Honors Introduction to Partial Differential Equations (3-0-3)
Prerequisite: Grade of B or better in Math 222H and either grade of B or better in Math 221H or Math 213H. Or grade of A in Math 222 and either grade of A or grade of A in Math 213. Topics enhance those of Math 331 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 332 - Introduction to Functions of a Complex Variable (3-0-3)
Prerequisite: Math 211 or Math 213 and Math 222 all with a grade of C or better. Functions of a complex variable: Cauchy-Riemann equations, Cauchy-Goursat theorem, integration, series, residues, poles, geometrical aspects. Emphasis on techniques. **Effective From: Fall 2010**

Math 332H - Honors Introduction to Functions of a Complex Variable (3-0-3)
Prerequisite: Grade of B or better in Math 222H and either grade of B or better in Math 211H or Math 213H. Or grade of A in Math 222 and either grade of A in Math 211 or grade of A in Math 213. Topics enhance those of Math 332 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 333 - Probability and Statistics (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Descriptive statistics and statistical inference. Topics include discrete and continuous distributions of random variables, statistical inference for the mean and variance of populations, and graphical analysis of data. **Effective From: Fall 2012**

Math 333H - Honors Probability and Statistics (3-0-3)
Prerequisite: Math 112H with a grade of B or better or Math 112 with a grade of A or Math 133 with a grade of A. Topics enhance those of Math 333 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Fall 2012**

Math 334 - Operations Research (3-0-3)
Prerequisite: Math 244 with a grade of C or better or Math 333 with a grade of C or better. Considers mathematical methods found especially in contemporary fields such as operations research and reliability engineering. Topics include linear programming, graph theory, finite mathematics, differential equations, matrices, and determinants. **Effective From: Spring 2009**

Math 335 - Vector Analysis (3-0-3)
Prerequisite: Math 211 with a grade of C or better or Math 213 with a grade of C or better. Algebra and calculus of vectors. Topics include the theorems of Gauss, Green, and Stokes, and curvilinear coordinates. **Effective From: Spring 2009**

Math 336 - Applied Abstract Algebra (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Classical algebra from a modern and constructive viewpoint. Emphasis is on the development of algorithmic and computational skills. Topics include rings, fields, and groups and their applications to science and engineering. **Effective From: Fall 2012**

Math 337 - Linear Algebra (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. Matrices, determinants, systems of linear equations, vector spaces, linear transformations, eigenvalues, eigenvectors, and related topics. **Effective From: Fall 2012**

Math 337H - Honors Linear Algebra (3-0-3)
Prerequisite: Math 112H with a grade of B or better or Math 112 with a grade of A or Math 133 with a grade of A. Topics enhance those of Math 337 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Fall 2012**

Math 340 - Applied Numerical Methods (3-1-3)
Prerequisites: Math 211 with a grade of C or better or Math 213 with a grade of C or better, and CS 101 with a grade of C or better or CS 113 with a grade of C or better or CS 115 with a grade of C or better or Math 240 with a grade of C or better. Introduction to numerical methods with emphasis on mathematical models. Implements and investigates numerical techniques for the solution of linear and nonlinear systems of equations, eigenvalue problems, interpolation and approximation, techniques of optimization, Monte Carlo methods, and applications to ordinary differential equations and integration. **Effective From: Spring 2009**

Math 340H - Honors Applied Numerical Methods (3-0-3)
Prerequisites: CS 101 with a grade of C or better or CS 113 with a grade of C or better or CS 115 with a grade of C or better. Grade of B or better in Math 213H or grade of A in Math 211 or Math 213. Topics enhance those of Math 240 and concepts are

studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 341 - Statistical Methods II (3-0-3)
Prerequisite: Math 244 with a grade of C or better or Math 333 with a grade of C or better. Covers applications of classical statistical inference. Topics include transformation of variables, moment generating technique for distribution of variables, introduction to sampling distributions, point and interval estimation, maximum likelihood estimators, basic statistical hypotheses and tests of parametric hypotheses about means of normal populations, chi-square tests of homogeneity, independence, goodness-of-fit. **Effective From: Spring 2009**

Math 344 - Regression Analysis (3-0-3)
Prerequisite: Math 333 with a grade of C or better or Math 341 with a grade of C or better. An introduction to statistical data analysis using regression techniques. Topics include least squares estimation, hypothesis testing, prediction, regression diagnostics, residual analysis, variance stabilizing transformations, regression using indicator variables, variable selection, and model building. **Effective From: Spring 2009**

Math 345 - Multivariate Distributions (3-0-3)
Prerequisites: Math 244 with a grade of C or better or Math 333 with a grade of C or better. Topics include discrete and continuous multivariate distributions and their moments, multivariate distributions including multivariate normal and multinominal distributions, order statistics, conditional probability and the use of conditioning, discrete time Markov chains and their examples, discrete time branching processes, homogeneous and nonhomogeneous Poisson processes. **Effective From: Spring 2009**

Math 346 - Mathematics of Finance I (3-0-3)
Prerequisite: Math 112 with a grade of C or better or Math 133 with a grade of C or better. The main topics include basic problems in interest, annuities, certain amortization and sinking funds, bonds and related securities. **Effective From: Fall 2012**

Math 347 - Mathematics of Finance II (3-0-3)
Prerequisites: Math 346 and Math 244 or Math 333 all with a grade of C or better. This course introduces mathematical models of bond and stock prices, which lead to arbitrage pricing of options and other derivative securities, and portfolio management. These areas of mathematical finance have a great impact on the way financial markets function. Topics include risk-free, and risky assets, portfolio management, futures, and options. **Effective From: Fall 2010**

Math 371 - Physiology and Medicine (3-0-3)
Prerequisite: Math 222 with a grade of C or better. Mathematical models of organs and organ systems: the heart and circulation, gas exchange in the lungs, electrical properties of excitable membranes, neuro-biological clocks, the renal countercurrent mechanism, muscle mechanics. The biology is introduced with each topic. Emphasis is on quantitative problem solving, model building, and numerical simulation. **Effective From: Spring 2009**

Math 372 - Population Biology (3-0-3)
Prerequisite: Math 222 with a grade of C or better. Introduction to the mathematics of populations: Malthus' model of geometric population growth, Euler's renewal equations, age structure in human populations, predator satiation, chaos, mathematical models of inheritance, and the theory of epidemics. The ability to weave back and forth between physical concepts and mathematical notation is emphasized as well as the relationships between random and non-random models of similar phenomena. **Effective From: Spring 2009**

Math 373 - Introduction to Mathematical Biology (3-0-3)
Prerequisites: Math 211 with a grade of C or better or 213 with a grade of C or better or 213H with a grade of C or better and Math 337 with a grade of C or better. This course provides an introduction to the use of mathematical techniques applied to problems in biology. Discrete and continuous models of biological phenomena will be discussed. Biological topics discussed range from the subcellular molecular systems and cellular behavior to physiological problems, population biology and developmental biology. Techniques of phase plane analysis for differential equations are introduced in the course. No prior background in biology is necessary. **Effective From: Spring 2009**

Math 388 - Introduction to Chaos Theory (3-0-3)
Prerequisite: Math 211 with a grade of C or better or Math 213 with a grade of C or better. An elementary treatment of chaos theory and its applications concentrating on discrete dynamical systems. Uses theory and applications illustrated by computer experiments to develop such topics as bifurcation, attractors, the logistic map, period-doubling routes to chaos, symbolic dynamics, Sarkovskii's theorem, fractals, and Julia and Mandelbrot sets for complex dynamics. **Effective From: Spring 2009**

Math 391 - Numerical Linear Algebra (3-0-3)
Prerequisites: Math 337 with a grade of C or better and CS 113 with a grade of C or better or CS 115 with a grade of C or better or CS 101 with a grade of C or better. This course provides an introduction to computational linear algebra. Topics include direct solution of linear systems, iterative methods for linear systems, fast Fourier transforms, least squares problems, singular value

decomposition and eigenvalue/eigenvector problems. **Effective From: Spring 2009**

Math 401 - Undergraduate Research Seminar (1-1-1)
Research seminar intended for students who participate in year-long research projects. Methodologies and techniques needed for summer research projects are discussed. Presentations of current research topics are made by various faculty. **Effective From: Spring 2008**

Math 410 - Co-op Work Experience II (3 credits)
Prerequisites: Math 310 with a grade of C or better, departmental approval, and permission of the Office of Cooperative Education and Internships. Provides major-related work experience. Mandatory participation in seminars and completion of requirements that include a report and/or project. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Math 426 - Advanced Discrete Analysis (3-0-3)
Prerequisite: Math 226 with a grade of C or better or Math 326 with a grade of C or better. Topics include graphs, trees and their applications, grammars, finite state machines, Turing machines and Petri nets, applied combinatorics -- Stirling, Catalan, and Ramsey numbers, Polya-Burnside counting methods, finite Markov chains and coding theory. **Effective From: Spring 2009**

Math 430 - Analytical and Computational Neuroscience (3-1-3)
Prerequisites: Math 211 with a grade of C or better or Math 213 with a grade of C or better, and Math 222 with a grade of C or better, and CS 113 with a grade of C or better or CS 115 with a grade of C or better or Math 340 with a grade of C or better. A mathematical and computational introduction to the biophysical mechanisms that underlie physiological functions of single neurons and synapses. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, nerve impulse propagation in axons and dendrites, single- and multi-compartmental modeling, synaptic transmission, calcium handling dynamics and calcium dependent currents and processes. **Effective From: Fall 2013**

Math 431 - Systems Computational Neuroscience (3-1-3)
Prerequisites: MATH 430 with a grade of C or better or departmental approval. This course provides a mathematical and computational introduction to operations of neuronal systems and networks. Topics covered include central pattern generators, neuroethology of sensory systems, sensory-motor transformations, models of various brain regions, models of visual processes, large networks modeling, models of learning and memory, neural coding and mathematics of neural networks. **Effective From: Fall 2013**

Math 432 - Mathematics of Financial Derivatives I (Capstone I) (3-0-3)
Prerequisites: Math 222 with a grade of C or better and Math 346 with a grade of C or better. Mathematical analysis of models encountered in the area of financial derivatives. Topics include modeling and analysis of futures markets, determination of future prices, hedging strategies, swaps, option markets, stock options and their trading strategies. **Effective From: Spring 2009**

Math 433 - Mathematics of Financial Derivatives II (Capstone II) (3-0-3)
Corequisite: Math 340 with a grade of C or better. Math 432 with a grade of C or better. Mathematical analysis of models encountered in the area of financial derivatives with emphasis on numerical methods. Topics include: Binomial Trees, Black Scholes Models, Finite Difference Methods. **Effective From: Fall 2011**

Math 440 - Advanced Applied Numerical Methods (3-0-3)
Prerequisites: Math 331 with a grade of C or better and Math 340 with a grade of C or better. A survey of numerical methods for solving ordinary and partial differential equations. Includes initial-value and boundary-value problems for ordinary differential equations and for elliptic, hyperbolic, and parabolic partial differential equations. **Effective From: Spring 2009**

Math 440H - Honors Advanced Applied Numerical Methods (3-0-3)
Prerequisites: grade of B or better in Math 331 and grade of B or better in Math 340. Topics enhance those of Math 440 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 441 - Actuarial Mathematics I (3-0-3)
Prerequisite: Math 346 with a grade of C or better. Topics include the economics of insurance, individual risk models for a short term, survival distributions and life tables, life insurance per year, life annuities, and net premiums. **Effective From: Spring 2009**

Math 442 - Actuarial Mathematics II (3-0-3)
Prerequisite: Math 441 with a grade of C or better. Topics include net premium reserves, insurance models including expenses, nonforfeiture benefits, and dividends. **Effective From: Spring 2009**

Math 443 - Statistical Methods (3-0-3)
Prerequisite: Math 341 with a grade of C or better. Topics include complete sufficient statistics and uniformly minimum variance estimators, general linear hypotheses and related topics, nonparametric inference including rank and order statistics, permutation

methods, U-statistics, and Pitman efficiency. **Effective Until: Spring 1996**

Math 444 - Applied Sampling Methods and Quality Control (3-0-3)
Prerequisite: Math 333 with a grade of C or better, or Math 244 with a grade of C or better and Math 341 with a grade of C or better. An introduction to sample survey and statistical quality control. Topics include sampling from a finite population and different sampling techniques, more detailed study of random sampling and stratification, control charts and acceptance sampling plans in statistical quality control. **Effective From: Spring 2009**

Math 445 - Introduction to Experimental Design (3-0-3)
Prerequisite: Math 333 with a grade of C or better, or Math 244 with a grade of C or better and Math 341 with a grade of C or better. Basic concepts and principles of designs are covered. Topics include randomized blocks, Latin squares, factorial designs. **Effective From: Spring 2009**

Math 446 - Topics in Applied Statistics (3-0-3)
Prerequisite: Math 341 with a grade of C or better or Math 333 with a grade of C or better. Topics may include biostatistics, environmental statistics, statistical consulting. **Effective From: Spring 2009**

Math 447 - Applied Time Series Analysis (3-0-3)
Prerequisite: Math 341 with a grade of C or better or Math 333 with a grade of C or better. An introduction to applied univariate time series analysis. Topics include regression techniques for modeling trends, smoothing techniques (moving average smoothing, exponential smoothing), autocorrelation, partial auto-correlation, moving average, and autoregressive representation of series, Box-Jenkins models, forecasting, model selection, estimation, and diagnostic checking, Fourier analysis, and spectral theory for stationary processes. **Effective From: Fall 2010**

Math 448 - Stochastic Simulation (3-0-3)
Prerequisite: Math 333 with a grade of C or better and Math 340 with a grade of C or better. An introduction in the use of computer simulation to study stochastic models. Topics include the generation of samples of continuous and discrete random variables and processes with applications to stochastic models, statistical analysis of the results, and variance reduction techniques. **Effective From: Spring 2009**

Math 450H - Methods of Applied Mathematics I (Capstone I) (3-0-3)
Prerequisites: Math 331 with a grade of C or better, Math 337 with a grade of C or better, and Math 340 with a grade of C or better. Combines mathematical modeling with physical and computational experiments conducted in the Undergraduate Mathematics Computing Laboratory. **Effective From: Spring 2009**

Math 451H - Methods of Applied Mathematics II (Capstone II) (3-0-3)
Prerequisite: Math 450H with a grade of C or better. Small teams of students conduct research projects under the guidance of faculty members who perform applied research. **Effective From: Spring 2009**

Math 453 - High-Performance Numerical Computing (3-0-3)
Prerequisites: Math 391 with a grade of C or better and Math 440 with a grade of C or better. The course covers state-of-the-art numerical algorithms for solving large-scale problems accurately and efficiently. Topics include iterative methods for linear systems and eigenvalue computations, introduction to parallel program and parallel numerical algorithms and spectral methods. An instructor-selected advanced topic will be included in the course. **Effective From: Spring 2009**

Math 460 - Differential Geometry of Curves and Surfaces (3 credits)
Prerequisites: Math 222 with a grade of C or better. Curves in the plane and Euclidean space, moving frames, surfaces in Euclidean space, orientability of surfaces, Gaussian and mean curvatures, surfaces of revolution, ruled surfaces, minimal surfaces, special curves on surfaces, Theorema Egregium, the intrinsic geometry of surfaces. **Effective From: Spring 2009**

Math 473 - Intermediate Differential Equations (3-0-3)
Prerequisites: Math 222 with a grade of C or better and Math 337 with a grade of C or better. Topics in the qualitative behavior of solutions of ordinary differential equations with applications to engineering problems. Includes phase plane analysis, stability, dynamical systems, and chaos. **Effective From: Spring 2009**

Math 475 - Intermediate Partial Differential Equations (3-0-3)
Prerequisites: Math 331 with a grade of C or better and Math 337 with a grade of C or better. A survey of methods, beyond separation of variables, for analyzing and solving the fundamental partial differential equations of mathematical physics. Considers first-order equations, Laplace's equation, the wave equation, the heat equation, and linear hyperbolic systems. Emphasizes using methods of calculus to solve canonical initial- and boundary-value problems. **Effective From: Spring 2009**

Math 475H - Honors Intermediate Partial Differential Equations (3-0-3)
Prerequisites: Grade of B or better in Math 331H and Math 337H or Grade of A in Math 331 and Math 337. Topics enhance those

of Math 475 and concepts are studied in detail. Emphasizes science and engineering applications. **Effective From: Spring 2009**

Math 477 - Stochastic Processes (3-0-3)
Prerequisites: Math 244 with a grade of C or better or Math 333 with a grade of C or better and Math 337 with a grade of C or better. This course introduces the theory and applications of random processes needed in various disciplines such as mathematical biology, finance, and engineering. Topics include discrete and continuous Markov chains, Poisson processes, as well as topics selected from Brownian motion, renewal theory, and simulation. **Effective From: Spring 2009**

Math 480 - Introductory Mathematical Analysis (3-0-3)
Prerequisite: Math 211 with a grade of C or better or Math 213 with a grade of C or better. Builds on principles taught in basic calculus courses. Topics discussed include continuity, differentiation, integration, and the limit process of sequences and series. **Effective From: Spring 2009**

Math 481 - Advanced Calculus (3-0-3)
Prerequisite: Math 480 with a grade of C or better. Systematic development of partial differentiation, multiple and improper integrals, transformations, inverse and implicit function theorems, and integrals over curves and surfaces. **Effective From: Spring 2009**

Math 491 - Independent Study in Mathematics (3-0-3)
Prerequisites: Senior standing and departmental approval. Each student works under the direct supervision of a member of the Department of Mathematical Sciences. The work consists primarily of a project applying the student's mathematical skills to an engineering- or science-oriented project. **Effective From: Spring 2009**

Math 493 - Seminar in Actuarial Science (1-0-1)
Prerequisite: Departmental approval. A series of lectures by practicing actuaries on topics of technical and/or current practices. Subjects announced at the time of registration. Progress is evaluated through projects and term papers. A comprehensive report summarizing some aspect of special interest to the student is required. **Effective From: Spring 2009**

Math 495 - Topics in Applied Mathematics (3-0-3)
Prerequisites: Math 331 with a grade of C or better, Math 332 with a grade of C or better, and Math 340 with a grade of C or better, or departmental approval. A survey of selected areas of applied mathematics. Case histories of problems in applied mathematics from an industrial background. **Effective From: Spring 2009**

GRADUATE COURSES:

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, or departmental approval. Methods and applications for systems of ordinary differential equations: existence and uniqueness for solutions of ODEs, linear systems, stability analysis, phase plane and geometrical methods, Sturm-Liouville eigenvalue problems.

Math 590 - Graduate Co-op Work Experience I (3 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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 604 - Mathematical Finance (3-0-3)
Prerequisites: Fin 641 Derivatives, Math 605 Stochastic Calculus, or permission of the instructor. This course will explore the structure, analysis, and use of financial derivative instruments deployed in investment strategies and portfolio risk management. Topics include continuous time dynamics, arbitrage pricing, martingale methods, and valuation of European, American, and path dependent derivatives. **Effective From: Fall 2011**

Math 605 - Stochastic Calculus (3 credits)
This course provides an introduction to stochastic calculus. Topics include conditioning, Poisson processes, martingales, Brownian motion, Ito integrals, Ito's formula, stochastic differential equations, Feynman-Kac formula, Girsanov's theorem, and the martingale representation theorem. Financial applications include pricing, hedging, and interest rate models. **Effective From: Fall 2009**

Math 606 - Term Structure Models (3-0-3)
Prerequisites: Math 605, or permission of the instructor. Corequisite: Math 608. This course will develop the mathematical structure of interest rate models and explore the considerable hurdles involved in practical implementation. Short rate models, single and multifactor; the Heath-Jarrow-Morton framework; and modern Libor market models will be examined. **Effective From: Fall 2011**

Math 607 - Credit Risk Models (3-0-3)
Prerequisites: Math 604, 605, 606 or permission of the instructor. This course explores mathematical models and methods for credit risk measurement and rating. The nature of credit risk is reviewed through examination of credit instruments, including credit default swaps, collateralized debt obligations, and basket credit derivatives. These instruments, through which risk exposure opportunities and hedging possibilities are created and managed, are explored with respect to dynamics and valuation techniques, applying PDE methods and stochastic processes. **Effective From: Fall 2011**

Math 608 - Partial Differential Equations for Finance (3 credits)
This course presents the subject of partial differential equations (PDE's) with a strong emphasis on the PDE's arising in the study of stochastic processes and finance. The focus is on analytical and numerical methods for obtaining solutions in a form useful for solving problems in financial engineering. Topics include modeling with PDE's, classification of PDE's, analytical and numerical methods for PDE's and application to finance. **Effective From: Fall 2009**

Math 609 - Projects in Mathematical and Computational Finance (3-0-3)
Prerequisites: Math 604 Mathematical Finance, Math 605 Stochastic Calculus, Math 606 Term Structure Models, or permission of the instructor. This project course requires students to demonstrate attained mastery of the material studies in the prerequisite courses. Projects also extend students? knowledge of specific areas beyond that covered in earlier courses into areas such as particle filtering or optimization techniques for term structure model calibration. The aim is to broaden the students? classroom focus to the more unconstrained, open ended and less well defined contexts that are frequently encountered in practice. **Effective From: Fall 2011**

Math 610 - 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 is given several basic papers or books on a research topic of current interest. The student prepares two lectures on his/her topic to be given at the end of the semester. A sample list of active fields of research includes acoustics, electromagnetic theory, elasticity, fluid dynamics, combustion, and mathematical biology. **Effective From: Fall 2010**

Math 611 - Numerical Methods for Computation (3 credits)
This course provides a practical introduction to numerical methods. Numerical solution of linear systems. Interpolation and quadrature. Interative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial and boundary value problems for ODE's. Introduction to numerical solution of PDE's. Applicatons drawn from science, engineering, and finance. **Effective From: Spring 2009**

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 615 - Approaches to Quantitative Analysis in the Life Sciences (3 credits)
A graduate seminar-style course based around case studies of common data analytic methods used in the life sciences. The case studies are designed to help students who are interested in applications of statistical thinking to biological sciences appreciate the scope of quantitative methods, their underlying concepts, assumptions and limitations. While the mathematics of specific methods are not covered, students of the course will get an understanding of the diverse approaches to statistical inference in the life sciences. **Effective From: Fall 2009**

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 639 - Mathematical Modeling II (3-0-3)
Continuation of Math 613 (Advanced Applied Mathematics I, Modeling). Concepts and strategies of Mathematical modeling are developed by case studies in a selection of areas. Topics will be complementary to those presented in Math 613, and include for example, the mathematical theory of elasticity and electromagnetism. **Effective From: Fall 2006**

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 - Methods of Applied Mathematics I (3 credits)
Prerequisite: Math 222 or departmental approval. A survey of mathematical methods for the solution of problems in the applied sciences and engineering. Topics include: ordinary differential equations and elementary partial differential equations. Fourier series, Fourier and Laplace transforms, and eigenfunction expansions.

Math 652 - Methods of 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 654 - Clinical Trials Design and Analysis (3 credits)
Prerequisites: Math 665 or equivalent with Departmental approval. Statistical methods and issues in the design of clinical trials and analysis of their data. Topic include clinical trial designs for phases 1-4, randomization principle and procedures, analysis of pharmacokinetic data for bioequivalence, multi-center trials, categorical data analysis, survival analysis, longitudinal data analysis, interim analysis, estimation of sample size and power, adjustment for multiplicity, evaluation of adverse events, and regulatory overview. **Effective From: Fall 2007**

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 659 - Survival Analysis (3 credits)
Prerequisites: Math 665 or equivalent with Departmental approval. Introduction to statistical methods for modeling time-to-event data in the presence of censoring and truncation, with emphasis on applications to the health sciences. Topics include survival and hazard functions, censoring and truncation, parametric and nonparametric models for survival data, competing-risks, regression models including Cox proportional hazards model and time-dependent covariates, one and two sample tests, and use of appropriate statistical software for computations. **Effective From: Fall 2007**

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 661 and Math 663 cannot both be used toward degree credits at NJIT. **Effective From: Fall 2010**

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 663 - Introduction to Biostatistics (3-0-3)
Prerequisites: Undergraduate Calculus. Introduction to statistical techniques with emphasis on applications in health related sciences. This course will be accompanied by examples from biological, medical and clinical applications. Summarizing and

displaying data; basic probability and inference; Bayes' theorem and its application in diagonostic testing; estimation, confidence intervals, and hypothesis testing for means and proportions; contingency tables; regression and analysis of variance; logistic regression and survival analysis; basic epidemiologic tools; use of statistical software. Math 661 and Math 663 cannot both be used toward degree credits at NJIT. **Effective From: Fall 2010**

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 665 - 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. **Effective From: Fall 2007**

Math 666 - Simulation for Finance (3 credits)
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/Math 666. **Effective From: Spring 2010**

Math 668 - Probability Theory (3 credits)
The subject matter of this course deals with the foundations of axiomatic probability - based on abstract measure theory, stochastic convergence, limit theorems, conditional expectations and martingales - is aimed primarily at Ph.D. level students. Modified pre-requisite require appropriate background in real analysis. Course content remains unchaged. **Effective Until: Fall 2008**

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 688 - Mathematical and Statistical Methods in Materials Science (3 credits)
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science. **Effective From: Fall 2006**

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. **Effective From: Spring 2006**

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, 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 is given several basic papers or books on a research topic of current interest. The student prepares two lectures on his/her topic to be given at the end of the semester. A sample list of active fields of research includes acoustics, electromagnetic theory, elasticity, fluid dynamics, combustion, and mathematical biology. **Effective Until: Summer 2010**

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 credits)
Prerequisite: Math 712 and proficiency in a computer programming language (FORTRAN, C, or C++). Derivation and analysis of finite difference schemes for systems of partial differential equations in two and three spatial dimensions and time. Issues pertaining to efficient implementation of algorithms and to stability of physical and numerical boundary conditions. Pseudo-spectral and spectral methods to solve partial differential equations. Approximation properties of Fourier and Chebyshev series and techniques based on the Fast Fourier Transform (FFT) and on matrix multiplication to numerically compute partial derivatives. Time-discretization techniques suitable for use with pseudo-spectral and spectral methods. Model systems arising in wave propagation, fluid dynamics, and mathematical biology will be considered.

Math 715 - Mathematical Fluid Dynamics I (3-0-3)
Introduction to the basic ideas of fluid dynamics, with an emphasis on rigorous treatment of fundamentals and the mathematical developments and issues. The course focuses on the background and motivation for recent mathematical and numerical work on the Euler and Navier-Stokes equations, and presents a mathematically intensive investigation of various model equations of fluid dynamics (e.g., the Korteweg-de-Vries equations). **Effective From: Fall 2005**

Math 716 - Mathematical Fluid Dynamics II (3-0-3)
Continuation of Math 715. Further development of the ideas of fluid dynamics, with an emphasis on mathematical developments and issues. A selection of topics will be developed in some detail, for example: Stokes flow and low-Reynolds-number hydrodynamics; flow at high Reynolds number and boundary layers; shock waves and hyperbolic systems; dynamics of interfacial flows; hydrodynamic stability; rotating fluids. **Effective From: Fall 2005**

Math 717 - Inverse Problems and Global Optimization (3-0-3)
Introduction to inverse problems and global optimization. Linear, quasi-linear, and nonlinear inverse problems are studied with emphasis on regularization techniques. Bayesian statistical approaches and Monte Carlo methods are introduced and discussed in the context of inverse problems. The mathematical foundations of simulated annealing, genetic algorithms, and TABU are presented. **Effective From: Fall 2006**

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 722 - Wave Propagation (3-0-3)
Derivation of linear wave equations describing acoustic, electromagnetic, elastodynamic and hydrodynamic phenomena. Fundamental solutions and their application to initial value problems. Applications and solution of boundary value problems using Green's functions, image and spectral methods. Related time harmonic problems, including radiation, scattering, diffraction and transmission phenomena. Dispersive waves and the method of stationary phase. Linear waves in anisotropic media. **Effective From: Fall 2006**

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. **Effective Until: Spring 2007**

Math 763 - Generalized Linear Models (3 credits)

Prerequisites: Math 662 and Math 665 or departmental approval. Theoretical and applied aspects of generalized linear models. Classical linear models, nonlinear regression models, and generalized estimating equations. **Effective From: Fall 2011**

Math 767 - Fast Numerical Algorithms (3-0-3)
The course covers state-of-the-art, analysis-based, fast numerical algorithms for computing discrete summations/transforms and for solving differential/integral equations. In particular, this course presents fast multiple methods and their descendants, including fast Fourier transform for nonequispaced data, fast Gauss transform, fast iterative solver and direct solver for elliptic boundary value problems. **Effective From: Fall 2008**

Math 768 - Probability Theory (3 credits)
Prerequisite: Math 645 or departmental approval. Measure theoretic introduction to axiomatic probability. Probability measures on abstract spaces and integration. Random variables and distribution functions, independence, 0-1 laws, basic inequalities, modes of convergence and their interrelationships, Laplace-Stieltjes transforms and characteristic functions, weak and strong laws of large numbers, conditional expectation, discrete time martingales. **Effective From: Spring 2009**

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 (0 credit)
All master's and doctoral students receiving departmental or research-based awards must register for this course each semester. **Effective From: Fall 2006**

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: Mechanical Engineering

UNDERGRADUATE COURSES:

ME 215 - Engineering Materials and Processes (2-2-3)
Prerequisite: Chem 126 or Chem 122. Students also must register for the lab component. Combined lecture and laboratory relating to the study of engineering materials. Processes of formation from liquid and particle state, plastic forming, molding deformation, and metal removal. Effects of heat treatment on material properties. Laboratory exercises involve basic machine tools and computer-controlled equipment. **Effective From: Spring 2013**

ME 231 - Kinematics of Machinery (3-0-3)
Prerequisites: CIS 101, Mech 234. Design, selection, and evaluation of mechanisms for various applications. Topics include displacement, velocity, and acceleration analysis of planar linkages, synthesis of function generators and motion generators, design of cams, gear-tooth geometry and analysis of gear trains.

ME 304 - Fluid Mechanics (3-0-3)
Prerequisites: Mech 236, ME 311. Introduction to the basic principles of conservation of mass, momentum, and energy as they apply to engineering systems which utilize fluids. Some of the topics are dimensional analysis, theoretical and empirical analysis of one-dimensional compressible and incompressible flow, empirical analysis of external and internal flows, and elementary boundary layer theory.

ME 305 - Introduction to System Dynamics (3-0-3)
Prerequisites: Math 222, Mech 236, ME 231. Principles of dynamic system modeling and response with emphasis on mechanical, electrical, and fluid systems. Application of computer simulation techniques.

ME 310 - Co-op Work Experience I (zero credits)
Prerequisites: completion of freshman year, approval of department, and permission of the Office of Cooperative Education and Internships. Students gain major-related work experience and reinforcement of their academic program. Work assignments facilitated by the co-op office and approved by the department. Mandatory participation in seminars and completion of a report. **Effective From: Fall 2011**

ME 311 - Thermodynamics I (3-0-3)
Prerequisites: Math 211, Phys 111. Thermodynamic fundamentals. Topics are the first and second laws of thermodynamics, physical properties of pure substances, entropy, ideal and real gases, and gaseous mixtures.

ME 312 - Thermodynamics II (3-0-3)
Prerequisite: ME 311. A continuation of ME 311 including studies of irreversibility and combustion. Thermodynamic principles are applied to the analysis of power generation, refrigeration, and air-conditioning systems. Introduction to solar energy thermal processes, nuclear power plants, and direct energy conversion.

ME 315 - Stress Analysis (3-0-3)
Prerequisites: Math 222, Mech 237, ME 215. Problems related to mechanical design. Topics include two-dimensional elasticity, transformation of stress and strain, plane stress problems, axisymmetric members, buckling criteria, and failure theories.

ME 316 - Machine Design (3-0-3)
Prerequisites: ME 231, ME 315. Aspects of the design process and design of machine elements. Mini-projects are used to introduce engineering design procedures.

ME 339 - Fundamentals of Mechanical Design (3-0-3)
Prerequisite: Mech 234. For industrial engineering majors. Topics include kinematics of mechanisms, machine components, and a brief intro-duction to mechanical vibrations. Students gain the ability to deal with design problems from the viewpoint of a non-specialist.

ME 343 - Mechanical Laboratory I (2-2-3)
Prerequisites: EE 405, Math 225, Mech 236. Corequisite: ME 304. Students also must register for the lab component. Laboratory and lecture in instrumentation and measurement for mechanical engineering students. Applications for the sensing of such variables as pressure, tem-perature, mass flow, and displacement. Particular attention to the applicability and sensitivity of instruments.

ME 403 - Mechanical Systems Design I (2-1-3)
Prerequisites: ME 304, ME 305, ME 312, ME 316. Corequisite: ME 407. Lectures and projects covering problem solving methodology in the design, analysis, and synthesis of mechanical and thermal systems. The student's academic background combines with engineering principles and topics to serve as a foundation for broad engineering projects. Emphasis on creative thinking and the engineering design process in projects involving the optimal conversion of resources.

ME 405 - Mechanical Laboratory II (1-2-2)
Prerequisite: ME 343, ME 312. Corequisite: ME 407. Laboratory emphasizing the use of fundamental principles and instrumentation systems for the analysis and evaluation of mechanical components within a system.

ME 406 - Mechanical Laboratory III (1-2-2)
Prerequisite: ME 405, ME 407. Laboratory covering the testing and evaluation of complete mechanical systems.

ME 407 - Heat Transfer (3-0-3)
Prerequisites: Math 222, ME 304, ME 311. A study of the three fundamental modes of heat transfer: conduction, convection, and radiation. A physical interpretation of the many quantities and processes in heat transfer using numerical methods. Theory is applied to the analysis and design of heat exchangers and other applications. Where appropriate, computer simulation is used.

ME 408 - Mechanical Systems Design II (1-2-2)
Prerequisite: ME 403, ME 407. A continuation of ME 403 from a more integrated viewpoint, with lectures on special topics. Concepts in optimization and computer simulation are considered in the design and synthesis of mechanical engineering systems. The projects are more comprehensive, emphasizing creative design, and requiring design decisions of a more sophisticated nature.

ME 410 - Co-op Work Experience II (3 credits)
Prerequisites: ME 310, approval of the department, and permission of the Office of Cooperative Education and Internships. Full-time work experience of approximately one semester's duration. Provides major related work experience as co-op/internship. Mandatory participation in seminars and completion of requirements that include a report and project. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

ME 415 - Advanced Manufacturing Processes (3-0-3)
Prerequisites: ME 215 and ME 316. A lecture course discussing principles of conversion of liquid and solid materials in products. The notion of the Unit Manufacturing processes is used to analyze advanced technologies of the change of mass, geometry, composition, phases and structure. **Effective From: Spring 2009 Until: Spring 2012**

ME 425 - Finite Element Method in Mechanical Engineering (3-0-3)
Prerequisites: CIS 101, Math 222, and Mech 237. Introduction to central ideas underlying the finite element method in mechanical engineering and its computer implementation. Fundamental concepts such as interpolation functions for one- and two-dimensional elements, bar element method, Galerkin's method, discretization of a model, methods of assembling global matrices, and the final solution techniques for obtaining nodal values. Specific applications to mechanical engineering problems in trusses, beams, torsion, heat transfer, fluid flow, plane stress, and plane strain.

ME 430 - Introduction to Computer-Aided Design (2-2-3)
Prerequisites: CIS 101, Math 222. Introduction to basic concepts of computer-aided design as applied to mechanical engineering design problems. Topics include numerical techniques, computer graphics, geometric modeling, design optimization, and databases for design. The laboratory uses current CAD software packages for mechanical design. Projects involve applications of the basic principles using student's own as well as available software.

ME 431 - Introduction to Robotics and Automation (3-0-3)
Prerequisites: CIS 101, Mech 236. Introduction to mechanics and control of robotic manipulators. Topics include spatial transformations, kinematics, dynamics, trajectory generation, actuators and control, and relations to product design and flexible automation.

ME 432 - Principles of Air Conditioning and Refrigeration (3-0-3)
Prerequisites: ME 304, ME 312; Corequisite: ME 407. A course in the fundamentals of air conditioning and refrigeration. Topics covered are psychometrics, cooling and heat load calculations, air distribution systems, duct design, vapor compression and

absorption systems, and the principles of cooling towers.

ME 433 - Vibration Analysis (3-0-3)
Prerequisites: Mech 236, Math 222. An introduction to the fundamental theory of mechanical vibrations. Undamped and damped systems with single and multiple degrees of freedom, transient vibration, vibrations of continuous media, and analog and numerical methods. **Effective From: Spring 2013**

ME 435 - Thermodynamics (3-0-3)
Prerequisites: Math 211, Phys 111. Intended for non-mechanical engineering students of all disciplines. Topics include the basic laws of thermodynamics, properties of fluids and solids, analysis of open and closed systems, gas and vapor power cycles, refrigeration and air conditioning, and an introduction to heat transfer. Cannot be taken for credit by mechanical engineering students.

ME 437 - Structural Analysis (3-0-3)
Prerequisite: ME 315. Fundamentals of structural analysis. Consideration of stresses and deflections of beams as well as the design of beams, columns, trusses, and structural connections of steel, reinforced concrete, and timber structures.

ME 438 - Introduction to Physical Metallurgy (3-0-3)
Prerequisites: Chem 126 or Chem 122, and ME 215. Introduction to metallic microstructures, solid solutions and the mechanical properties of metals and alloys. Physical understanding of diffusion processes is emphasized in covering the relationship between the nature of metals and different heat treating processes. **Effective From: Spring 2013**

ME 439 - Principles of Tribology (3-0-3)
Prerequisites: Chem 126, Mech 237. An introduction to the principles of wear resistance of machine parts and tribology. Physical understanding of different mechanisms of wear and friction and methods of increasing durability.

ME 441 * - Computer Simulation and Analysis in Mechanical Engineering (2-2-3)
Prerequisites: ME 430. This course covers various topics in Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE). The course provides an in-depth understanding and skill of constructing 2-D drawings using well-known commercial CAD package, and integrating 3-D solid modeling techniques into simulation, and analysis animation of new designs using commercial CAD/CAE software. The students will have hands-on experience to analyze Structure, Heat Transfer, and Computational Fluid Dynamics problems by using several different software packages. The course also focuses on CAD Product Data Exchange using both Direct Database conversion and International Standards based conversion methods between major CAD/CAE systems. Typical industrial applications will be illustrated.

ME 451 - Introduction to Aerodynamics (3-0-3)
Prerequisites: ME 304, ME 311. Introduction to the basic principles and properties of fluid flow around immersed bodies. Topics include the kinematics and dynamics of fluid fields, the thin airfoil, finite wing theory, and one-dimensional compressible flow.

ME 452 - Dynamics of Space Flight (3-0-3)
Prerequisites: Mech 236, Math 222. An introduction to the mechanics of space flight. After a brief introduction to the physics of the solar system, the dynamics of space flight are developed from the Newtonian viewpoint. Covers the performance and propulsion methods of rocketry.

ME 454 - Compressible Flow (3-0-3)
Prerequisites: ME 304, ME 312, Math 222. Equations of one-dimensional compressible flow. Topics are flows with variable areas, friction, mass addition, heat addition, normal shocks, and combination of these effects. Special topics in two-dimensional flows such as oblique shocks. **Effective Until: Spring 2012**

ME 455 - Automatic Controls (3-0-3)
Prerequisite: ME 305. Introduction to the principles of automatic controls. Emphasis on systems, considering their mechanical, hydraulic, pneumatic, thermal, and displacement -aspects. First and second order linear systems. Introduction to system analysis techniques such as Nyquist and Bode diagrams and applications in system design.

ME 470 - Engineering Properties of Plastics (3-0-3)
Prerequisites: ME 215, Mech 237. A study of the physical properties of the various commerical thermosetting and thermoplastic resins. An introduction to linear viscoelastic theory and its relationship to measurable mechanical properties of plastics. Also, engineering properties such as flammability, chemical resistance, and electrical properties.

ME 471 - Introduction to Polymer Processing Techniques (3-0-3)
Prerequisites: ME 304, ME 407. A study of the various plastics processing techniques, including extrusion, injection molding, blow molding, compression molding, thermoforming, rotational molding, casting, etc. The relationship between product design and choice of process will be presented.

ME 472 - Introduction to Biomechanical Engineering (3-0-3)
Prerequisites: ME 316 or equivalent; or permission of the instructor. Introduction to biomechanical engineering integrating the principles of mechanics with the notions of physiology into simple mathematical models consisting of sets of governing equations. Topics include anatomy; basic concepts and definitions of biomechanical engineering; basic solid mechanics such as human force and motion; basic fluid mechanics such as the cardiovascular system and blood circulation; engineering design of general assistive devices. **Effective Until: Spring 2012**

ME 490 - Mechanical Engineering Project A (3-0-3)
Prerequisites: departmental approval required. One or more individually selected projects. Projects usually require library research, design, cost analysis, planning of testing. Also involves an engineering report and a technical presentation.

ME 490H - Honors Mechanical Engineering Project I (3-0-3)
Prerequisites: member of Honors College and departmental approval required. Similar to ME 490.

ME 491 - Mechanical Engineering Project B (3-0-3)
Prerequisite: ME 490 and departmental approval required. One or more selected projects. Projects usually require library research, design, cost analysis, planning of testing. Also involves an engineering report and a technical presentation.

ME 491H - Honors Mechanical Engineering Project II (3-0-3)
Prerequisites: member of Honors College, and departmental approval required. Similar to ME 491.

GRADUATE COURSES:

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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, thermodynamics, heat transfer and differential equations. Fundamentals of

conduction, convection and radiation heat transfer. Practical engineering applications of heat exchangers including the design approaches by Mean Temperature Difference and Effectiveness-NTU methods, fins, convection fouling factors, and variable property analysis. **Effective From: Fall 2006**

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: undergraduate differential equations and system dynamics. One-, Two- and Multiple degree of freedom systems, Lagrange's equation of motion, Runge-Kutta computation, Finite Element Method and classical methods for normal mode analysis, matrix notation and iteration procedure, and Fourier series representation for the solution of vibration problems. **Effective From: Fall 2006**

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)
The course presents the basics of nanotechnology and the principles and application of advanced instrumentation for the characterization of nanostructures. Topics include atomic force microscopy, near-field optics, dielectric spectroscopy, and light scattering. The significant component of the course is laboratory work at the W. M. Keck Foundation Laboratory and research project. **Effective From: Fall 2007**

ME 620 - Stress Methods in Mechanical Design (3 credits)
Prerequisites: undergraduate differential equations and strength of materials. Governing equations and solutions for analysis and design of structural and machine elements; appropriate boundary conditions to investigate pipes and rods subjected to shrink and force fits; rotating disks of uniform and variable thickness; beam and plate elements; and thermal stresses and stress concentrations in mechanical design. **Effective From: Fall 2006**

ME 621 - Energy Methods in Mechanical Design (3 credits)
Prerequisites: undergraduate differential equations and strength of materials. Use of energy methods to design structural and machine elements. Includes approximate solutions for problems using conservation of energy and several variational approaches; the role of energy in failure criteria; combined loads; and the relationship of variational methods to the development of finite element solutions. **Effective From: Fall 2006**

ME 622 - Finite Element Methods in Mechanical Engineering (3 credits)
Prerequisites: undergraduate differential equations and strength of materials. Using variational formulation and Ritz approximation, element equations for bar, beam, potential flow, heat transfer, torsion of a solid bar and plane elasticity problems are derived and solved with computer programs. **Effective From: Fall 2006**

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 632 - Mechanical Engineering Measurements (3 credits)
This course offers extensive mechanical engineering lab experience, including measurement fundamentals, hands-on experiments, uncertainty analysis, technique comparison, and professional engineering reports. It also focuses on the fundamental principles behind each methodology and relevant applications. The topics cover measurement in major mechanical engineering areas including thermodynamics, thermofluids, and control. Specialized experiments include fluidization, CAD/CAM, and NC machining. Comparisons of experimental results against theoretical or computational results are also required. **Effective From: Fall 2009**

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: undergraduate linear algebra (matrices operation) and differential equations. Adaptation of computer for solving engineering design problems; design morphology; simulation and modeling; algorithms; problem-oriented languages; use of available software; computer graphics, and automated design. **Effective From: Fall 2006**

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: Knowledge of Pro/Engineer (or IDEAS). Structure and properties of plastics including stress-strain behavior and the effect of fillers and reinforcements. Designing for impact, flexure, shear, friction, puncture, creep and fatigue. Case studies of structural, electrical, and optical applications. **Effective From: Fall 2006**

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 791 - Graduate Seminar and Professional Presentations (0 credits)
Regular attendance required of all students in the Mechanical Engineering PhD program. Each PhD student is required to make a 15 minute presentation on a topic related to the student's research with an additional 10 minutes to address audience questions. The seminar participants eveluate each speaker. **Effective From: Fall 2006**

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

UNDERGRADUATE COURSES:

Mech 234 - Engineering Mechanics (2-0-2)
Prerequisites: Phys 111, Math 112. A course for industrial and mechanical engineering students in which the equilibrium of particles and rigid bodies subject to concentrated and distributed forces is studied.

Mech 235 - Statics (3-0-3)
Prerequisites: Phys 111, Math 112.Provides an understanding of equilibrium of particles and rigid bodies subject to concentrated and distributed forces.

Mech 236 - Dynamics (2-0-2)
Prerequisites: Mech 234 (or Mech 235 with a grade of C or better or Mech 320). Provides an understanding of the mathematics of the motion of particles and rigid bodies, and of the relation of forces and motion of particles. **Effective From: Fall 2011**

Mech 236H* - Honors Dynamics (2-0-2)**
Prerequisites: Mech 234 or Mech 235 and enrolled in the Honors College. Course material similar to Mech 236 except in addition, the student will be involved in a research project.

Mech 237 - Strength of Materials (3-0-3)
Prerequisites: Mech 235 with a grade of C or better (or Mech 234 for IE, ME majors) and a working knowledge of statics with emphasis on force equilibrium and free body diagrams. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions. Lab should be taken concurrently

Mech 320 - Statics and Strength of Materials (3-0-3)
Prerequisites: Phys 111, Math 112. For chemical engineering and electrical engineering majors. Statics provides an understanding of the equilibrium of particles and rigid bodies, including simple machines, trusses, and frictional forces. Mechanics of materials covers pressure vessels, thermal stresses, torsion of shafts, stresses and deflection in beams, and column action.

Mech 320H - Honors Status and Strength of Materials (3-0-3)**
Prerequisites: Phys 111, Math 112, and enrolled in the Honors College. For chemical engineering, electrical engineering, and biomedical engineering majors. Course material similar to Mech 320 except in addition, the student will design and perform several laboratory tests.

GRADUATE COURSES:

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. **Effective Until: Fall 2011**

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

UNDERGRADUATE COURSES:

NURS 301 - Theory and Practice of Professional Nursing (3-0-3)
Building on the historical and theoretical foundations of the profession, students explore the theme of health, the continuum of health illness, the sociocultural variations that influence health and response to illness, and the many dimensions of health. Nursing interventions are explored in relation to ethical, social, legal, political, and personal issues as students clarify their own professional identity, responsibility and power.

NURS 302 - Comprehensive Health Assessment (3-0-3)
Focuses on total health assessment with differentiation between normal and abnormal findings. The total health assessment content focuses on individuals across the life span. Emphasis is placed on data collection and analysis through history and physical examination.

NURS 304 - Nursing Informatics (4-0-4)
Computer applications for nursing. Exposes students to PC-based and mainframe computer systems through computer laboratory and field experiences.

NURS 305 - Adaptations and Alterations in Body Functions (3-0-3)
Reviews and extends fundamental concepts of physiology and changes that produce signs and symptoms and the body's remarkable ability to compensate for these illness-related changes. Findings will establish the database for formulating appropriate nursing strategies.

NURS 306 - Pharmacology (2-0-2)
Prerequisite or corequisite: NURS 305. Reviews and extends students? previous knowledge of pharmacological science. Explores mechanisms of actions of drugs used to treat various health conditions at the cellular level.

NURS 307 - Epidemiology in Nursing Practice (2-0-2)
An introduction to population-based approach to health care. Incorporate information on the etiology and predictors of events in order to design health promotion and disease prevention strategies.

NURS 401 - Patterns of Community Health (3-6-6)
Prerequisites: completion of all NURS 300-level courses. Focuses on nursing knowledge and interventions directed to enhance community health for diverse populations. Clinical practicum focusing on clients with diverse needs and in a variety of settings enhances classroom learning.

NURS 402 - Environmental and Occupational Health (4-0-4)
Prerequisites: completion of all NURS 300-level courses. Prepares students to assess changes in health status related to the environment or the workplace. Students are provided with the skills needed to evaluate, and recommend control strategies for the phenomena.

NURS 403 - Nursing Care Delivery Systems (3-6-6)
Prerequisites: completion of all NURS 300-level courses. Focuses on the professional nurse's leadership and management role within health care systems. The multi-faceted aspects of the role of the nurse as a leader and manager are explored in depth, with emphasis on the role of the nurse as change agent. Includes organizational behavior, decision-making, the change process, the management of health care delivery, and nursing care within health care organizations.

NURS 404 - Research Applications in Nursing Practice (3-0-3)
Prerequisites: Completion of all NURS 300-level courses. Prepares students to critically analyze nursing issues from an applied research perspective.

GRADUATE COURSES:

R705:504 - Human Diversity and Social Issues in the Community (3 credits)
For more details go to Rutgers Catalog.

R705:534 - Community Health Nursing Theory II (3 credits)
For more details go to Rutgers Catalog.

Operations Managment :

Offered by the School of Management. See Management course list for faculty.

UNDERGRADUATE COURSES:

OM 375 - Management Science (3-0-3)
Prerequisite: Mgmt 216. Introduction to statistical and mathematical techniques used in management decision making. Develop the concepts of management science and use its techniques with unrestricted focus. Operations management applications are made in factory settings, health-care and other service industries, education and government agencies.

OM 475 - Production Planning and Control (3-0-3)
Prerequisites: OM 375, junior or senior standing. The components and functioning of in-production, planning, and control systems. Material, equipment, and labor requirements for optimizing continuous and intermittent manufacturing operations. The use of a computer to simulate such models.

OM 476 - Quality Control (3-0-3)
Prerequisites: OM 375, junior or senior standing. Deals with measuring, and improving the performance of the service and/or production processes being managed. Performance assessment is an important component of any management system's excellence. In managing a service-oriented or a manufacturing-based company, performance measurement and analysis should be built into the management processes of identifying and overcoming problems that are central to continuous improvement. The topics include cost analysis, control and improvement, continuous quality improvement, and the other assessment methods for planning and controlling production and service company-wide.

GRADUATE COURSES:

R711:585 - Control Models (3 credits)
For more details go to Rutgers Catalog.

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Abbreviations

The following abbreviations are used in this catalog:

GMAT	-	Graduate Management Admission Test
GPA	-	Grade Point Average
GRE	-	Graduate Record Examinations
GUR	-	General University Requirements
LSAT	-	Law School Admission Test
MCAT	-	Medical College Admission Test
TOEFL	-	Test of English as a Foreign Language
Rutgers-New Brunswick	-	Rutgers University, New Brunswick campus
UMDNJ	-	University of Medicine and Dentistry of New Jersey

Degree Programs

- Applied Physics
- Architecture
- BioChemistry
- BioInformatics
- Biology
- Biomedical Engineering
- BioPhysics
- Business
- Business and Information Systems
- Chemical Engineering
- Chemistry
- Civil Engineering
- Communication and Media
- Computational Sciences
- Computer Engineering
- Computer Science
- Computing and Business
- Digital Design
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- Engineering Science
- Engineering Technology
  - Computer Technology
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  - Construction Engineering Technology
  - Construction Management Technology
  - Electrical and Computer Engineering Technology
  - Mechanical Engineering Technology
  - Medical Informatics Technology
  - Surveying Engineering Technology
  - Technology Education Option
  - Telecommunications Management Technology
- Environmental Science
- Fine Arts
- History
- Human-Computer Interaction
- Industrial Design

Courses

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- Afro-American and African Studies
- Anthropology
- Architecture
- Art Design
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- Biology
- Biomedical Engineering
- Career Development Services
- Chemical Engineering
- Chemistry
- Civil Engineering
- Classics
- Communication and Media
- Computer Science
- Co-op
- Criminal Justice
- Digital Design
- Economics
- Education, Science, Technology and Society
- Electrical and Computer Engineering
- Engineering Design
- Engineering Graphics
- Engineering Science
- Engineering Technology
  - Computer Technology
  - Concrete Industry Management
  - Construction Engineering Technology
  - Construction Management Technology
  - Electrical and Computer Engineering Technology
  - Manufacturing Engineering Technology
  - Mechanical Engineering Technology
  - Medical Informatics Technology
  - Surveying Engineering Technology

- Industrial Engineering
- Information Systems
- Information Technology
- Interior Design
- International Business
- Law, Technology and Culture
- Mathematical Sciences
  - Applied Math
  - Applied Statistics
  - Mathematical Biology
  - Mathematics of Finance and Actuarial Science
- Mechanical Engineering
- Science, Technology and Society
- Theatre Arts and Technology
- Web and Information Systems

  - Telecommunications Management Technology
- English
- Entrepreneurship
- Environmental Engineering
- Environmental Policy Studies
- Environmental Science
- Finance
- Fine Arts
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- Geology
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- Industrial Engineering
- Information Systems
- Information Systems Management
- Information Technology
- Interior Design
- International Studies
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- Journalism, Writing and Media
- Literature
- Management
- Marketing
- Materials Science and Engineering
- Mathematics
- Mechanical Engineering
- Mechanics
- Nursing
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5. IT Project Management
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affordablecollegesonline.org

Affordable Colleges Online ranked NJIT 3rd in "AC Online's Highest Return on Investment Colleges in New Jersey" ranking.

AC Online analyzed 162 colleges in New Jersey and ranked the top 24 colleges that provided students the biggest return on investment. Colleges were ranked based on several criteria including:

[Browse the interactive viewbook](#) »
[Download the viewbook as a PDF](#) »

Considering NJIT? Join us for an Open House!

Graduate Open Houses

Thursday, August 1, 2013
5:00PM to 7:30PM
Fenster Hall, Room 100, Admissions Office
Reserve Your Spot.

Thursday, August 15, 2013
5:00PM to 7:30PM
Campus Center Atrium
Reserve Your Spot.

- Net tuition prices (Provided by IPEDS/NCES)
- Graduate's average starting salaries and ROI calculation (Provided by Payscale)
- Fully accredited, 4-year not-for-profit institutions (Provided by the Carnegie Foundation)

Read more.

Related Links

- Info for guidance counselors
- Info for transfer counselors
- Info for parents

Registrar

Office of the Registrar

COMMENCEMENT INFORMATION

Fall and Spring Registration Instructions

2013 January Graduates

2013 May Graduates

2013 August Candidates for Graduation

Complete Academic Calendars

Sep	2	Monday	Labor Day
Sep	3	Tuesday	First day of classes Fall semester
Sep	7	Saturday	Saturday classes begin
Sep	9	Monday	Last day to add a course
Sep	10	Tuesday	W grades posted for course withdrawals
Oct	21	Monday	Last day for 25% refund based on total withdrawal - No refund for total withdrawal after this date
Nov	4	Monday	Last day to withdraw
Nov	4	Monday	Spring Registration Begins
Nov	26	Tuesday	Follow Thursday schedule
Nov	27	Wednesday	Follow Friday schedule
Nov	28	Thursday	Thanksgiving Recess - no classes
Nov	29	Friday	Thanksgiving Recess - no classes

Registrar @ Your Service

Online:Highlander Pipeline

24-Hour Email

Student Mall Staff

Spring/Fall Office Hours:
M-Th-F, 8:30 a.m.-4:30 p.m.
T-W, 8:30 a.m.-6:00 p.m.

Summer Hours
M-F, 8:30 a.m.-5:00 p.m

- **NJIT Privacy Policy**
- **Customer Service Credo**
- **Campus Directory**
- **Visiting NJIT: Maps and Directions**

Dec	11	Wednesday	Last day of classes
Dec	12	Thursday	Reading Day
Dec	13	Friday	Final exams begin
Dec	19	Thursday	Final exams end
Dec	20	Friday	Final grades due on Registrar's Office
Jan	20	Monday	Martin Luther King, Jr. Day
Jan	21	Tuesday	First day of classes Spring semester
Jan	25	Saturday	Saturday classes begin
Jan	27	Monday	Last day to add a course

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NJIT New Jersey Institute of Technology
THE EDGE IN KNOWLEDGE

Information for: **Current Students**

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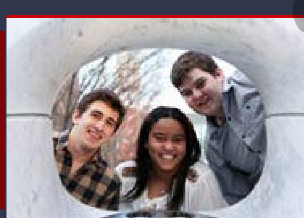
August 30
First Year Connections 2.0
NJIT Campus



September 02
University Closed
NJIT Campus

September 03
Fall 2013 Semester Classes Begin
NJIT Campus

September 04
Welcome Back Greek Block Party!
Campus Green & Atrium
2pm

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

Contact Us | **Maps & Directions**

NJIT Course Catalog Archives

The archived online NJIT Undergraduate and Graduate Catalogs are the same as those in print. These archives are not indexed for website searches and are in PDF format.

Current (2011-2012)

- Undergraduate
- Graduate

Undergraduate Catalogs

- 2009-2010
- 2007-2008
- 2004 - 2005
- 2003-2004
- Fall 2000 (This catalog contains all changes to courses and academic programs through May, 2000.)
- 1997-2000
- 1994-1997
- 1991-1994

Graduate Catalogs

- 2009-2010
- 2007-2008
- 2004 - 2005
- 2003-2004
- Spring 2000 (This catalog contains all changes to courses and academic programs approved through December 1999.)
- 1996-1999
- 1992-1995

Pharmaceutical Engineering

Administered By: Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering

Administration

Program Director	Piero M. Armenante
Associate Director	Laurent Simon

Program Objective:
The Master of Science Program in Pharmaceutical Engineering is a program developed and administered by the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering at NJIT. The primary objective of the program is to educate professionals and provide them with the skills required to work in the pharmaceutical field, with particular emphasis on the engineering aspects of drug manufacturing, pharmaceutical production, pharmaceutical development, and pharmaceutical operations.

The pharmaceutical/medical technology industry is the largest manufacturing industry in New Jersey. New Jersey is home to the headquarters of more global pharmaceutical and medical technology companies than any other state in the country, or any single country throughout the world. NJIT's M.S. program in Pharmaceutical Engineering provides the intellectual climate and the necessary tools needed to prepare students for positions and career advancement within the industry, based on the rigorous technological requirements of this highly regulated work environment.

The program is designed to provide opportunities for specialization in such areas as pharmaceutical processing and manufacturing, validation and regulatory issues in the pharmaceutical industry, pharmaceutical facility design, pharmaceutical packaging technology, reaction engineering for pharmaceutical production, pharmaceutical separation processes, pharmacokinetics and drug delivery, molecular modeling for drug discovery, pharmaceutical synthesis, fluid mixing in the pharmaceutical industry, instrumental analysis, and industrial quality control.

Master of Science in Pharmaceutical Engineering

Admission Requirements:
An undergraduate degree in chemical engineering or, in most cases, mechanical engineering, with a cumulative grade point average (GPA) of at least 3.0 on a 4.0 scale is usually required. Applicants with: (1) a science degree, (2) an engineering degree in a discipline other than chemical or mechanical engineering, or (3) a GPA below 3.0 but at least 2.8, may be conditionally admitted to the program. Conditions may involve completion of a bridge program designed on a case-by-case basis, and typically requiring taking extra bridge courses, as further explained below. Depending on the background of the student, admission conditions may additionally require taking undergraduate courses (e.g., chemistry) or graduate courses. Bridge and undergraduate courses do not count toward degree credit; graduate-level courses do.

Submission of Graduate Record Examination (GRE) scores is encouraged in all cases, and required of those seeking financial support and those whose last prior degree is from an institution outside the United States. International students must also submit scores from the Test of English as a Foreign Language (TOEFL). According to university policy, a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based) is required.

The admission requirements described above can be partially relaxed for applicants with significant industrial experience in the pharmaceutical industry (5+ years). The admission requirements for such candidates will be established on a case-by-case basis, and will be determined through an interview with the prospective student and the submission of letters of support attesting the level of experience attained.

Bridge Program:
The Pharmaceutical Engineering program has been designed so that applicants with different backgrounds can be admitted. Nevertheless, the program is strongly oriented toward the engineering component of "Pharmaceutical Engineering". In addition, since the pharmaceutical industry is a chemistry-based industry a chemical engineering background is the most appropriate to enter the program (mechanical engineers are also generally well prepared to enter the program). This implies that students who have a science background (e.g., a chemistry or pharmacy B.S. degree) or an engineering degree in a discipline other than chemical or, possibly, mechanical engineering, may be required to take a bridge program. 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. The 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).

A grade point average of at least 3.0 must be achieved in the bridge courses. Students should pay special attention to the successful completion of the bridge courses, since failure to do so may preclude them from enrolling in regular PhEn courses. PhEn 500 and PhEn 501 can and should be taken concurrently. Both courses are only offered in the fall semester. Successful completion of both PhEn 500 and PhEn 501 is required to enroll in PhEn 502, which is offered only in the spring semester. Students must take the bridge courses before taking any other PhEn courses, with the exception of PhEn 601 and PhEn 604, which can be taken concurrently with the bridge courses. As already mentioned, admission conditions may also include taking additional undergraduate or graduate courses, if needed.

Degree Requirements:
The Master of Science in Pharmaceutical Engineering is a 30-credit program structured along two different tracks. The two tracks have a common 15-credit core. Each track has an additional 6-credit track-core, as described below. Each track has 9 credits of electives selected by the student in consultation with, and subject to, the approval of the program advisor for the selected track

Students have the option of fulfilling 6 of the 9 credits of electives by doing a Master's Thesis. The thesis option is primarily, but not exclusively, meant for full-time students. Full-time students receiving support (full or partial) must complete a Master's Thesis. Part-time students working in the pharmaceutical industry are encouraged to pursue a Master's Thesis, possibly conducted at their site and in collaboration with their supervisor.

Students must maintain an overall cumulative grade point average of at least 3.0 throughout their academic career. Students are certified for graduation only if they:

- achieve an OVERALL cumulative grade point average of at least 3.0; and
- achieve a grade point average of at least 3.0 in the required seven CORE COURSES; and
  achieve a grade point average of at least 3.0 in the BRIDGE COURSES.

Students may not repeat a course without approval of both the Program Director and the Office of Graduate Studies, located in the East Building, Suite 140. The grade received in a repeated course will replace the original grade in the calculation of the cumulative grade point average, although the first grade will still appear on the transcript. A MAXIMUM OF TWO COURSES MAY BE REPEATED. Students who receive an F in a course are required to repeat the course.

Program of Study:
The program of study includes common core courses, track-specific core courses, elective courses, and, if the students so chooses, a thesis (in lieu of some elective courses), as specified below. The common core courses cover a variety of topics ranging from drug dosage forms to drug manufacturing processes, validation and regulatory issues, design criteria and unit operations for pharmaceutical processes, pharmacokinetics and drug delivery.

The program has two tracks, i.e.:

- Track 1 - Process Development and Design for Drug Substance Manufacturing. This track is focused on the engineering aspects of chemical reaction and separation processes required for the manufacturing of active pharmaceutical ingredients.
- Track 2 - Process Development and Design for Drug Product Manufacturing. This track is focused on the engineering aspects of processes required for the manufacturing of final drug products.

All students must take the same five (5) common core courses as well as the two (2) track-specific core courses for the track that they have selected. Irrespective of the track selected, the total number of core courses (7) and the corresponding core credits (21) are the same for both tracks.

Course Requirements:

- Five (5) core courses common to both tracks (3 credits each; 15 credits total), as follows:

		PhEn 601	Principles of Pharmaceutical Engineering (3 credits)
		PhEn 603	Pharmaceutical Unit Operations: Processing of Liquid and Dispersed Phase Systems (3 credits)
		PhEn 604	Validation and Regulatory Issues in the Pharmaceutical Industry (3 credits)
		PhEn 606	Pharmaceutical Unit Operations: Solids Processing (3 credits)
		PhEn 618	Principles of Pharmacokinetics and Drug Delivery (3 credits)

- Two (2) additional core courses specific to the track selected (3 credits each; 6 credits total), as follows:

Track 1 � Process Development and Design for Drug Substance Manufacturing:

		PhEn 612	Pharmaceutical Reaction Engineering (3 credits)
		PhEn 614	Pharmaceutical Separation Processes (3 credits)

Track 2 � Process Development and Design for Drug Product Manufacturing:

		PhEn 602	Pharmaceutical Facility Design (3 credits)
		PhEn 605	Pharmaceutical Packaging Technology (3 credits)

- Three (3) additional elective courses (3 credits each) selected from the list of available courses (9 credits total). Electives can be selected from among pharmaceutical engineering courses (such as the courses in the track not chosen by the student), as well as appropriate courses in disciplines such as chemical engineering, mechanical engineering, industrial engineering, biomedical engineering, chemistry, biology, mathematics, and others. A partial list of electives is provided below.

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. Part-time students working in the pharmaceutical industry are eligible and encouraged to pursue the thesis option. NJIT requires that a student must register for thesis during the last semester before graduation, even if this requires taking addition thesis credit beyond the required 6.

List of Elective Courses:
The following is a non-exhaustive, partial list of courses that can be taken as elective courses [all courses are 3-credits unless otherwise stated]:

		PhEn 602	Pharmaceutical Facility Design (3 credits)
		PhEn 605	Pharmaceutical Packaging Technology (3 credits)
		PhEn 612	Pharmaceutical Reaction Engineering (3 credits)
		PhEn 614	Pharmaceutical Separation Processes (3 credits)
		PHEN616	
		PhEn 700	Master's Thesis (3 credits)
		PhEn 701	Master's Thesis (6 credits)
		PhEn 702	Selected Topics in Pharmaceutical Engineering (3 credits)
		PhEn 725	Independent Study (3 credits)
		BME 627	Introduction to Biomedical Engineering (3 credits)
		BME 672	Biomaterials (3 credits)
		BME 675	Computer Methods in Biomedical Engineering (3 credits)
		ChE 611	Thermodynamics (3 credits)
		ChE 624	Transport Phenomena I (3 credits)
		ChE 626	Mathematical Methods in Chemical Engineering (3 credits)

		ChE 628	Biochemical Engineering (3 credits)
		ChE 656	Industrial Catalysis: Fundamentals & Applications (3 credits)
		ChE 675	Statistical Thermodynamics (3 credits)
		ChE 681	Polymerization-Principles and Practice (3 credits)
		Chem 601	Special Topics in Chemistry I (3 credits)
		Chem 602	Advanced Organic Chemistry II: Reactions (3 credits)
		Chem 603	Advanced Organic Chemistry Laboratory (3 credits)
		Chem 605	Advanced Organic Chemistry I: Structure (3 credits)
		Chem 606	Physical Organic Chemistry (3 credits)
		Chem 644	Fundamentals of Adhesion (3 credits)
		Chem 658	Advanced Physical Chemistry (3 credits)
		Chem 661	Instrumental Analysis Laboratory (3 credits)
		Chem 664	Advanced Analytical Chemistry (3 credits)
		Chem 673	Biochemistry (3 credits)
		CS 610	Data Structures and Algorithms (3 credits)
		CS 631	Data Management System Design (3 credits)
		EM 636	Project Management (3 credits)
		EM 637	Project Control (3 credits)
		EM 640	Distribution Logistics (3 credits)
		IE 604	Advanced Engineering Statistics (3 credits)
		IE 605	Engineering Reliability (3 credits)
		IE 618	Engineering Cost and Production Economics (3 credits)
		IE 672	Industrial Quality Control (3 credits)
		IE 673	Total Quality Management (3 credits)
		IE 674	Quality Maintenance and Support Systems (3 credits)
		IE 704	Sequencing and Scheduling (3 credits)
		ME 624	Microlevel Modeling in Particle Technology (3 credits)
		ME 664	Experiments and Simulations in Particle Technology (3 credits)
		MnE 601	Computerized Manufacturing Systems (3 credits)
		MnE 602	Flexible and Computer Integrated Manufacturing (3 credits)

Student Involvement in Research:
In addition to taking courses, students have the opportunity to work, one-on-one, with faculty members on research projects in areas of common interest, allowing maximum flexibility for independent work, and providing students with valuable research experience. Students have the option to complete a Master's thesis. PART-TIME STUDENTS WORKING IN THE PHARMACEUTICAL INDUSTRY ARE ENCOURAGED TO PURSUE A MASTER'S THESIS, POSSIBLY CONDUCTED AT THEIR SITE AND IN COLLABORATION WITH THEIR SUPERVISOR.

Qualified and research oriented students have the option of continuing their studies at NJIT by pursuing a Ph.D. in chemical engineering, industrial engineering, chemistry, or related disciplines. The NJIT-Industry Collaborative Ph.D. Program allows greater flexibility to industrial students who are interested in pursuing their Ph.D. while working full-time in industry.

For further information please contact:

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Catalog and curricula information approved by the relevant academic department.

Pharmaceutical Systems Management

Administered By: Department of Mechanical and Industrial Engineering

Program Director:	Sanchoy K. Das

Pharmaceutical Systems Management

The MS program in Pharmaceutical Management (MSPhM) is designed to train and educate professionals for careers in the pharmaceutical industry by providing them with skills in the areas of quantitative systems analysis, planning and design of pharmaceutical process operations, and project management and implementation, relative to all technology intensive operations in this highly sophisticated industry. Application areas will include manufacturing operations, systems automation, packing and distribution, quality control and regulatory compliance, process and product validation, and supply chain management. Offered by the Department of Industrial and Management Systems Engineering in collaboration with the Pharmaceutical Engineering program, degree integrates a strong focus on technical oriented operations management with advanced knowledge of pharmaceutical manufacturing, validation, research and development processes.

DEGREE REQUIREMENTS: A minimum of 30 credits beyond a B.S. degree is required. A thesis or independent research is optional.

ADMISSION REQUIREMENTS: A B.S. degree in an engineering, information technology, science, or related technical discipline. A bridge program is also available for suitable candidates from other majors. Individuals who have been working in the pharmaceutical industry for two or more years, and are now looking for additional skills to further progress their careers would be ideal candidates.

CORE COURSES (18 credits)

EM 602	Management Science (3 credits)
EM 636	Project Management (3 credits)
IE 673	Total Quality Management (3 credits)
IE 618	Engineering Cost and Production Economics (3 credits)
PhEn 601	Principles of Pharmaceutical Engineering (3 credits)
PhEn 604	Validation and Regulatory Issues in the Pharmaceutical Industry (3 credits)

ELECTIVE COURSES: (12 credits-select 4)

EM 634	Legal, Ethical and Intellectual Property Issues for Engineering Managers (3 credits)
EM 635	Management of Engineering Research and Development (3 credits)
IE 699	Special Topics in Industrial Engineering (3 credits)
EM 637	Project Control (3 credits)
IE 659	Supply Chain Engineering (3 credits)
IE 621	Systems Analysis and Simulation (3 credits)
MnE 601	Computerized Manufacturing Systems (3 credits)

		PhEn 605	Pharmaceutical Packaging Technology (3 credits)
		PhEn 602	Pharmaceutical Facility Design (3 credits)
		HRM 601	Organizational Behavior (3 credits)

Catalog and curricula information approved by the relevant academic department.

Physics

Administered By: Physics Departments of NJIT and Rutgers-Newark

Administration

Chairperson (NJIT)	N M. Ravindra
Chairperson (Rutgers-Newark)	Grace Spruch
Coordinators of Joint Graduate Programs	Haimin Wang
Undergraduate Program Advisors	Keun H. Ahn, Andrew J. Gerrard, Andrei Sirenko, Gordon A. Thomas, Tao Zhou
Administrative Coordinator	Renee Crawley
Administrative Assistant	Leslie M. Williams
Customer Service Representative	Cindy Montalvo-Harden

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Professors	Andrei Sirenko, Andrew J. Gerrard, Ken K. Chin, N M. Ravindra, Gordon A. Thomas, Andrei Sirenko, Andrew J. Gerrard
Associate Professors	Nissim M. Towfik, Onofrio L. Russo, Camelia Prodan, Tao Zhou
Assistant Professors	Wenda Cao, Keun H. Ahn
Distinguished Research Professors	Louis J. Lanzerotti
Research Professors/Special Lecturers	Reginald Farrow, Anthony T. Fiory, Oktay H. Gokce, Richard H. Janow, Jeongwoo Lee, Libarid A. Maljian, Gelu M. Nita, Halina Opyrchal, Jan Opyrchal, Slawomir Piatek, Vitaly A. Shneidman, George E. Georgiou, Andres Jerez

Rutgers- Newark Faculty

Professors Rank II	Daniel Murnick
Professor	Zhen Wu
Associate Professor	Martin Schaden
Associate Professor Lecturer	John Rollino
Administrative Assistant	Elizabeth Wheeler

Degrees Offered: Master of Science in Physics; Doctor of Philosophy in 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 degree physics in a joint program combining the resources of two of New Jersey's public research universities.

Interdisciplinary physics research is available in collaboration with faculties of NJIT, Rutgers-Newark and Rutgers-New

Brunswick, and 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 Renewable Energy Laboratory, National Solar Observatory, Lucent Technologies Bell Labs Innovations, U.S. Army Research Laboratory, and other industrial and federal research laboratories.

Master of Science in Physics

The program is for students with an undergraduate degree in physics, applied physics, or engineering, who wish to apply physics to biological problems, optical science, microelectronics, device physics, materials science, solar cells, surface science, laser physics, solar phenomena, and other related areas.

Admission Requirements:
A bachelor's degree in physics, applied physics, or related areas from an accredited institution is required. An undergraduate GPA above 3.0 is required. Students must submit GRE (general test) scores. In addition, applicants are required to provide letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550 (pencil and paper) and 213 (computer-based).

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 R755:791 Applied Physics Seminar.

Required:
12 credits:

R755:611	Advanced Classical Mechanics (3 credits)
R755:621	Classical Electrodynamics (3 credits)
R755:631	Quantum Mechanics (3 credits)
R755:641	Statistical Mechanics (3 credits)

Project or Thesis (required):
3 credits:

R755:700	Master's Project (3 credits) ***or***
R755:701	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 Physics

This program is for students in applied physics that are interested in and committed to scholarly research.

Admission Requirements:
Applicants are expected to have a master's degree in physics, applied physics, or related engineering disciplines from an accredited institution. Highly qualified students with bachelor's degrees may be accepted directly into the doctoral program. A GPA of at least 3.5 in undergraduate and previous graduate studies is normally required for admission. The GRE (general test) and advanced (physics) test scores are required. Applicants are required to provide three letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550 (pencil and paper) and 213 (computer-based).

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 R: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 R755:790 Doctoral Dissertation

Seminar: All doctoral students must enroll in R755:791 Applied Physics Seminar each semester, including each semester they are enrolled in R755:790 Doctoral Dissertation.

Required:
18 credits:

R755:611	Advanced Classical Mechanics (3 credits)
R755:621	Classical Electrodynamics (3 credits)
R755:631	Quantum Mechanics (3 credits)
R755:641	Statistical Mechanics (3 credits)
R755:721	Classical Electrodynamics II (3 credits)
R755:731	Quantum Mechanics II (3 credits)

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.

Power and Energy Systems

Administered By: Department of Electrical and Computer Engineering

Administration

Chair	Leonid Tsybeskov
Associate Chair (Undergraduate)	Marek Sosnowski
Associate Chair (Graduate)	Durgamadhab Misra

Faculty

Distinguished Professors	Yeheskel Bar-Ness, Atam P. Dhawan, Bernard Friedland, Jacob Savir
Professors	Ali N. Akansu, Nirwan Ansari, John D. Carpinelli, Haim Grebel, Richard A. Haddad, Alexander M. Haimovich, Durgamadhab Misra, Edip Niver, Yun-qing Shi, Kenneth S. Sohn, Marek Sosnowski, Leonid Tsybeskov, Gerald Whitman, Mengchu Zhou, Sotirios G. Ziavras
Associate Professors	Ali Abdi, Hongya Ge, Sui-hoi E. Hou, Walid Hubbi, Roberto Rojas-Cessa, Osvaldo Simeone
Assistant Professors	Abdallah Khreishah
University Lecturers	Mohammed Feknous, Serhiy P. Levkov, Timothy W. Steele

Advisors

Undergraduate Advisor	Shivon S. Boodhoo
Undergraduate Advisor Upper Division and Transfers	Marek Sosnowski
MS Electrical Engineering Advisor	Durgamadhab Misra
PHD Electrical Engineering Advisor	Durgamadhab Misra
MS Computer Engineering Advisor	Mengchu Zhou
PHD Computer Engineering Advisor	Durgamadhab Misra
MS Telecommunications Advisor	Roberto Rojas-Cessa
MS Internet Engineering Advisor	Roberto Rojas-Cessa
MS Power and Energy Systems Advisor	Mengchu Zhou

Master of Science in Power and Energy Systems

Master of Science in Power and Energy Systems (PES)

A program for students with an undergraduate degree in engineering who wish either to specialize in an advanced phase of electrical power engineering and energy systems to prepare for a more advanced degree.

Admission Requirements:

Applicants are expected to have undergraduate backgrounds in physics, mathematics (through differential equations and vector analysis), electrical networks and devices, electronics, analysis and design methods, transients, electromagnetic fields, and appropriate laboratory work in some of these areas. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 79 out 120 (or 550 in the old score system). For further information, see the Admissions section in this catalog.

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 (3-0-3)
		ECE 232	Circuits and Systems II (3-1-3)
		ECE 333	Signals and Systems (3-0-3)
		ECE 341	Energy Conversion (3-0-3)
		ECE 361	Electromagnetic Fields I (3-0-3)
		ECE 362	Electromagnetic Fields II (3-0-3)
		ECE 372	Electronic Circuits II (3-0-3)

Graduate Certificate Program:

A 12-credit graduate certificate in Power and Energy Systems is available and can be taken as a step toward this degree. See Graduate Certificates in the Degree Programs section of this catalog. For further information, call the Associate Vice President of Continuing and Distance Education, Division of Continuing Professional Education, 1 (800) 624-9850 or (973) 596-3060; e-mail cpe@njit.edu.

Degree Requirements:

This master's program consists of 30 credits that can include 6 credits of a master thesis (ECE 701), or 3 credits of a master's project (ECE 700). As a requirement for graduation, students must achieve a 3.0 cumulative GPA in graduate-level courses, not including the master's thesis or project. The project grade must be B or better.

The course requirements are shown in the following table.

Core Courses: (9 Credits) (3 courses are required from the following):

		ECE 601	Linear Systems (3 credits)
		ECE 610	Power System Steady-State Analysis (3 credits)
		ECE 612	Computer Methods Applied to Power Systems (3 credits)

Specialized Courses/Electives: Group A: Minimum 9 credits (3 courses) are required:

		ECE 611	Transients in Power Systems (3 credits)
		ECE 613	Protection of Power Systems (3 credits)
		ECE 616	Power Electronics (3 credits)
		ECE 698	Selected Topics in Electrical and Computer Engineering (3 credits)
		Mgmt 620	Management of Technology (3 credits)

Electives: Group B: 12 credits (non-thesis), 9 credits with Project (3 credits), or 6 credits with Thesis (6 credits) are required from the following:

		ECE 618	Renewable Energy Systems (3 credits)
		ECE 698	Selected Topics in Electrical and Computer Engineering (3 credits)
		ECE 617	Economic Control of Interconnected Power Systems (3 credits)
		ECE 698	Selected Topics in Electrical and Computer Engineering (3 credits)
		ME 607	Advanced Thermodynamics (3 credits)
		ME 610	Applied Heat Transfer (3 credits)

	*	EnE 671	Environmental Impact Analysis (3 credits)
		IE 614	Safety Engineering Methods (3 credits)
		Mgmt 620	Management of Technology (3 credits)
		Mgmt 691	Legal and Ethical Issues (3 credits)
	*	Mgmt 692	Strategic Management (3 credits)

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* Mgmt 692 and other business and management courses can be included as optional electives based on the student background, instructor approval and advisor approval.

Catalog and curricula information approved by the relevant academic department.

Professional and Technical Communication

Administered By: Department of Humanities

Administration

Chairperson	Carol S. Johnson
Program Director Graduate	Nancy W. Coppola

Faculty

Professors	Nancy W. Coppola, Norbert Elliot, Burt J. Kimmelman
Associate Professors	Carol S. Johnson, Nancy L. Steffen, Christopher T. Funkhouser
Assistant Professors	Philip A. Klobucar
Adjuncts	Robert P. Myre, Blake Haggerty, Kenneth C. Ronkowitz

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 communication professionals who want to develop abilities in

- Social media
- user-centered design
- usability testing and knowledge management
- advanced communication theory and research methods
- technical editing
- writing and speaking in teams, in corporations, and in technology

Masters of Science in Professional and Technical Communication

Please see our web site http://www.njit.edu/MSPTC for updated information.

The Master of Science in Professional and Technical Communication (MSPTC) prepares students for careers in the rapidly growing field of technical communication. This degree enables students to acquire an understanding of information technologies and to approach communication issues with new problem-solving skills. Professional experts will provide strong theoretical foundations within a practical framework. The MSPTC is entirely and only available online (in distance learning format).

Admission Requirements:
Students must have an undergraduate degree in any field with strong interest in science and technology and must submit the following.

- a statement outlining how the degree will meet personal and professional objectives;
- a current resume;
- one letter of recommendation;
- a portfolio of work (Three samples of writing, web development, CD-ROM, or other appropriate media that demonstrate

abilities for clear expression);
- Graduate admission application;
- Official transcripts of all prior work and certificate of graduation;
- GRE scores (These scores are required of all international applicants, all applicants who have earned their last degree outside of the United States, and students who wish to apply for merit-based financial support on individual basis; other applicants do not need GRE scores);
- TOEFL scores of 550 (pencil and paper) or 79 (IBT) are required of all international applicants.

Graduate Certificate Programs: Two 12-credit graduate certificates are available as a step toward this degree

- Technical Communication Essentials
- Communication and Information Design

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; e-mail: cpe@njit.edu.

DEGREE REQUIREMENTS:

Students must complete a minimum of 30 degree credits taken over a minimum of two semesters. Five core courses must be completed by all students; five elective courses allow students to specialize in selected areas of professional and technical communication.

Students must design and maintain an ePortfolio of work completed within the courses. This work, organized around core competencies within each seminar in the program, will be reviewed by the instructional faculty every semester. In the final semester before graduation, students are required to take PTC 691 ePortfolio Capstone Seminar and make an oral presentation of their portfolio.

CORE COURSES:
15 credits:

		PTC 601	Advanced Professional and Technical Communication (3 credits)
		PTC 603	Identity, Technology, and Communication (3 credits)
		PTC 604	Communication Theory and Research (3 credits)
		PTC 605	Elements of Visual Design (3 credits)
		PTC 606	Advanced Information Design (3 credits)

ePortfolio (required)
3 credits:

		PTC 691	ePortfolio Capstone Seminar (0)

ELECTIVE COURSES
15 credits from:

		PTC 610	Research Methods for Information Design (3 credits)
		PTC 620	Proposal Writing (3 credits)
		PTC 622	Working in Teams: Collaborative and Interpersonal Communications (3 credits)
		PTC 624	Professional and Technical Editing (3 credits)
		PTC 626	Hypertext Design Studio (3 credits)
		PTC 628	Analyzing Social Networks (3 credits)
		PTC 629	Theory and Practice of Social Media (3 credits)
		PTC 631	Communication and Environmental Problem Solving (3 credits)
		PTC 632	Content Management and Information Architecture (3 credits)
		PTC 640	Health Communications (3 credits)
		PTC 642	Corporate Media and Communication (3 credits)
		PTC 644	Communication in Technology Transfer and Innovation (3 credits)

		PTC 650	ELearning Design for Mobile (3 credits)
		PTC 698	Selected Topics in Professional and Technical Communication (3 credits)
		PTC 700	Master's Project (3 credits)
		PTC 701	Master's Thesis (6 credits)
		PTC 725	Independent Study in Professional and Technical Communication (3 credits)

Software Engineering

Administered By: The Computer Science Department & the College of Computing Sciences

Administration

Chairperson	Michael A. Baltrush
Associate Chairperson	James M. Calvin

Faculty

Distinguished Professor	Joseph Y. Leung
Professors	James M. Calvin, Narain Gehani, James Geller, James McHugh, Ali Mili, Marvin K. Nakayama, Yehoshua Perl, Frank Y. Shih, Boris S. Verkhovsky, Jason T. Wang
Associate Professors	Michael A. Baltrush, Cristian M. Borcea, Alexandros Gerbessiotis, Daochuan Hung, Chengjun Liu, Usman W. Roshan, John W. Ryon, Andrew Sohn, Dimitrios Theodoratos
Assistant Professors	Reza Curtmola, Guiling Wang, Zhi Wei
Senior University Lecturers	Osama Eljabiri, Dionissios Karvelas, Morty D. Kwestel, Theodore L. Nicholson, Wallace Rutkowski
University Lecturers	George Blank, Jonathan J. Kapleau, Junilda Spirollari

Advisor

Advisor	Amanda D. Ackerman, Casey L. Hennessey

Website

Website	cs.njit.edu

Software engineering is the disciplined application of computer science knowledge to the analysis, design, development, evaluation and evolution of software products. Because software pervades economic and personal activity worldwide and because it is increasingly being used in critical applications, the software industry is under intense pressure to deliver quality software. Because software production remains a labor intensive activity, the demand for large volumes of high quality software translates into high demand for qualified software engineers. *MS in Software Engineering* consists of a judicious balance of theoretical computer science foundations that afford graduates the means to remain abreast of developments in software engineering in the long term and practical applications that afford graduates the means to be operational in the short term.

Admission Requirements

Applicants are expected to have completed an undergraduate degree in computer science, information systems, information technology, or another computing related field. Students lacking the appropriate background will be considered for conditional admission on a case-by-case basis and may be required to take bridge courses (bridge courses do not count for credit towards the degree).

MS in Software Engineering (MSSE) (33 credits)

Curriculum

Required Courses (six)

	*	CS 684	Software Testing and Quality Assurance (3-0-3)
	*	CS 685	Software Architecture (3-0-3)
	*	CS 683	Software Project Management (3-0-3)
		IS 676	Requirements Engineering (3 credits)
	*	CS 673	Software Design and Production Methodology (3 credits)

Elective Courses

(select any five)

	*	CS 633	Distributed Systems (3 credits)
	*	CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits)
	*	CS 656	Internet and Higher-Layer Protocols (3 credits)
	*	CS 630	Operating System Design (3 credits)
	*	CS 631	Data Management System Design (3 credits)
	*	CS 696	Network Management and Security (3 credits)
		IS 690	Web Services and Middleware (3 credits)
		IS 663	System Analysis and Design (3 credits)
		EM 636	Project Management (3 credits)
		EM 637	Project Control (3 credits)
		Mgmt 620	Management of Technology (3 credits)

Software Engineering Bridge Courses:

	*	CS 505	Programming, Data Structures, and Algorithms (3 credits)
		IS 390	Requirements Analysis and Systems Design (3-0-3)
		Math 111	Calculus I (4-1-4)
		Math 333	Probability and Statistics (3-0-3)

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* Students can take other CS courses with advisor approval

Catalog and curricula information approved by the relevant academic department.

Telecommunications

Administered By: Department of Electrical and Computer Engineering(ECE) and Department of Computer Science(CS)

Administration

Chair	Leonid Tsybeskov
Associate Chair (Undergraduate)	Marek Sosnowski
Associate Chair (Graduate)	Durgamadhab Misra

Faculty

Distinguished Professors	Yeheskel Bar-Ness, Atam P. Dhawan, Bernard Friedland, Jacob Savir
Professors	Ali N. Akansu, Nirwan Ansari, John D. Carpinelli, Haim Grebel, Richard A. Haddad, Alexander M. Haimovich, Durgamadhab Misra, Edip Niver, Yun-qing Shi, Kenneth S. Sohn, Marek Sosnowski, Leonid Tsybeskov, Gerald Whitman, Mengchu Zhou, Sotirios G. Ziavras
Associate Professors	Ali Abdi, Hongya Ge, Sui-hoi E. Hou, Walid Hubbi, Roberto Rojas-Cessa, Osvaldo Simeone
Assistant Professors	Abdallah Khreishah
University Lecturers	Mohammed Feknous, Serhiy P. Levkov, Timothy W. Steele

Advisors

Undergraduate Advisor	Shivon S. Boodhoo
Undergraduate Advisor Upper Division and Transfers	Marek Sosnowski
MS Electrical Engineering Advisor	Durgamadhab Misra
PHD Electrical Engineering Advisor	Durgamadhab Misra
MS Computer Engineering Advisor	Mengchu Zhou
PHD Computer Engineering Advisor	Durgamadhab Misra
MS Telecommunications Advisor	Roberto Rojas-Cessa
MS Internet Engineering Advisor	Roberto Rojas-Cessa
MS Power and Energy Systems Advisor	Mengchu Zhou

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 CS 333, ECE 321 and ECE 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. GRE scores must be submitted. International students must also achieve a minimum TOEFL score of 550 (pencil and paper) and 213 (computer-based).

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.

{		CS 251	Computer Organization (3-0-3) ***or***
		ECE 353	Computer Organization and Architecture (3-0-3) ***or***
		ECE 252	Microprocessors (3-0-3)
		CS 332	Principles of Operating Systems (3-0-3)
		CS 333	Introduction to UNIX Operating Systems (3-0-3)
		CS 505	Programming, Data Structures, and Algorithms (3 credits)
	*	ECE 501	Linear Systems and Random Signals (3 credits)
		ECE 321	Random Signals and Noise (3-0-3)
		ECE 333	Signals and Systems (3-0-3)
		ECE 481	Digital Communications Systems (3-0-3)

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

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 is required.

Core:
15 credits:

		CS 630	Operating System Design (3 credits)
		CS 651	Data Communications (3 credits)
{		CS 652	Computer Networks-Architectures, Protocols and Standards (3 Credits) ***or***
		ECE 683	Computer Network Design and Analysis (3 credits)
		ECE 642	Communication Systems I (3 credits)
		ECE 644	Wireless Communication (3 credits)

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.

		CS 604	Client/Server Computing (3 credits)
		CS 631	Data Management System Design (3 credits)
		CS 633	Distributed Systems (3 credits)
		CS 637	Real-Time Systems (3 credits)
{		CS 650	Computer Architecture (3 credits) ***or***
		ECE 690	Computer Systems Architecture (3 credits)

		CS 654	Telecommunication Networks Performance Analysis (3 credits)
{		CS 656	Internet and Higher-Layer Protocols (3 credits) ***or***
		ECE 637	Internet and Higher-Layer Protocols (3 credits)
{		IS 658	Multimedia Systems (3 credits) ***or***
		ECE 649	Compression in Multimedia Engineering (3 credits)
		CS 665	Algorithmic Graph Theory (3 credits)
{		CS 668	Parallel Algorithms (3 credits) ***or***
		ECE 785	Parallel Processing Systems (3 credits)
		IS 679	Information Systems Strategy (3 credits)
{		CS 696	Network Management and Security (3 credits) ***or***
		ECE 638	Network Management and Security (3 credits)
{		CS 697	Principles of Broadband ISDN and ATM (3 credits) ***or***
		ECE 639	Principles of Broadband Networks (3 credits)
		CS 752	Communication Protocol Synthesis and Analysis (3 credits)
		ECE 673	Random Signal Analysis I (3 credits)
		ECE 685	Network Interface Design (3 credits)
		ECE 742	Communication Systems II (3 credits)
		ECE 755	Advanced Topics in Digital Communications (3 credits)
		ECE 757	Advanced Wireless Communications (3 credits)
		ECE 783	Computer Communication Networks (3 credits)
		MIS 635	Management of Telecommunications (3 credits)
		MIS 636	Telecommunications: Policies and Regulations

Project, Thesis (optional):
3 credits:

{		CS700	***or***
		ECE 700	Master's Project (3 credits)

6 credits:

		CS701	
		ECE 701	Master's Thesis (3 credits)

Area of Specialization:
The following are suggested areas of specialization and sample elective courses for each. Students may develop an individual area of specialization in consultation with a graduate advisor.

Management and Administration:

{		CS 696	Network Management and Security (3 credits) ***or***
		ECE 638	Network Management and Security (3 credits)
		CIS 679	Management of Computer and Information Systems (3 credits)
		MIS 635	Management of Telecommunications (3 credits)
		MIS 636	Telecommunications: Policies and Regulations

and one additional course.

Communication Systems:

{		CS 697	Principles of Broadband ISDN and ATM (3 credits) ***or***
		ECE 639	Principles of Broadband Networks (3 credits)

{	IS 658	Multimedia Systems (3 credits) ***or***
	ECE 649	Compression in Multimedia Engineering (3 credits)
	ECE 673	Random Signal Analysis I (3 credits)
	ECE 742	Communication Systems II (3 credits)
	ECE 755	Advanced Topics in Digital Communications (3 credits)
	ECE 757	Advanced Wireless Communications (3 credits)
	ECE 685	Network Interface Design (3 credits)

Networking:

	CS 604	Client/Server Computing (3 credits)
	CS 633	Distributed Systems (3 credits)
	CS 637	Real-Time Systems (3 credits)
{	CS 650	Computer Architecture (3 credits) ***or***
	ECE 690	Computer Systems Architecture (3 credits)
	CS 654	Telecommunication Networks Performance Analysis (3 credits)
{	CS 656	Internet and Higher-Layer Protocols (3 credits) ***or***
	ECE 637	Internet and Higher-Layer Protocols (3 credits)
	CS 665	Algorithmic Graph Theory (3 credits)
{	CS 668	Parallel Algorithms (3 credits) ***or***
	ECE 785	Parallel Processing Systems (3 credits)
{	CS 696	Network Management and Security (3 credits) ***or***
	ECE 638	Network Management and Security (3 credits)
{	CS 697	Principles of Broadband ISDN and ATM (3 credits) ***or***
	ECE 639	Principles of Broadband Networks (3 credits)
	ECE 673	Random Signal Analysis I (3 credits)
	ECE 783	Computer Communication Networks (3 credits)

Information Technologies:

	CS 604	Client/Server Computing (3 credits)
	CS 631	Data Management System Design (3 credits)
{	IS 658	Multimedia Systems (3 credits) ***or***
	ECE 649	Compression in Multimedia Engineering (3 credits)
{	CS 696	Network Management and Security (3 credits) ***or***
	ECE 638	Network Management and Security (3 credits)

one additional course.

Other CS and ECE courses related to telecommunications may be selected as elective courses with the written approval of the corresponding graduate advisor.

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* ECE 321 and ECE 333 may be substituted for ECE 501.

Catalog and curricula information approved by the relevant academic department.

Transportation

Administered By: Executive Committee for the Interdisciplinary Program in Transportation

Administration

Program Director	Athanassios Bladikas

Faculty

Professor	Lazar Spasovic, I J. Chien
Associate Professors	Athanassios Bladikas, Janice R. Daniel, Rongfang Liu, Jian Yang

Degrees Offered: Master of Science in Transportation; Doctor of Philosophy in Transportation
NJIT's transportation program prepares students to be transportation planners, engineers, and managers who can plan, design, operate, and manage transportation systems capable of satisfying society's transportation needs.

Transportation is vital to our society's proper functioning, providing mobility of people, goods and services. It enables people to access job markets and participate in recreational, cultural, educational, and social activities. It adds value to products by moving them to their destination in time for their use. The transportation field also is a major contributor to the economy, as a consumer of resources and as a supplier of jobs.

Transportation functions in a very complex environment which, at the beginning of the 21st Century, is characterized by constant change in the technological, regulatory and legal frameworks. Transportation professionals must not only be able to meet the technological challenges of new systems, they must also be capable of fitting these systems into the social, economic, and physical environments in a manner that improves the quality of life for all.

Through the NJIT-based Institute for Transportation, the transportation graduate program provides excellent opportunities for students to engage in research on all forms of transportation, including all phases of activities concerned with the provision of services and the movement of people and goods. The Institute for Transportation is a major resource for public and private organizations and is well-known for its academic programs and research activities.

Master of Science in Transportation

This is a program for students from diverse educational backgrounds with a variety of career goals that prepares them for careers in designing, planning, operating, maintaining and managing urban and rural transportation systems. The master's degree is a valued professional credential for individuals engaged in the transportation field.

Off-Campus Programs: At the New Jersey Department of Transportation (NJ DOT), in Trenton, NJIT offers sufficient courses to fulfill all degree requirements. All courses are taught by NJIT faculty and are open to non-DOT employees. For further information about extension programs, 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

Admission Requirements:
Applicants should have a bachelor's degree from an accredited institution with some undergraduate background in economics, mathematics, probability and statistics, and computers.

Bridge Program: Students who lack an appropriate background may be admitted and required to make up deficiencies by taking a program of courses designed in consultation with graduate advisors. These courses are taken in addition to the degree requirements. See the undergraduate catalog for descriptions of 100- to 400-level courses. Students may be required to take or demonstrate that they already have taken courses equivalent to the following:

	*	CE 350	Transportation Engineering (3-0-3)
		CIS 101	Computer Programming and Problem Solving (2-1-2)
		Econ 265	Microeconomics (3-0-3)
		Math 105	Elementary Probability and Statistics (3-0-3)
		Math 309	Mathematical Analysis for Technology (3-0-3)

Degree Requirements:
Students must select one area of specialization and take a minimum of 30 credits. Tran 792 Seminar is required for all students who receive departmental or research-based awards. A maximum of 6 credits may be taken from the 500-level courses for the master of science.

Three general areas of specialization are available. While they share a common methodological core, each is designed to suit various interests:

Transportation Engineering focuses on traffic engineering, physical design and operational aspects of transportation systems. This area is best suited for students with an undergraduate engineering degree.

Transportation Planning emphasizes the analysis and planning aspects, in particular the integration of transportation systems with urban and regional considerations such as economics, land use, and the environment.

Advanced Transportation Systems and Technologies emphasizes the use of emerging technologies such as intelligent transportation systems in planning, design and operations of multi- and inter-modal transportation systems.

Core:
Required for all specializations

9 credits:

		Tran 603	Introduction to Urban Transportation Planning (3 credits)
{		Tran 610	Transportation Economics (3 credits) ***or***
		Econ 565	Managerial Economics (3 credits)
{		Tran 650	Urban Systems Engineering (3 credits) ***or***
		EM 602	Management Science (3 credits)

Project, Thesis (optional):
Students may elect to complete a master's project or thesis. These courses are considered as electives.

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

Areas of Specialization:
Additional elective courses for all areas of specialization may be taken with approval of the graduate advisor.

Transportation Engineering:
Required:
9 credits:

		Tran 615	Traffic Studies and Capacity (3 credits)
		Tran 625	Public Transportation Operations and Technology (3 credits)
		Tran 752	Traffic Control (3 credits)

Elective:
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, from:

		CE 611	Project Planning and Control (3 credits)
		EM 691	Cost Estimating for Capital Projects (3 credits)

		EnE 671	Environmental Impact Analysis (3 credits)
		HRM 601	Organizational Behavior (3 credits)
		IE 651	Industrial Simulation (3 credits)
		Math 661	Applied Statistics (3 credits)
		ME 635	Computer-Aided Design (3 credits)
		Mgmt 692	Strategic Management (3 credits)
		MIS 648	Decision Support Systems for Managers (3 credits)
		Mrkt 632	Marketing Strategy for Technology-Based Organizations (3 credits)
		Tran 552	Geometric Design of Transportation Facilities (3 credits)
		Tran 602	Geographic Information Systems (3 credits)
		Tran 608	Behavioral Issues in Transportation Studies (3 credits)
		Tran 640	Distribution Logistics (3 credits)
		Tran 653	Traffic Safety (3 credits)
		Tran 659	Flexible and Rigid Pavements (3 credits)
		Tran 700	Master's Project (3 credits)
		Tran 701	Master's Thesis (6 credits)
		Tran 753	Airport Design and Planning (3 credits)
		Tran 754	Port Design and Planning (3 credits)
		Tran 755	Intelligent Transportation Systems (3 credits)
		Tran 760	Urban Transportation Networks (3 credits)

Transportation Planning:
Required:
9 credits:

		Tran 655	Land Use Planning (3 credits)
{		Tran 625	Public Transportation Operations and Technology (3 credits) ***or***
		Tran 705	Mass Transportation Systems (3 credits)
		Tran 765	Multi-modal Freight Transportation Systems Analysis (3 credits)

Elective:
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, from:

		CE 611	Project Planning and Control (3 credits)
		EnE 671	Environmental Impact Analysis (3 credits)
		Fin 630	Applied Business Econometrics (3 credits)
		HRM 601	Organizational Behavior (3 credits)
		HRM 606	Human Resource Management (3 credits)
		HRM 662	Organizational Diagnosis and Development (3 credits)
		Math 661	Applied Statistics (3 credits)
		Mgmt 691	Legal and Ethical Issues (3 credits)
		Mgmt 692	Strategic Management (3 credits)
		MIS 620	E-Commerce Technologies (3 credits)
		Mrkt 632	Marketing Strategy for Technology-Based Organizations (3 credits)
		Tran 602	Geographic Information Systems (3 credits)
		Tran 604	Public and Private Financing of Urban Areas (3 credits)
		Tran 608	Behavioral Issues in Transportation Studies (3 credits)
		Tran 615	Traffic Studies and Capacity (3 credits)
		Tran 640	Distribution Logistics (3 credits)
		Tran 643	Transportation Finance (3 credits)
		Tran 653	Traffic Safety (3 credits)

		Tran 720	Discrete Choice Modeling for Travel Demand Forecasting (3 credits)
		Tran 740	Management of Transportation Carriers (3 credits)
		Tran 753	Airport Design and Planning (3 credits)
		Tran 755	Intelligent Transportation Systems (3 credits)
		Tran 760	Urban Transportation Networks (3 credits)

Advanced Transportation Systems and Technologies :
Required:
9 credits:

		Tran 615	Traffic Studies and Capacity (3 credits)
		Tran 755	Intelligent Transportation Systems (3 credits)
		Tran 765	Multi-modal Freight Transportation Systems Analysis (3 credits)

Elective:
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, from:

		CIS 610	Data Structures and Algorithms (3 credits)
		CIS 651	Data Communications (3 credits)
		CIS 661	Systems Simulation (3 credits)
		ECE 609	Artificial Neural Networks (3 credits)
		ECE 642	Communication Systems I (3 credits)
		EM 714	Multicriteria Decision Making (3 credits)
		EnE 671	Environmental Impact Analysis (3 credits)
		HRM 601	Organizational Behavior (3 credits)
		IE 624	Heuristic Methods (3 credits)
		IE 642	Network Flows and Applications (3 credits)
		IE 644	Application of Stochastic Modeling in Systems Control (3 credits)
		IE 651	Industrial Simulation (3 credits)
		IE 705	Mathematical Programming in Management Science (3 credits)
		IE 706	A Queueing Approach to Performance Analysis (3 credits)
		Math 661	Applied Statistics (3 credits)
		ME 635	Computer-Aided Design (3 credits)
		MIS 648	Decision Support Systems for Managers (3 credits)
		Mrkt 632	Marketing Strategy for Technology-Based Organizations (3 credits)
		Mrkt 636	Design and Development of High Technology Products (3 credits)
		Mrkt 640	Industrial Marketing Management (3 credits)
		Tran 602	Geographic Information Systems (3 credits)
		Tran 608	Behavioral Issues in Transportation Studies (3 credits)
		Tran 625	Public Transportation Operations and Technology (3 credits)
		Tran 640	Distribution Logistics (3 credits)
		Tran 752	Traffic Control (3 credits)
		Tran 760	Urban Transportation Networks (3 credits)

Doctor of Philosophy in Transportation

The doctoral program is for well-qualified students who are mature in scholarship and purpose. It offers a well-balanced mixture of theoretical studies and experimental research. A student must demonstrate creative thinking, self-motivation, and ability to do independent research. In their research, students are expected to deal with complex issues, effectively formulate difficult problems, devise new methodology, and achieve new and exceptional results.

Admission Requirements:
Students should have adequate preparation in mathematical and other analytical techniques, and substantial knowledge of the ideas and techniques of synthesis. A thorough understanding of the social and economic factors intrinsic to the functioning and

development of transport in urban areas also is necessary. It is expected that students will have earned a minimum GPA of 3.5 in a master's degree program in engineering, planning, or business administration from an accredited university. Outstanding students with baccalaureate degrees also may be accepted. All applicants must take the GRE. Full-time study is preferred for doctoral studies.

Degree Requirements:
Requirements consist of a minimum of 54 credits of course work beyond the bachelor's degree, including at least 12 credits of 700-level courses, passage of a qualifying examination, a minimum of 36 credits of Tran 790 Doctoral Dissertation and Tran 791 Doctoral Seminar. Independent original research must be conducted by the candidate in a specific area of transportation. Dissertation work must be of publishable quality.

Dissertation: A program committee must approve a dissertation topic and an NJIT faculty member, approved by the program, must be available to supervise the dissertation research. An oral defense of the dissertation is required after the dissertation committee accepts the written document.

Qualifying Examination: All doctoral students must pass a doctoral qualifying examination. To prepare adequately for the examination, students should take appropriate course work in transportation engineering, transportation planning, and advanced transportation systems and technologies, as well as other related subjects.

The examination has four parts: the first three are written, and the fourth is oral. The oral part is given after the written parts are evaluated.

Part I Analytical Techniques

Part II Transportation Facilities and Operations

Part III Transportation Planning and Technologies

Part IV Oral (includes a field problem)

For additional information about doctoral degree requirements, refer to the Academic Policies and Procedures section of this catalog.

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* Students who have demonstrated professional transportation work experience may have this course wavied.

Joint PhD Program in Urban Systems

New Jersey Institute of Technology
Rutgers University Newark

RBHS Google Search

Social Science Perspectives on Cities

The Joint PhD Program in Urban Systems examines the complex interrelationships within urban environments, including the social, cultural, political, economic, geographic, organizational, and bioenvironmental factors that influence urban populations. The program has three specializations: 1) Urban Educational Policy, 2) Urban Environment, and 3) Urban Health.

New Jersey's Two Research Universities

The Urban Systems PhD program is sponsored jointly by the New Jersey Institute of Technology (NJIT), and Rutgers University -Newark The program draws on the academic resources of both universities, which are located in close proximity in the University Heights section of Newark.

Optical Science and Engineering Courses: Offered by the Physics Departments of NJIT.

UNDERGRADUATE COURSES:

OPSE 301 - Introduction to Optical Science and Engineering (3-0-3)
Prerequisites: Phys 121. Laboratory and lecture introduces optics and photonics principles with their elementary applications for applied physics, engineering, computer science, or biology majors. Topics include speed at light, reflection, refraction, geometric optics, interference and interferometry, polarization, dispersion, birefringence, fiber-optics, diffraction, introduction to spectroscopy and ray tracing.

OPSE 310 - Virtual Instrumentation (3-0-3)
Prerequisites: CS 113 or CS 115. Intended for all engineering, computer science, and science majors. Covers the basics of virtual instrumentation including use of IEEE GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform such as National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisition and instrument control, instrument status, and acquisition speed.

OPSE 402 - High Power Laser and Photonics Applications (3-0-3)
Prerequisite: Phys 121. Open to all engineering, computer science, and science majors with junior or senior standing. Advanced combined laboratory and lecture course emphasizing photonics and high power laser applications. Topics include Maxwell's equations, principles of lasers, electro-optics, non-linear optics, absorption and transmission of light, bio-optics, fiber-optic communications, chemiluminescence, scattering from periodic surfaces and colloids, sensors. Topics and experiments change on a semester basis depending on interests of enrolled students.

OPSE 410 - Biophotonics (3-0-3)
Prerequsite: Phys 121. An introduction to the interaction of light with biological tissues. Biophotonics for diagnostic and therapeutic applications will be discussed. Topics include propagation of light in turbid tissues, absorption, scattering, laser surgery, and optical rotation.

GRADUATE COURSES:

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.

OPSE 610 - Virtual Instrumentation (3 credits)
Prerequisites: A college level programming course. Intended for all engineering, computer science, and science majors. Covers virtual instrumentation including use of IEEE, GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform, such as, National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisitions and instrument control, instrument status, and acquisition speed. **Effective From: Spring 2007**

Pharmaceutical Bioprocessing: Offered by the Otto H. York Department of Chemical, Biological and Pharmaceutical Engineering

GRADUATE COURSES:

PhB 505 - Principles of Pharm. Microbiology and Biochemistry (3 credits)
Prerequisites: Graduate standing. This course covers major concepts of cell biology including cell physiology and structure, molecular biology, and genetics. Cellular chemistry, life cycles, and regulation are discussed as well as the fundamentals of biochemistry related to physical organic chemistry, including buffers, blood proteins, enzymes, carbohydrates, fats, and nucleic acids. This is a required course for PhB students with no or limited knowledge of biology. **Effective From: Spring 2010**

PhB 590 - Graduate Co-op Work Experience I (3 additive credits)
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Cooperative education internship provides on-the-job reinforcement of the academic program by placement in major-related work situations at pharmaceutical companies or companies serving the pharmaceutical industry. Work assignment developed or approved by the co-op office and evaluated by the department. Cannot be used for degree credit. **Effective From: Spring 2010**

PhB 591 - Graduate Co-op Work Experience II (3 additive credits)
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Same range of activities as in PhB 590. Cannot be used for degree credit. **Effective From: Spring 2010**

PhB 592 - Graduate Co-op Work Experience III (3 additive credits)
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Same range of activities as in PhB 590 and PhB 591. Cannot be used for degree credit. **Effective From: Spring 2010**

PhB 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: Permissions from Pharmaceutical Bioprocessing Graduate Advisor and Career Development Services. Same range of activities as in PhB 590, PhB 591 and PhB 592. Cannot be used for degree credit. **Effective From: Spring 2010**

PhB 610 - Biotechnology-Biopharmaceutical, Processes and Products (3 credits)
Prerequisites: PhB 505, if required and PhEn 601. This course covers biological processes used in the pharmaceutical and biotechnology industry to obtain pharmaceutical products, including biochemical processes for antibiotic production and peptide extraction, and biopharmaceutical process to obtain recombinant proteins, monoclonal antibodies, cytokines, hormone and blood products, therapeutic enzymes, antibodies, vaccines, and nucleic acid therapeutics. **Effective From: Spring 2010**

PhB 615 - Bioseparation Processes (3 credits)
Prerequisites: If required, PhEn 500, PhEn 501, PhEn 502 and PhB 505; PhEn 601. This course covers the principles, methods and unit operations for the separation and recovery of biologically obtained molecules and especially proteins. Also studied here is the relationship between the chemistry of biological molecules and efficient separation and preservation of biological activity, with special emphasis on separation of biomolecules. **Effective From: Spring 2010**

PhB 630 - Pharmaceutical Bioprocess Engineering (3 credits)
Prerequisites: If required, PhEn 500, PhEn 501, PhEn 502 and PhB 505; Phen 601. This course covers the principles and methods to develop and operate bioprocess engineering systems, with emphasis on pharmaceutical bioprocessing and the use of chemical engineering principles to obtain products of therapeutic values. Topics include cell line selection, cell growth kinetics, substrate utilization, product formation, transport phenomena in biosystems, and bioreactors. **Effective From: Spring 2010**

PhB 698 - Special Topics in Pharmaceutical Bioprocessing I (3 credits)
Prerequisites: Graduate standing and permission of the instructor. Topics of current interest in Pharmaceutical Bioprocessing. **Effective From: Spring 2010**

PhB 699 - Special Topics in Pharmaceutical Bioprocessing II (3 credits)
Prerequisites: Graduate standing and permission of the instructor. Topics of current interest in Pharmaceutical Bioprocessing. **Effective From: Spring 2010**

PhB 701B - Master's Thesis (3 credits)
Prerequisites: Matriculation in the MS program in PhB and approval of PhB Program Advisor. Original research under the guidance of a Thesis Advisor. A written thesis must be approved by a three-member Thesis Committee including the primary advisor and at least one member of the CBPE faculty. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree. **Effective From: Spring 2010**

PhB 701C - Master's Thesis (6 credits)
Prerequisites: Matriculation in the MS program in PhB and approval of PhB Program Advisor. Original research under the guidance of a Thesis Advisor. A written thesis must be approved by a three-member Thesis Committee including the primary advisor and at least one member of the CBPE faculty. A student must continue to register for at least 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree. **Effective From: Spring 2010**

PhB 725 - Independent Study I (3 credits)
Prerequisites: Permission from the Program Advisor in PhB (not the Thesis Advisor), as well as completion of courses prescribed by a supervising faculty member (who cannot be the student's Thesis Advisor). This special course covers areas of study in which one or more students may be interested, but which is not of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member. **Effective From: Spring 2010**

PhB 726 - Independent Study II (3 credits)
Prerequisites: Permission from the Program Advisor in PhB (not the Thesis Advisor), as well as completion of courses prescribed by a supervising faculty member (who cannot be the student's Thesis Advisor). This special course covers areas of study in which one or more students may be interested, but which is not of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member. **Effective From: Spring 2010**

PhB 791 - Graduate Seminar (Non-Credit)
Prerequisites: Graduate standing. Required, when offered, of all PhB graduate students receiving departmental or research-based awards. The student must register each semester until completion of the degree, if the Graduate Seminar is offered. Outside speakers and department members present their research for general discussion. **Effective From: Spring 2010**

Pharmaceutical Engineering: Offered by the Department of Chemical Engineering.

GRADUATE COURSES:

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 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 Unit Operations: Processing of Liquid and Dispersed Phase Systems (3 credits)
This course examines methodologies, both applied and fundamental, to analyze and scale up manufacturing pharmaceutical processes involving liquid and dispersed-phase systems, such as liquid and multiphase mixing, sterilization and sanitation, lyophilization, filtration, centrifugation and others. The emphasis is primarily on the engineering aspects of the parmaceutical processes examined in the course. **Effective From: Fall 2006**

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 606 - Pharmaceutical Unit Operations: Solids Processing (3 credits)
This course examines methodologies, both applied and fundamental, to analyze and scale up manufacturing pharmaceutical processes involving solids processing, such as solids characterization, blending, milling, granulation, tableting, coating, and others. The emphasis is primarily on the engineering aspects of the pharmaceutical processes examined in the course.

PhEn 612 - Pharmaceutical Reaction Engineering (3 credits)
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)
This course covers separation processes in general and pharmaceutical separations in particular. Specific processes to be studied include distillation, extraction, crystallization, adsorption, ion exchange, chromatography, moving bed processes, electrophoresis, freeze drying, microfiltration/ultrafiltration, reverse osmosis, and pervaporation.

PhEn 618 - Principles of Pharmacokinetics and Drug Delivery (3 credits)
The course covers the basic principles of pharmacokinetics, including drug transport, parenteral and enteral routes of drug administration, and factors affecting drug absorption, distribution, metabolism, and excretion. Mathematical pharmacokinetic models and drug delivery processes are also presented and quantitatively studied.

PhEn 698 - Special Topics in Pharmaceutical Engineering I (3 credits)
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 700 - 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 701 - 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

UNDERGRADUATE COURSES:

Phys 102 - General Physics (3-0-3)
Prerequisite: None. Intended for students in architecture, computer science (B.A. only), STS and other disciplines requiring laboratory science electives. Elementary statics and dynamics. Subjects discussed are kinematics, Newton's laws of motion, energy, momentum, conservation principles, and mechanical properties of matter. Lab must be taken concurrently. **Effective From: Spring 2009**

Phys 102A - General Physics Laboratory (0-2-1)
Prerequisite: None. This course is the laboratory component of Phys 102 and must be taken concurrently. **Effective From: Spring 2009**

Phys 103 - General Physics (3-0-3)
Prerequisite: Phys 102 with grade of C or better. A continuation of Phys 102 for students in architecture, computer science (B.A. only), STS and other disciplines requiring laboratory science electives. Topics discussed are heat, thermodynamics, sound, wave motion, illumination, geometric and physical optics, and color. Lab must be taken concurrently. **Effective From: Spring 2009**

Phys 103A - General Physics Laboratory (0-2-1)
Prerequisite: Phys 102 with grade of C or better. This course is the laboratory component of Phys 103 and must be taken concurrently. **Effective From: Spring 2009**

Phys 105 - Physics A (3-0-3)
Corequisite: Math 108. First semester of a two-semester sequence with Phys 106. The sequence is equivalent to Phys 111. Placement is determined by performance on standardized entrance examinations. A study of elementary mechanics with emphasis on the fundamental laws of mechanics and conservation laws. Topics include scalar and vector quantities, rectilinear motion, equilibrium and Newton's laws of motion, friction, work and energy, impulse, and momentum. Lab must be taken concurrently. **Effective From: Spring 2009 Until: Fall 2011**

Phys 105A - Physics A Laboratory (0-2-1)
Corequisite: Math 108. Placement in this course is determined by performance on standardized entrance examinations. This course is the laboratory component of Phys 105 and must be taken concurrently. **Effective From: Spring 2009 Until: Fall 2011**

Phys 105W - Physics A Workshop (0-1-0)
Corequisite: Math 108. **Effective From: Spring 2009 Until: Fall 2011**

Phys 106 - Physics B (3-0-3)
Prerequisite: Phys 105 and Math 108 or Math 109 or Math 110, with grade of C or better. Second semester of a two-semester sequence with Phys 105. An extension of Phys 105 in the area of mechanics. Topics include rotational motion, torque, inertia and angular momentum, static equilibrium, gravity, and a full review of mechanics at the level equivalent to Phys 111. Lab must be taken concurrently. **Effective From: Spring 2009**

Phys 106A - Physics B Laboratory (0-2-1)
Prerequisite: same as Phys 106. This course is the laboratory component of Phys 106 and must be taken concurrently. **Effective From: Spring 2009 Until: Fall 2011**

Phys 111 - Physics I (3-0-3)
Prerequisite: Math 131; Corequisite: Math 111 or Math 132. Elementary mechanics with an emphasis on the fundamental concepts and laws of mechanics, especially the conservation laws. Topics are scalar and vector quantities of mechanics; rectilinear and circular motion; equilibrium and Newton's laws of motion; work, energy, momentum; the conservation laws. Lab must be taken concurrently. See Phys 111A. **Effective From: Spring 2009**

Phys 111A - Physics I Laboratory (0-2-1)
Corequisite: Math 111. Laboratory component of Phys 111 and Phys 111H. Lab must be taken concurrently with Phys 111 or Phys 111H. **Effective From: Spring 2009**

Phys 111H - Honors Physics I (3-0-3)
Prerequisite: Math 131; Corequisite: Math 111 or Math 111H or Math 132. Admission to this course is by invitation, based on class standing and standardized entrance exams. First semester of a three-semester program in Honors Physics. Covers the material in Phys 111, but topics are treated more comprehensively and in greater depth. More extensive use of mathematics. Lab must be taken concurrently. See Phys 111A. **Effective From: Spring 2009**

Phys 111W - Physics I Workshop (0-1-0)
Corequisite: Math 111 or Math 111H. Workshop for Phys 111. **Effective From: Spring 2009 Until: Fall 2011**

Phys 114 - Introduction to Data Reduction with Applications (3-0-3)
Prerequisite: Math 131; Corequisite: Math 111 or Math 132. Physics majors only. An introduction to both the theory and application of error analysis and data reduction methodology. Topics include the binomial distribution and its simplification to Gaussian and Poisson probability distribution functions, estimation of moments, and propagation of uncertainty. Forward modeling, including least-squares fitting of linear and polynomial functions are discussed. The course enables students to apply the concepts of the data reduction and error analysis using data analysis software to real data sets found in the physical sciences. **Effective From: Spring 2009**

Phys 121 - Physics II (3-0-3)
Prerequisites: PHYS 111 with a grade of C or better. Math 111 or 111H or 132. Co-requisite: Math 112 or Math 133. This course deals with an introduction to electricity and magnetism. Topics include simple dc circuits, the electric field, the magnetic field, electric potential, capacitance relationships between electric and magnetic fields, inductance, and simple ac circuits. Lab must be taken concurrently. See Phys 121A. **Effective From: Spring 2012**

Phys 121A - Physics II Laboratory (0-2-1)
Prerequisites: Phys 111 or Phys 111H or Phys 106 and Math 111 or Math 111H all with grade of C or better. Corequisite: Math 112. **Effective From: Spring 2009**

Phys 121H - Honors Physics II (3-0-3)
Prerequisites: PHYS 111 with a grade of C or better. Math 111 or 111H or 132. Co-requisite: Math 112 or Math 133. This is the second semester of a three-semester program in Honors Physics. The course covers the material given in Phys 121. Greater use is made of vector analysis. In addition, an introduction to Maxwell's equations for the electromagnetic field and their application to physical problems is given. Lab must be taken concurrently.See Phys 121A. **Effective From: Spring 2012**

Phys 202 - Introductory Astronomy and Cosmology (3-0-3)
Prerequisite: None. A non-mathematical presentation of contemporary views of the origin, evolution, and structure of the solar system, stars, galaxies, and the universe. Special topics include neutron stars, black holes, gravitationally strange objects, and the ?big bang.? **Effective From: Spring 2009**

Phys 202A - Astronomy and Cosmology Laboratory (0-2-1)
Corequisite: Phys 202. Includes demonstration of physical principles applicable to astronomy. Use of telescope for lunar, solar and planetary observations. **Effective From: Spring 2009**

Phys 203 - The Earth in Space (3-0-3)
Prerequisite: None. Introduces fundamental phenomena, such as plate tectonics, erosion, volcanism, and glaciation. Studies the interaction between the Earth's four major reservoirs?atmosphere, hydrosphere, biosphere and solid earth; investigates the dependence of the Earth on the Sun; the effect of the Moon on the Earth. Extends knowledge gained from studying the Earth to other planets in this solar system. **Effective From: Spring 2009**

Phys 203A - The Earth in Space Laboratory (0-2-1)
Corequisite: Phys 203. Optional laboratory course associated with Phys 203. **Effective From: Spring 2009**

Phys 204 - Biophysics of Life (3-0-3)
A non-mathematical view of how living entities work in terms of the basic concepts of physics. The course will discuss how these concepts underline topics ranging from birth to death, from touch to pleasure, from vision to beauty, and from a thought to a heartbeat. **Effective From: Fall 2013**

Phys 231A - Physics III Laboratory (0-2-1)
Prerequisite: Phys 121 or Phys 121H and Math 112 or Math 112H, all with grade of C or better. **Effective From: Spring 2009**

Phys 231H - Honors Physics III (4-0-4)
Prerequisite: Phys 121 or Phys 121H and Math 112 or Math 112H, all with grade of C or better. Third semester of a three-semester program in Honors Physics. Physical optics is treated in greater detail. Modern physics includes a greater number of topics, with special emphasis on the wave-particle duality in nature. Lab must be taken concurrently. See Phys 231A. **Effective From: Spring 2009**

Phys 233 - Physics III (3-0-3)
Prerequisite: Phys 121. Intended for students in chemical engineering only. Topics include elements of simple harmonic motion, wave motion, interference and diffraction, quantum mechanics, semiconductor models, carrier distribution, Fermi functions, and selected topics. **Effective From: Spring 2002 Until: Spring 2008**

Phys 234 - Physics III (3-0-3)
Prerequisite: Math 112 or Math 112H. Elements of simple harmonic motion, wave motion, geometric and physical optics are considered. The wave and particle duality of nature is emphasized and made plausible by an examination of the important experiments and theories which lead to the modern concepts of matter and radiation. The conservation laws are broadened to include the equivalence of mass and energy. **Effective From: Spring 2009**

Phys 234H - Honors Physics III (3-0-3)
Prerequisites: Math 112 or Math 112H. Third semester of a three-semester program in Honors Physics. Physical optics is treated in greater detail. Modern physics includes a greater number of topics, with special emphasis on the wave-particle duality in nature. Lab must be taken concurrently. **Effective From: Spring 2009**

Phys 235 - Physics III (4-0-4)
Prerequisites: Phys 121 and 121A. Intended for students in computer engineering. Topics include simple harmonic motion, wave motion, interference and diffraction, photons, electrons, and the wave particle duality. Thermodynamics and heat transfer are introduced. **Effective Until: Spring 2008**

Phys 310 - Introduction to Atomic and Nuclear Physics (3-0-3)
Prerequisites: Phys 234 or Phys 234H; Math 222 or Math 222H, all with grade of C or better. Selected topics in atomic physics including the Pauli Exclusion Principle and the Atomic Shell Model. In nuclear physics, the two-body problem, nuclear models, alpha, beta, and gamma radiation, acclerators, and nuclear detectors are studied. 21&62:750:403 may be substituted for this course. **Effective From: Spring 2009**

Phys 311 - Co-op Work Experience I (3 credits)
Prerequisite: Acceptance into the co-op program. Students gain major-related experience and reinforcement of the academic program. Work assignments are facilitated and approved by the Office of Cooperative Education and Internships. Participation in seminars and a final report/project is mandatory. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Phys 320 - Astronomy and Astrophysics I (3-0-3)
Prerequisites: Phys 121 or Phys 121H, with grade of C or better. A quantitative introduction to the astronomy of the sun, earth, and solar system, with an emphasis on the physical principles involved. Includes celestial mechanics, planetary atmospheres and the physics of comets, asteroids and meteorites. **Effective From: Spring 2009**

Phys 321 - Astronomy and Astrophysics II (3-0-3)
Prerequisite: Phys 320, with grade of C or better. A quantitative introduction to the astronomy of the stars, the galaxy, and cosmology, with an emphasis on the physical principles involved. Includes stellar interiors, stellar evolution, galactic dynamics, large-scale structure and early history of the universe. **Effective From: Spring 2009**

Phys 322 - Observational Astronomy (3-0-3)
Prerequisite: Phys 320, with grade of C or better. Most class time is spent in an observatory performing observations of celestial objects such as the Sun, Moon, planets, stars, stellar clusters, and galaxies. Experimental projects include charting the skies, asterophotography (film and CCD), measuring masses of planets, rotational period of the Sun, topography of the Moon, H-R diagrams of stellar clusters, etc. **Effective From: Spring 2009**

Phys 335 - Introductory Thermodynamics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 211 or Math 213 or Math 213H, all with grade of C or better. Corequisites: Math 222, Math 238 or Math 335. Introductory thermodynamics, kinetic theory, statistical physics. Topics include equations of state, the three laws of thermodynamics, reversible and irreversible processes. 21&62:750:315 may be substituted for this course. **Effective From: Spring 2009**

Phys 350 - Biophysics I (3-0-3)

Prerequisite: Phys 121 or Phys 121H with a grade of C or better. This course presents an introduction to general biophysics and a preparation for medical school and biotechnology careers. It features molecules, viruses and cells racing to form enormous electric fields, succumbing to diseases and creating life. It explains how key medical devices preserve life. It asses students? progress using questions just like those on the medical school entrance exams and seeks an understanding of a few, simple principles of life science. **Effective From: Spring 2009**

Phys 390 - Selected Topics of Current Interest in Physics (1-0-1)
Prerequisite: Phys 234 or Phys 234H, with grade of C or better. Seminar covering topics that are currently in the forefront of physics. The lecture series offers exposure to such topics as nuclear physics, solid state physics, plasma physics, the special and general theories of relativity, and the history and philosophy of science. **Effective From: Spring 2009**

Phys 411 - Co-op Work Experience II (3 credits)
Prerequisites: Phys 311, with grade of C or better, and acceptance into the co-op program. Provides for co-op work assignments which must be approved by the Office of Cooperative Education and Internships. Participation in seminars and a final -report/project are mandatory. Note: Normal grading applies to this COOP Experience **Effective From: Spring 2013**

Phys 418 - Fundamentals of Optical Imaging (2-2-3)
Prerequisites: Phys234 or Phys 234H or Phys 231H, with grade of C or better. This is a course with both lectures and experiments and the emphasis is on the hands-on experiences. Upon completion of the course, students should not only grasp the basic concepts involved in imaging science, but also be able to work on simple real world imaging systems. The main content of the lecture part of this course can be summarized as the following: Optical sources, detectors and their working mechanism; Image formation and transmission; Optical imaging system and their characteristics; Imaging processing and algorithms. This course is developed in close collaboration with Edmund Optics Inc. **Effective From: Spring 2009**

Phys 420 - Special Relativity (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. An introduction to Einstein's Special Theory of Relativity at the advanced undergraduate level. Topics include invariance of the speed of light, relativity of time and space, the Lorentz transformations, space-time diagrams, the twin paradox and time travel, relativistic mechanics, rotating reference frames, laser gyroscopes, superluminal motion, phase and group velocities, and applications in high-energy physics, relativistic engineering, nuclear physics, astrophysics, and cosmology. **Effective From: Spring 2009**

Phys 421 - General Relativity (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. An introduction to Einstein's General Theory of Relativity at the advanced undergraduate level. Topics include review of Newton's Theory of Gravitation, review of Einstein's Special Theory of Relativity, tensor calculus on both flat and curved manifolds, the covariant derivative, curvature, Einstein's Gravitational Field Equations, the weak-field limit, gravitational radiation, the black hole solution, Hawking radiation, the No-Hair Theorem, cosmology, and a history of the Universe. **Effective From: Spring 2009**

Phys 430 - Classical Mechanics I (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H and Math 328 or Math 335, all with grade of C or better. Newtonian mechanics of particles and systems. Lagrange's and Hamilton's approaches. Continuous systems. 21&62:750:361 may be substituted for this course. **Effective From: Spring 2009**

Phys 431 - Classical Mechanics II (3-0-3)
Prerequisites: Phys 430, with grade of C or better. Theory of small oscillations and mechanical waves. Rigid bodies. Topics include stability, linearization methods, forced vibrators and perturbation theory, fluids and mechanics of continuous media. 21&62:750:362 may be substituted for this course. **Effective From: Spring 2009**

Phys 432 - Electromagnetism I (3-0-3)
Prerequisite: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H and Math 328 or Math 335, all with grade of C or better. Electrostatics and magnetostatics, Maxwell's equations with applications, and electrodynamics. **Effective From: Spring 2009**

Phys 433 - Electromagnetism II (3-0-3)
Prerequisite: Phys 432, with grade of C or better. Maxwell's equations with applications and electrodynamics. **Effective From: Spring 2009**

Phys 441 - Modern Physics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. Topics include wave-particle duality, wave mechanics, two-state quantum systems, the motion of an electron in a periodic lattice, band theory of solids, electrical, thermal and magnetic properties of solids, and plasmas and super fluid systems. 21&62:750:316 may be substituted for this course. **Effective From: Spring 2009**

Phys 442 - Introduction to Quantum Mechanics (3-0-3)
Prerequisite: Phys 430, with grade of C or better. Wave-particle duality, the Schrodinger and Heisenberg formulations of quantum mechanics. The hydrogen atom, perturbation theory, and concepts of degeneracy, composite states and general properties of eigenfunctions. 21&62:750:404 may be substituted for this course. **Effective From: Spring 2009**

Phys 443 - Modern Optics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with a grade of C or better. Electromagnetic theory of light, interference, diffraction, polarization, absorption, double refraction, scattering, dispersion, aberration, and an introduction to quantum optics. Other topics include holography, lasers, information retrieval, spatial filtering, and character recognition. **Effective From: Spring 2009**

Phys 444 - Fluid and Plasma Dynamics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. Introduces the basics of plasma physics. Covers the following plasma parameters, single particle motions, plasma as fluid, waves, diffusion and resistivity, equilibrium and instability, kinetic theory, nonlinear effects. Applications in three areas: controlled fusion, astrophysics, and interaction between light and plasma. **Effective From: Spring 2009**

Phys 446 - Solid State Physics (3-0-3)
Prerequisite: Math 222, with grade of C or better. Corequisite: Phys 442. An introduction to modern concepts of the solid state. Topics include crystal structure and diffraction, crystal binding and elastic properties, thermal properties, dielectric phenomena, band theory of solids and Fermi surfaces, electrical conductors, semiconductors, magnetism, and super-conductivity. 21&62:750:406 may be substituted for this course. **Effective From: Spring 2009**

Phys 448 - Semiconductor Physics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. The physics of semiconductors is examined and applied to problems of interest to the engineer. The course includes the following topics: the band theory of solids, conduction in solids, hole and electron statistics, and P-N junction theory with emphasis placed upon low-level and high-level injection. Metal semiconductor contacts and P-N-P transistor theory are also discussed. **Effective From: Spring 2009**

Phys 450 - Advanced Physics Laboratory (1-4-3)
Prerequisites: Phys 335, Phys 430, Phys 432, all with grade of C or better. Introduction to electrical measurements; instrumentation; theoretical and applied electronics, solid state electronic devices, digital circuitry; computer design; experiments in modern physics. **Effective From: Spring 2009**

Phys 451 - Biophysics II (3-0-3)
Prerequisites: Phys 121 with a grade of C or better. An introduction to electrical aspects of biophysics and a preparation for medical school and biotechnology careers. Covering how medical devices work and using active learning with reports on new research. **Effective From: Spring 2013**

Phys 452 - Atomic and Nuclear Physics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. Topics include atomic spectra, atomic structure, and nuclear physics. **Effective From: Spring 2009**

Phys 456 - Introduction to Solid State Physics (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. Treats the same topics as Phys 446 while introducing the necessary modern physics. Designed for students choosing a minor in applied physics. Students majoring in applied physics are ineligible. **Effective From: Spring 2009**

Phys 461 - Mathematical Methods of Theoretical Physics (3-0-3)
Prerequisites: Phys 430, Phys 432, Phys 433, all with grade of C or better. Topics include vector and tensor analysis, matrix methods, complex variables, Sturm-Liouville theory, special functions, Fourier series and integrals, integral equations, and numerical solutions of differential equations. **Effective From: Spring 2009**

Phys 480 - Topics in Applied Physics (3-0-3)
Prerequisite: Permission of instructor. Current topics and interests in applied physics and physics. Emphasis is on research and scientific development in microelectornics, optoelectronics, optical physics, materials science, surface science, solar physics, and modern physics. **Effective From: Spring 2009**

Phys 481 - Applied Solid State Physics: Microelectronics I (3-0-3)
Prerequisite: Phys 446, with grade of C or better. Topics include physics of bipolar and field effect devices, Phonon and optical spectra, unipolar devices, and thermal and high field properties of semiconductor devices. **Effective From: Spring 2009**

Phys 482 - Applied Solid State Physics: Microelectronics II (3-0-3)
Prerequisite: Phys 446, with grade of C or better. Topics include large-scale integrated circuits, device characteristics, charge-coupled devices, LED and semiconductor lasers, photodetectors, and electrical and optical properties of materials. **Effective From: Spring 2009**

Phys 483 - Applied Solid State Physics (0-6-3)
Prerequisite: Phys 446, with grade of C or better. Introduction to digital concepts; binary circuits and microprocessor architecture. Applications of discrete solid-state devices and integrated circuits are explored both in theory and practice. The laboratory also serves as an introduction to hardware and software components of a typical microcomputer. **Effective From: Spring 2009**

Phys 485 - Computer Modeling of Applied Physics Problems (3-0-3)
Prerequisites: Phys 234 or Phys 234H or Phys 231H and Math 222 or Math 222H, all with grade of C or better. General computer programming modeling methods and techniques. Numerical solutions to integro-differential equations. Eigenvalues problems. Application of computer-aided-design and other packages. 21&62:750:461 may be substituted for this course. **Effective From: Spring 2009**

Phys 490 - Independent Study (3-0-3)
Prerequisite: Departmental approval. Undertake individual research or a project under the supervision of a member of the physics department. 21&62:750:485, 486 may be substituted for this course. **Effective From: Spring 2009**

Phys 490H - Honors Independent Study (3-0-3)
By arrangement with a physics faculty member. Fulfills Honors College capstone course requirement.

R750:315 - Introductory Thermodynamics (3)
For more details go to Rutgers Catalog.

R750:316 - Introduction to Modern Physics (3)
For more details go to Rutgers Catalog.

R750:333 - Applications of Mathematics to Physics (3)
For more details go to Rutgers Catalog.

R750:403 - Introduction to Atomic and Nuclear Physics (3)
For more details go to Rutgers Catalog.

R750:404 - Quantum Mechanics (3)
For more details go to Rutgers Catalog.

R750:406 - Introductory Solid-State Physics (3)
For more details go to Rutgers Catalog.

R750:407 - Advanced Physics Laboratory I (1)
For more details go to Rutgers Catalog.

R750:408 - Advanced Physics Laboratory II (1)
For more details go to Rutgers Catalog.

R750:461 - Computational Methods in Applied Physics (3)
For more details go to Rutgers Catalog.

R750:485 - Individual Research in Physics (BA,BA)
For more details go to Rutgers Catalog.

R750:493 - Readings in Physics (BA,BA)
For more details go to Rutgers Catalog.

GRADUATE COURSES:

Phys 555 - Physics Laboratory Techniques (3 credits)
Prerequisite: B.S. or B.A. with course emphasis in a pure science or major engineering discipline. A training workshop in principles in mechanics, electricity and magnetism, wave motion, geometric and physical optics, and modern physics; experiments involving hands-on use of laboratory apparatus to solve numerous practical physics problems.

Phys 593 - Graduate Co-op Work Experience IV (0 credits)
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work. **Effective From: Fall 2006**

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 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 688 - Mathematical and Statistical Methods in Materials Science (3 credits)
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science. **Effective From: Fall 2006**

Phys 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 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

Phys 701 - Master's Thesis (3 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. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

Phys 721 - Classical Electrodynamics II (3 credits)
Prerequisite: Phys 621 or equivalent; basic knowledge of tensor analysis. Simple radiating systems, scattering and diffraction; special theory of relativity; dynamics of relativistic particles and electromagnetic fields; collisions between charged particles, energy loss, and scattering; radiation from accelerated charge, synchrotron radiation, and bremsstrahlung. **Effective From: Fall 2009**

Phys 725 - Independent Study (3 credits)
Prerequisites: permission from the graduate advisor (not thesis advisor) in Physics, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

Phys 728 - 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 731 - Quantum Mechanics II (3 credits)
Prerequisite: Phys 631 or equivalent. Review of quantum mechanics and theory of special relativity; second quantization; relativistic one-particle problem; Klein-Gordon equation and Dirac equation; canonical field theory; relativistic scattering theory; introduction to quantum electrodynamics and quantum field theory; Feynman diagrams and applications. **Effective From: Fall 2009**

Phys 774 - Fundamentals of Spectroscopy (3 Credits)
The major objectives of this course are to integrate theory and practice and to bring together different branches of Academic Studies and Industrial Research through the presentation of critical aspects of modern Spectroscopy. The course will provide a valuable theoretical introduction and an overview of modern topics in spectroscopy, which are of current interest and importance in Semiconductor Industry and Biomedicine. A wide range of techniques is considered, including optical Near field spectroscopy, X-ray, Raman, Neutron scattering, and FT-IR spectroscopy. **Effective From: Fall 2006**

Phys 789 - Physics of Advanced Semiconductor Device Processing (3 credits)
Prerequisites: NJIT: EE 657, 26:755:687; or equivalent. Intended for doctoral students in applied physics, electrical engineering, and materials science. (Rutgers = 26:755:789)Silicon and GaAs technologies: crystal growth methods, epitaxy, oxidation, lithography, dry and wet etching techniques, polysilicon, diffusion, ion implantation, metallization (including silicidation), process integration, analytical characterization techniques, assembly and packaging, and yield and reliability. **Effective From: Fall 2009**

Phys 790 - Doctoral Dissertation and Research (Credits as designated, 1st and 2nd sem.)
Prerequisites: passing grade on departmental qualifying examination and approval of doctoral candidacy. Corequisite: Phys 791. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester. Registration for additional credits, up to 12 per semester, is permitted with the approval of the department graduate advisor. Experimental or theoretical investigation of a topic in applied physics, including microelectronics, materials science, and laser physics. Cooperative projects with industry or government agencies may be acceptable. Research and writing are carried out under the supervision of a designated graduate faculty member. The completed written dissertation should be a substantial contribution to the knowledge of the topic under research, and should be of sufficient merit to warrant publication in a leading scientific or technical journal.

R755:611 - Advanced Classical Mechanics (3 credits)
For more details go to Rutgers Catalog.

R755:621 - Classical Electrodynamics (3 credits)
For more details go to Rutgers Catalog.

R755:631 - Quantum Mechanics (3 credits)
For more details go to Rutgers Catalog.

R755:641 - Statistical Mechanics (3 credits)
For more details go to Rutgers Catalog.

R755:651 - Atomic and Molecular Physics (3 credits)
For more details go to Rutgers Catalog.

R755:654 - Nuclear and Particle Physics (3 credits)
For more details go to Rutgers Catalog.

R755:661 - Solid-State Physics (3 credits)
For more details go to Rutgers Catalog.

R755:667 - Modern Experimental Techniques for Materials Processing and Characterization (3 credits)
For more details go to Rutgers Catalog.

R755:671 - Applied Optics (3 credits)
For more details go to Rutgers Catalog.

R755:675 - Cellular Biophysics (3 credits)
For more details go to Rutgers Catalog.

R755:687 - Physics of Materials (3 credits)
For more details go to Rutgers Catalog.

R755:689 - Simulations of Electronic Device Structures (3 credits)
For more details go to Rutgers Catalog.

R755:690 - Directed Study of Applied Physics (3 credits)
For more details go to Rutgers Catalog.

R755:700 - Master's Project (3 credits)
For more details go to Rutgers Catalog.

R755:701 - Master's Thesis (6 credits)
For more details go to Rutgers Catalog.

R755:721 - Classical Electrodynamics II (3 credits)
For more details go to Rutgers Catalog.

R755:731 - Quantum Mechanics II (3 credits)
For more details go to Rutgers Catalog.

R755:732 - General Relativity and Gravitation (3 credits)
For more details go to Rutgers Catalog.

R755:761 - Solid-State Theory (3 credits)
For more details go to Rutgers Catalog.

R755:762 - Electronic Structure of Solids (3 credits)
For more details go to Rutgers Catalog.

R755:763 - Surface and Interface Physics (3 credits)
For more details go to Rutgers Catalog.

R755:771 - Quantum Electronics (3 credits)
For more details go to Rutgers Catalog.

R755:772 - Applied Plasma Physics (3 credits)
For more details go to Rutgers Catalog.

R755:773 - Particle-Solid Interactions (3 credits)
For more details go to Rutgers Catalog.

R755:774 - Principles of Spectroscopy (3 credits)
For more details go to Rutgers Catalog.

R755:775 - Electrical Properties of Polymers (3 credits)
For more details go to Rutgers Catalog.

R755:780 - Current Topics of Applied Physics (3 credits)
For more details go to Rutgers Catalog.

R755:781 - Physics of Advanced Semiconductor Devices (3 credits)
For more details go to Rutgers Catalog.

R755:787 - Physics of Sensors and Actuators (3 credits)
For more details go to Rutgers Catalog.

R755:789 - Physics of Advanced Semiconductor Device Processing (3 credits)

For more details go to Rutgers Catalog.

R755:790 - Doctoral Dissertation (Credits as designated)
For more details go to Rutgers Catalog.

R755:791 - Applied Physics Seminar (Non-credit)
For more details go to Rutgers Catalog.

R755:792 - Pre-Doctoral Research (3 credits)
For more details go to Rutgers Catalog.

Political Science: Offered by the Department of Political Science at Rutgers-Newark. Hill Hall (973/353-5105)

UNDERGRADUATE COURSES:

R790:201 - American National Government (3)
For more details go to Rutgers Catalog.

R790:304 - Introduction to Law and Legal Research (3)
For more details go to Rutgers Catalog.

R790:310 - Science, Technology, and Public Policy (3)
For more details go to Rutgers Catalog.

R790:321 - World Politics (3)
For more details go to Rutgers Catalog.

R790:330 - Eastern European Governments and Politics (3)
For more details go to Rutgers Catalog.

R790:334 - International Relations of the Middle East (3)
For more details go to Rutgers Catalog.

R790:338 - Political Economy of Government-Business Relations (3)
For more details go to Rutgers Catalog.

R790:356 - Sex, Law, and Public Policy (3)
For more details go to Rutgers Catalog.

R790:360 - Urban Politics and Public Policy (3)
For more details go to Rutgers Catalog.

R790:367 - Jurisprudence and Legal Theory (3)
For more details go to Rutgers Catalog.

R790:371 - Early Political Theory (3)
For more details go to Rutgers Catalog.

R790:372 - Modern Political Theory (3)
For more details go to Rutgers Catalog.

R790:377 - Ideology and Politics (3)
For more details go to Rutgers Catalog.

R790:387 - International Law (3)
For more details go to Rutgers Catalog.

R790:395 - Contemporary American Foreign Policy (3)
For more details go to Rutgers Catalog.

R790:417 - Problems in International Relations (3)
For more details go to Rutgers Catalog.

R790:435 - The American Presidency (3)

For more details go to Rutgers Catalog.

R790:436 - Legislatures and the Legislative Process (3)
For more details go to Rutgers Catalog.

R790:441 - Civil Liberties (3)
For more details go to Rutgers Catalog.

Public Administration: Offered by the Department of Public Administration at Rutgers-Newark

GRADUATE COURSES:

R834:521 - Technology and Public Administration (3 credits)
For more details go to Rutgers Catalog.

R834:523 - Human Resources Administration (3 credits)
For more details go to Rutgers Catalog.

R834:524 - Strategic Planning and Management (3 credits)
For more details go to Rutgers Catalog.

R834:541 - Political Economy and Public Administration (3 credits)
For more details go to Rutgers Catalog.

R834:542 - Government Budgeting Systems (3 credits)
For more details go to Rutgers Catalog.

R834:562 - Policy and Program Assessment (3 credits)
For more details go to Rutgers Catalog.

R834:582 - Health Care Management (3 credits)
For more details go to Rutgers Catalog.

R834:584 - Health Care Finance (3 credits)
For more details go to Rutgers Catalog.

R834:585 - Health Care Policy (3 credits)
For more details go to Rutgers Catalog.

R834:586 - Violence in the United States (3 credits)
For more details go to Rutgers Catalog.

R834:602 - Decision Making and Policy Analysis (3 credits)
For more details go to Rutgers Catalog.

Professional and Technical Communication:

GRADUATE COURSES:

PTC 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 usability analysis; visual information; ethics; global diversity, global communication; report writing; information literacy; communicating with new technologies; and technical writing style. Students begin development of the MSPTC ePortfolio. **Effective From: Spring 2012**

PTC 603 - Identity, Technology, and Communication (3 credits)
Prerequisite or corequisite: PTC 601. Examines the complex ways in which technology constructs and is constructed by society, with emphasis on interrelationships between technology and communication. Discussions focus on how technological change is expressed in social and political movements, literature, art, architecture, and philosophy and how they, in turn, influence the future direction of technology. Design and updating of the MSPTC ePortfolio will be required in this seminar. **Effective From: Fall 2012**

PTC 604 - Communication Theory and Research (3 credits)
Prerequisite or corequisite: PTC 601Reviews the major theories of communication and provides strategies for research in the field of Professional and Technical Communication. The course focuses on these research methods: problem statement and hypothesis formulation derived from theory; research design and data generation; existing information sources and their acquisition; and analytic techniques. Students develop analytic methods necessary to create a well-considered thesis proposal. Design and updating of the MSPTC ePortfolio will be required in this seminar. **Effective From: Spring 2007**

PTC 605 - Elements of Visual Design (3 credits)
Prerequisite or corequisite: PTC 601. Provides an understanding of and competency in the visual presentation of information. Course integrates theories of design, techniques of composition, and technologies of electronic and print publishing. Modules include both design principles and hands-on practice in visual literacy, layout and design, and graphic tools. Design and updating of the MSPTC ePortfolio will be required in this seminar. **Effective From: Spring 2007**

PTC 606 - Advanced Information Design (3 credits)
Develops online visual communication strategies and community building. The course will cover the design and creation of multimedia objects, usability heuristics, navigation theory, contemporary design practices and online community building. Students will be required to create media-rich multidimensional online projects that encourage and facilitate interaction and team-building in the online environment. Design and updating of the MSPTC ePortfolio will be required for this seminar. **Effective From: Fall 2010**

PTC 610 - Research Methods for Information Design (3 credits)
Introduces user research methods such as contextual inquiry, ethnographic field studies, card sorting, affinity diagramming, and usability testing that provide the foundation for user- centered interaction design. **Effective From: Fall 2010**

PTC 612 - Theory and Practice of Text Encoding (3 credits)
Prerequisite: PTC 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. **Effective From: Spring 2006**

PTC 620 - Proposal Writing (3 credits)
Prerequisite or corequisite: PTC 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. **Effective From: Spring 2006**

PTC 622 - Working in Teams: Collaborative and Interpersonal Communications (3 credits)
Prerequisite or corequisite: PTC 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. **Effective From: Spring 2006**

PTC 624 - Professional and Technical Editing (3 credits)
Prerequisite or corequisite: PTC 601 . Presents the theory and practice of editing professional and technical writing. Topics include correctness and conciseness, hard copy and on-line editing, editing graphics, document management, editor-author relationships, and ethical considerations in editing. Students edit writing samples from a variety of technical fields. **Effective From: Spring 2006**

PTC 626 - Hypertext Design Studio (3 credits)
Prerequisite: PTC 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. **Effective From: Spring 2006**

PTC 628 - Analyzing Social Networks (3 credits)
Prerequisite: PTC 601 for MSPTC students; approval of instructor for non-MSPTC students. This course will provide students with an overview of social networks by introducing them to the unique terminology of social networks (centrality, boundary spanners, directional ties, etc.) Positive and negative characteristics of social networks will be discussed, followed by visualizations and analyses of those characteristics. Students will read selected journal articles explaining how social networks relate to communication and the flow of information within organizations. The culmination of the course will be a project in which students will create and analyze their own social network, most likely drawing their data from the popular social media site Facebook and using ORA, a freeware social network analysis application created by Carnegie Mellon University. **Effective From: Fall 2011**

PTC 629 - Theory and Practice of Social Media (3 credits)
Introduces social media strategies for reading and writing in today's multi-cultural, screen-oriented, networked culture. Students study relationship between mediated communication and human community and gain hands-on experience with chatting, blogging, tagging, wiki writing, tweeting and social media presentation. Students strategize, plan, design and produce social media projects of their own. **Effective From: Fall 2010**

PTC 631 - Communication and Environmental Problem Solving (3 credits)
Prerequisite or corequisite: PTC 601. Develops critical thinking on ecological issues for problem solving by integrating technical information, human values, and communication with environmental change. Students combine theory, research and models, case studies, visual thinking, and scientific inquiry for application in individual decision-making course project. **Effective From: Spring 2006**

PTC 632 - Content Management and Information Architecture (3 credits)
Prerequisite or Corequisite: PTC 601. Today's complex systems often produce complex information needs that require new technical communication methods and tools. This course will focus on the use of Information Architecture methodologies (such as, DITA or DocBook) to develop a structure for presenting technical information and on Content Management tools for creating a single source repository for this information. Students will also use theory and practical applications to design and develop a structured online Help module. **Effective From: Fall 2007**

PTC 640 - Health Communications (3 credits)
This course will focus on the use of communication strategies to inform and influence individual and community decisions regarding health. The course will cover: the multidimensional nature of health communication, research in health communication, behavioral theories in health communication, rhetorical theories in health communication, legal and ethical concerns in health communication, the communication of risk and uncertainty, and the design of health campaigns. Students will be required to (a) research and prepare a health communication strategy for use in a specific context and (b) to design an accompanying print or hypertext document to be used in that context. **Effective From: Spring 2006**

PTC 642 - Corporate Media and Communication (3 credits)
Prerequisite or corequisite: PTC 601. Develops communication skills for contemporary global corporate and business markets. Students create informative easy-to-use digital media that explore the global communications challenges facing organizations-business, non-profit, educational, and social interest-in a manner that is well-researched, informative, and entertaining. **Effective From: Fall 2010**

PTC 644 - Communication in Technology Transfer and Innovation (3 credits)
In order to help prepare students for careers in a market-oriented productive economy, this course builds on the understanding that communication is essential to innovation development and technology transfer. Students first review the principles of successful technical communication and the models and literature of communication in technology transfer. Then, students apply

this knowledge in team-based projects to develop Technology Transfer Communication Strategy (TTCS) for technology start-up companies as needed (business plans, documentation, technical reports, etc.) **Effective From: Fall 2007**

PTC 650 - ELearning Design for Mobile (3 credits)
Designing eLearning for mobile platforms is a critical skill for today's technical communicator. Specific skills and tools are required to ensure a successful implementation. Based on proven user centered design concepts, this course provides the student with the skills necessary to create effective mobile training programs. **Effective From: Spring 2013**

PTC 691 - ePortfolio Capstone Seminar (0)
This course is taken in the student's final semester before graduation. Students complete final revisions of the ePortfolio of work completed in MSPTC seminars (may also include professional and service projects). Student ePortfolios must successfully demonstrate MSPTC core competencies and be presented in an oral presentaiton for faculty and other students. **Effective From: Fall 2008**

PTC 698 - Selected Topics in Professional and Technical Communication (3 credits)
Prerequisite or corequisite: PTC 601 **Effective From: Spring 2006**

PTC 700 - Master's Project (3 credits)
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation. **Effective From: Spring 2006**

PTC 701 - Master's Thesis (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. **Effective From: Spring 2006**

PTC 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. **Effective From: Spring 2006**

Quantitative Method: Offered by the UMDNJ-New Jersey Medical School

GRADUATE COURSES:

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

GRADUATE COURSES:

R960:577 - Introduction to Statistical Linear Models (3 credits)
For more details go to Rutgers Catalog.

Transportation: Offered by the Interdisciplinary Program in Transportation

GRADUATE COURSES:

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 - Pre-Doctoral Research (B = 3 credits, or, C = 6 credits)
Prerequisite: Permission of program director. For students admitted to the Doctor of Philosophy Program in Transportation who have not yet passed the qualifying examination. Research is carried out under the supervision of a faculty member in the program. Up to 6 credits may be applied toward the required dissertation credits for the program. **Effective From: Fall 2007**