College of Science and Liberal Arts

The College of Science and Liberal Arts (CSLA) is the home of discovery and scholarship with strong programs in the traditional disciplines of biology, chemistry, physics, mathematics and history. CSLA also is the home of interdisciplinary programs that include communication and media; law, technology and culture; science, technology and society; environmental science; and theatre arts and technology. The sciences and liberal arts have long been the foundation of a university education and they allow us to address the complexities of modern life at the intersection of science, technology, and human values.

With over 150 full-time teachers and researchers, the CSLA community represents a wide range of interests, but also shares the value of academic excellence. CSLA faculty and students are at the forefront of many national research activities, including solar astronomy, mathematical modeling, and the history of medicine and technology.

CSLA provides students with the intellectual foundations necessary to understand and analyze the technological world in which we live. The college's courses and degrees prepare students to ask questions about the world, to collect data and provide evidence, and to express ideas and conclusions with clarity and precision. These skills transcend specific professional competence and distinguish CSLA students as individuals who can blaze a trail for others and lead society into a rapidly evolving future.

Programs

- Applied Mathematics - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/applied-mathematics-ms)
- Applied Physics - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/applied-physics-ms)
- Applied Statistics - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/applied-statistics-ms)
- Applied Science - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/applied-sciences-ms)
- Biology - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/biology/ms)
- BioStatistics - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/biostatistics-ms)
- Chemistry - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/chemistry-environmental-science/chemistry-ms)
- Environmental Science - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/chemistry-environmental-science/environmental-science-ms)
- Environmental and Sustainability Policy - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/chemistry-environmental-science/environmental-sustainability-policy-ms)
- History - M.A. (http://catalog.njit.edu/graduate/science-liberal-arts/history/ms)
- Materials Science and Engineering - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/materials-science-engineering-ms)
- Mathematical and Computational Finance - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/mathematical-computational-finance-ms)
- Pharmaceutical Chemistry - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/chemistry-environmental-science/pharmaceutical-chemistry-ms)
- Professional and Technical Communication - M.S. (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/professional-technical-communication-ms)

Programs

- Applied Physics - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/applied-physics-phd)
- Biology - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/biology/phd)
- Chemistry - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/chemistry-environmental-science/chemistry-phd)
- Environmental Science - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/chemistry-environmental-science/environmental-science-phd)
- Materials Science & Engineering - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/physics/materials-science-engineering-phd)
- Mathematical Sciences - Ph.D. (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/phd)

Programs

- Applied Science (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/applied-science-cert)
- Applied Statistical Methods (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/applied-statistical-methods-cert)
- Biostatistics Essentials (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/biostatistics-essentials-cert)
- Digital Marketing Design Essentials (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/digital-marketing-design-essentials-cert)
- Financial Mathematics (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/financial-mathematics-cert)
- Instructional Design, Evaluation and Assessment (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/instructional-design-evaluation-assessment-cert)
- Quantitative Finance (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/quantitative-finance-cert)
- Quantitative Tools for Finance (http://catalog.njit.edu/graduate/science-liberal-arts/mathematical-sciences/quantitative-tools-finance-cert)

- Social Media Essentials (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/social-media-essentials-cert)
- Technical Communication Essentials (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/technical-communication-essentials-cert)
- User Experience Essentials (http://catalog.njit.edu/graduate/science-liberal-arts/humanities/user-experience-essentials-cert)

College of Science and Liberal Arts Courses

BIOL 590. Grad Coop Work Experience I. 3 credits, 3 contact hours.

BIOL 591. Graduate Coop Work Exper II. 3 credits, 3 contact hours.

BIOL 593. Graduate Co-Op Work Exp IV. 0 credits, 0 contact hours.

BIOL 601. Computational Biology I. 3 credits, 3 contact hours.
This course will describe mathematical and simulation techniques used in modeling a variety of biological systems. Students will learn stability analysis, phase space analysis, basic bifurication theory and numerical simulation techniques with examples from neuroscience, cell and molecular biology as well as ecology and evolution. Students enrolling in this course are expected to have basic knowledge of calculus, linear algebra and some programming abilities.

BIOL 605. Prin of Bioscience Processing. 3 credits, 3 contact hours.
This course covers the main concepts of cell physiology, molecular biology, and cell biology. The fundamental aspects of biochemistry that relate directly to pharmaceutical developments are discussed and include basic organic chemistry, blood and buffers, protein based enzymes, complex carbohydrates, nucleic acids, and fats. Those topics will then be integrated into a thorough understanding of Bioprocessing in pharmaceutical industries. This course is for Professional Science Master's Biotechnology students with limited knowledge of Biology.

BIOL 606. App Bioproc & Immun Based Ther. 3 credits, 3 contact hours.
Prerequisites: BIOL 605 or permission of the instructor. This course provides foundational knowledge about immunology and immunological applications relevant to bioprocessing science including immunoglobulin genetics, leukocyte activation and migration, transplant immunology, and immunotherapy and vaccines.

BIOL 610. Comparative Vertebrate Anatomy. 3 credits, 3 contact hours.
This course introduces students to the groups of vertebrates and explores the anatomical evolution of vertebrates within the context of the functional interrelationships of organs and the changing environments to which vertebrates have adapted. An ideal entry point into the ways living creatures interact with their immediate physical world, we examine how the forms and activities of animals reflect the materials available to nature and consider rules for structural design under environmental forces.

BIOL 612. Comparative Animal Physiology. 3 credits, 3 contact hours.
This course will explore how animals, from invertebrates to vertebrates, function from the cellular to the organism level. The study of the structure and function of the various organs provides insight into how animals survive extreme environments and how they respond to changes in their environment. The comparative approach shows that the underlying physiological principles that govern life are common to all animals and yet animals have evolved unique and sometimes startling physiological solutions to problems posed by their particular environments.

BIOL 622. Evolution. 3 credits, 3 contact hours.
This course will provide a comprehensive overview of research in the field of evolutionary biology. Topics will include: the development of evolutionary theory, the history of the evolution of life on Earth, the genetic bases of variation and heredity, natural selection, evolution and development, and speciation. The format will be brief lectures to review topics covered in text, followed by class discussions of relevant primary literature. Students will write two papers on the topic of their choice and will be required to lead a minimum of one class discussion.

BIOL 628. Cell Biology of Disease: Cells Gone Bad. 3 credits, 3 contact hours.
This course will briefly review normal physiological function of humans and will then extensively explore the basis of many human diseases at cellular lever. The goal is to understand how alterations in normal cell functions affect human physiology by reviewing current research in the field of cell biology.

BIOL 630. Critical Thinking for the Life Sciences. 3 credits, 3 contact hours.
Researchers in the biological sciences must understand and be able to effectively apply the scientific method, and they must also be able to clearly communicate their ideas and results. This course will involve heavy student participation and discuss the scientific method, analyze and discuss data gathering and organizing, and will analyze existing grant proposals with the goal of enabling graduate students to write a clear and convincing grant proposal.

BIOL 631. Proposal Prep for Extnl Fundin. 3 credits, 3 contact hours.
Prerequisite: BIOL 630. This course is intended for doctoral students in their first or second year who intend to apply for external funding for their research. The course is hands-on and students are required to identify sources of funding and to write and submit a grant proposal. Topics covered include developing research questions and hypotheses, organization of specific aims, components of the proposal, including significance, innovation, expected outcomes, potential pitfalls and broader impact. The course also emphasizes practices of good grantsmanship and provides an overview of how proposals are reviewed at NSF and NIH.

BIOL 635. Intro to Comp Neuroscience. 3 credits, 3 contact hours.
Prerequisite: Permission by instructor. Introduction to the modeling, computational and analysis techniques for single neurons and small neuronal networks. The course work is designed so that students can develop an independent modeling/computational project by the end of the semester. The required knowledge of neurobiology, electric circuits and numerical tools for the solution of differential equations will be introduced as needed.

BIOL 636. Advanced Comp Neuroscience. 3 credits, 3 contact hours.
Prerequisites: BIOL 635 or permission by the instructor. Modeling and computational analysis of biological neuronal networks. The course consists of lectures, scientific paper presentations and computational work. Students are expected to develop an independent modeling/computational project by the end of the semester.

BIOL 638. Computational Ecology. 3 credits, 3 contact hours.
An overview of computational approaches to the study of mathematical models in ecology. Topics include one-, two-, and multi-species models, life history analysis, spatial dynamics, epidemiology. The course is taught as a hands-on computer lab in which students explore models, perform simulations and solve problems.

BIOL 640. Cellular Neurophysiology. 3 credits, 3 contact hours.
Prerequisites: Graduate student status or permission of the instructor. This course will examine the nervous system from a functional perspective. The goal is to understand how ion channels and other components of nerve cells give rise to electrical excitability and synaptic function, and how those properties are then used for coding information and higher order function in the nervous system.

BIOL 641. Systems Neuroscience. 3 credits, 3 contact hours.
This course will examine neurophysical phenomena from a systems perspective. The course will review basic concepts of cellular neuroscience, such as excitability, impulse conduction, and integration of activity at the cellular, before focusing on network level physiology of the nervous system and its role in the generation of behavior. The goal is to provide students with the basic knowledge to understand neurobiological processes at all levels of complexity.

BIOL 645. Biological Imaging Techniques. 3 credits, 3 contact hours.
Prerequisites: Graduate student status or permission of the instructor. This combined lecture and lab course will introduce the students to a variety of approaches to examine biological structures at different microscopic scales: conventional light microscopy, fluorescent microscopy, modern high resolution light microscopy, and electron microscopy. In addition, the course will cover optical approaches to study the dynamics of cellular function, including calcium and voltage imaging, and molecular interactions.

BIOL 660. College Teaching. 3 credits, 3 contact hours.
College Teaching helps students in STEM fields who teach or plan to teach in colleges or universities develop important professional knowledge, skills, values, and dispositions that can enable them to help undergraduate and graduate students develop societally and personally significant abilities. The course emphasizes research-based methods demonstrated to be effective for enhancing learning in diverse people.

BIOL 672. Computational Systems Biology. 3 credits, 3 contact hours.
Prerequisite: Permission by the instructor. Introduction to the mathematical and computational modeling of biological systems with a focus on chemical, biochemical, metabolic and genetic networks. The course work is designed so that students can develop an independent modeling/computational project by the end of the semester. The required knowledge of biology and numerical tools for the solution of differential equations will be introduced as needed.

BIOL 698. Selected topics in Biology. 3 credits, 3 contact hours.
Survey of recent research topics in Biology at the Master's level.

BIOL 699. Selected Topics in Biology. 3 credits, 3 contact hours.
Survey of recent research topics in Biology at the Masters level.

BIOL 700. Master's Project. 0 credits, 0 contact hours.

BIOL 700B. Master's Project. 3 credits, 3 contact hours.

BIOL 701. Master's Thesis. 0 credits, 0 contact hours.

BIOL 701B. Master's Thesis. 3 credits, 3 contact hours.

BIOL 701C. Master's Thesis. 6 credits, 3 contact hours.

BIOL 725. Independent Study. 3 credits, 3 contact hours.

BIOL 726. Independent Study. 3 credits, 3 contact hours.

BIOL 788. Selected Topics in Biology. 3 credits, 3 contact hours.
Survey of recent research topics in Biology at the doctoral level.

BIOL 790. Doct Dissertation & Resrch. 0 credits, 0 contact hours.

BIOL 790A. Doct Dissertation & Resrch. 1 credit, 1 contact hour.

BIOL 790B. Doct Dissertation & Resrch. 3 credits, 3 contact hours.

BIOL 790C. Doctoral Dissertn & Resrch. 6 credits, 6 contact hours.

BIOL 790D. Doct Dissertation & Resrch. 9 credits, 0 contact hours.

BIOL 790E. Doctoral Dissertation. 12 credits, 12 contact hours.

BIOL 791. Biology Seminar. 0 credits, 0 contact hours.
This seminar includes student and faculty presentations on current papers, student presentations related to their research and occasional outside speakers. It will acquaint students with possible topics for dissertation search, and provide an opportunity to present and receive feedback on current work.

BIOL 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.

BIOL 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.

BIOL 792D. Pre-Doctoral Research. 12 credits, 12 contact hours.

BIOL 794. Computational Biology Colloquium. 1 credit, 1 contact hour.
Restriction: graduate standing. Students and outside speakers present and discuss current research activities in computational biology and related scientific areas.

CHEM 590. Graduate Co-Op Work Exper I. 3 credits, 3 contact hours.

CHEM 591. Graduate Co-Op Ork Exper II. 3 credits, 3 contact hours.

CHEM 592. Graduate Co-Op Work Exper III. 3 credits, 3 contact hours.

CHEM 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.
Restriction: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

CHEM 599. Methods for Teaching Assistants and Graduate Assistants. 3 credits, 3 contact hours.
Restriction: graduate standing. Required for all chemistry teaching assistants and graduate assistants. Covers techniques of teaching, interaction with students, and safety. Does not count as degree credit.

CHEM 601. Special Topics in Chemistry I. 3 credits, 3 contact hours.
Restriction: graduate standing and permission of the instructor. Topics of current interest in chemistry.

CHEM 605. Advanced Organic Chemistry I: Structure. 3 credits, 3 contact hours.
Prerequisite: undergraduate organic chemistry. Structure of organic molecules. Topics include atomic and molecular structure, stereochemistry, reactive intermediates (cations, anions, radicals, and carbenes), orbital symmetry, and spectroscopy.

CHEM 606. Physical Organic Chemistry. 3 credits, 3 contact hours.
Prerequisite: CHEM 502 or equivalent. Emphasis is placed on the physical aspects of the subject. Determination of reaction mechanisms, equilibria, and kinetics using simple molecular orbital theory and absolute reaction rate theory.

CHEM 610. Advanced Inorganic Chemistry. 3 credits, 3 contact hours.
Prerequisite: undergraduate physical chemistry or permission of the instructor. Theories of observed chemical and physical properties of the elements and their compounds; prediction of reactivity and properties of proposed new compounds.

CHEM 617. Mass Spectrometry and Interpretation of Mass Spectra. 3 credits, 3 contact hours.
Prerequisite: CHEM 125 and CHEM 126 or equivalent. Historical background, fundamentals and mechanics of operation for components incorporated into modern Mass Spectrometers: vacuum system, ion sources, mass filter, ion detection, plus computer operation and data collection. Explanation and interpretation of mass spectra and fragmentation patterns are a fundamental theme throughout the course. Lecture material includes principles of operation and appropriate applications for modern types of mass spectrometers: magnetic sector, quadrupole, time of flight, ion trap, FT-ICR. Theory and applications of electron impact, chemical, electrospray, and other ionization techniques including atmospheric sampling are covered. High resolution analysis using magnetic sector and FT - ion cyclotron instruments. Analytical applications in environmental, petroleum and biochemical analysis and applications and coupling of mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

CHEM 658. Advanced Physical Chemistry. 3 credits, 3 contact hours.
Prerequisite: one year of undergraduate physical chemistry. Principles and applications of quantum chemistry; the wave equation, its properties and mathematics; the Schrodinger equation and wave functions; the harmonic oscillator; variational and perturbational methods; atomic theory, structure, and properties; simple molecules, LCAO and valence bond theories; semi-empirical methods; time dependence, and introduction to electronic and vibration-rotation spectroscopy.

CHEM 661. Instrumental Analysis Laboratory. 3 credits, 3 contact hours.
Prerequisite: one year of undergraduate physical chemistry. Instruments for chemical analysis are discussed in class and used in the laboratory; basic theory; sample preparation; use of instruments and interpretation of data are covered for spectroscopy including UV0VIS, FTIR, AA, and NMR; HPLC, GC, ion chromatography, mass spectrometry. Applications to food science, pharmaceuticals, polymers, and other chemical areas.

CHEM 662. Air Pollution Analysis. 3 credits, 4 contact hours.
Prerequisite: undergraduate physical chemistry. Chemical and physical principles of gaseous species and trace level measurement techniques for airborne vapors and particulates. Emphasis on analyzing real air samples at the parts-per-billion level, meteorological dispersion and life times of pollutants are covered. Laboratory work in air pollution sampling methods for vapor and particulate species. Determination of primary air pollutants using wet chemical and instrumental techniques.

CHEM 664. Advanced Analytical Chemistry. 3 credits, 3 contact hours.
Prerequisite: undergraduate physical chemistry. The principles of chemical analysis as they apply to chromatography, electrochemistry, and spectroscopy. Sampling considerations, separations, and sample preparation steps. This course is a useful adjunct to CHEM 661, where these analytical techniques are considered in a more practical way.

CHEM 673. Biochemistry. 3 credits, 3 contact hours.
Prerequisite: undergraduate organic and physical chemistry, or suitable background in these subjects. Fundamentals of biochemistry related to physical organic chemistry for students who have an interest in biomedical engineering, chemistry, chemical engineering, or environmental science.

CHEM 700. Masters Project. 0 credits, 0 contact hours.
Prerequisite: matriculation for the master's degree. An extensive report involving an experimental, theoretical, or literature investigation is required. The literature investigation should result in a critical review of a specific area. Approval to register for the master's project must be obtained from the project advisor. Students must continue to register for at least 3 credits each semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

CHEM 700B. Masters Project. 3 credits, 3 contact hours.
Restriction: matriculation for the master's degree. An extensive report involving an experimental, theoretical, or literature investigation is required. The literature investigation should result in a critical review of a specific area. Approval to register for the master's project must be obtained from the project advisor. Students must continue to register for at least 3 credits each semester until the project is completed and a written report is accepted. Only a total of 3 credits will count toward the degree.

CHEM 701. Master's Thesis. 0 credits, 0 contact hours.
Prerequisite: matriculation for the master's degree in applied chemistry. Approval of thesis advisor is necessary for registration. Original research under the guidance of a departmental advisor. The final product must be a written thesis approved by at least three faculty members: the primary advisor, another from the department, and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum of 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

CHEM 701B. Masters Thesis. 3 credits, 3 contact hours.

CHEM 701C. Masters Thesis. 6 credits, 3 contact hours.

CHEM 702. Special Topics in Chemistry II. 3 credits, 3 contact hours.
Restriction: Graduate standing. Topics of current interest in chemistry.

CHEM 714. Pharmaceutical Analysis. 3 credits, 3 contact hours.
The objective of this course is to provide an overview of instrumental techniques used in the analysis of different pharmaceutical products. Many different types of analysis are carried out in the pharmaceutical industry pertaining to active ingredients, formulations as well as impurities and dgradants. The focus will be on instrumentation such as chromatography, mass spectroscopy, different types of spectroscopy, quality assurance and GMP.

CHEM 716. Integrated Drug Dev & Discover. 3 credits, 3 contact hours.
Prerequisites: Strong background in organic chemistry This course offers an overview of the drug development process combined with hands-on experience in computer-aided drug design. Topics include pharmacokinetics, bioavailability, drug formulation, and structure-based drug design.

CHEM 717. Mass Spectrometry and Mass Spectral Interpretation. 3 credits, 3 contact hours.
Prerequisites: CHEM 125 and CHEM126 or equivalent. CHEM 717 and EVSC 617 are comprised of CHWM 717 and EVSC 617 plus a research project: Research projects usually comprise experimental and mass spectrometry interpretation studies. These can be performed at NJIT or in the students corporate mass spectrometry facility. Projects may also include theory, data interpretation or literature reviews pertinent to a current active area in mass spectrometry research. Projects should be approved or in consult with the instructors.

CHEM 718. Organic Synthesis. 3 credits, 3 contact hours.
Organic Synthesis is widely used in the production of organic materials and pharmaceutical drugs. The course introduces modern synthetic methods to the graduate students of NJIT. The first part of the course teaches organic reactions categorized by their roles in synthesis. Topics include substitution and addition of carbon nucleophiles, functional group conversion, oxidation, reduction, concerted cycloadditions, aromatic substitutions, and organometallic catalysis. The second part of the course teaches general strategies to develop synthetic plans, special considerations for difficult synthetic targets, and examples of natural product synthesis.

CHEM 719. Drug Delivery Systems. 3 credits, 3 contact hours.
Prerequisites: Strong background in organic chemistry This course emphasizes the importance of effective drug delivery to achieve specific therapeutic outcomes. Students learn current trends in research on the design of drug delivery systems to release drug content in a controllable and targeted manner.

CHEM 725. Independent Study I. 3 credits, 3 contact hours.
Prerequisite: permission from the graduate advisor (not thesis advisor) in chemistry, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

CHEM 726. Independent Study II. 3 credits, 3 contact hours.
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

CHEM 727. Independent Study III. 3 credits, 3 contact hours.
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

CHEM 734. Thermochemical Kinetics-Detailed Mechanistic Modeling. 3 credits, 3 contact hours.
Prerequisite: graduate level course in either kinetics or reactor design, or permission of instructor. Quantitative estimation of thermochemical data and chemical reactions in the vapor phase, and to some extent in the liquid phase; theories of transition state, RRKM, and Quantum RRK; and detailed chemical modeling concepts for reactor design. Applied computer project is required.

CHEM 735. Combustion. 3 credits, 3 contact hours.
Prerequisite: thermodynamics and kinetics or equivalent, or permission of instructor. Thermodynamic properties of stable molecules and free radical species in combustion and oxidation of aliphatic hydrocarbons; reactions occurring in high temperature combustion systems; and related kinetic principles.

CHEM 737. Applications of Computational Chemistry and Molecular Modeling. 3 credits, 3 contact hours.
Students are exposed to hands-on applications and fundamental aspects of computational chemistry and molecular modeling in organic, inorganic, bio- and physical chemistry. The course provides methods to determine the thermochemistry of a reaction, and strength (energy)of interactions by organic drug-like molecules with proteins. The course teaches the student to evaluate relative energy of different structures plus chemical species stability, reactivity and equilibrium ratios in chemical environments.

CHEM 748. Nanomaterials. 3 credits, 3 contact hours.
New feature of the 700 level course will be hands-on small projects carried out by groups of two students in Professor Iqbal's laboratories during the second half of the semester. The projects will be selected from the topics covered in the course. A second feature will involve a lecture on a specialized nanomaterial topic given by an invited outside lecturer. This 3 credit interdisciplinary course is designed to teach and provide hands-on project experience to M.S. and Ph.D. graduate students in chemistry, physics/materials science, and chemical/biomedical/electrical engineering on the fundamentals, synthesis, characterization and applications of nanomaterials. 75% of the course will comprise of lectures-one or two of which will be given by invited outside lecturers. 25% of the course will involve small projects based on the syllabus and conducted in the research laboratories of the instructor.

CHEM 764. Advanced Analytical Chemistry. 3 credits, 3 contact hours.
Prerequisite: undergraduate General and Analytical Chemistry. The principles of chemical analysis as they apply to chromatography, electrochemistry, and spectroscopy. Sampling considerations, separations, and sample preparation steps. This course is a useful adjunct to CHEM 661, where these analytical techniques are considered in a more practical way.

CHEM 777. Principles Pharm Chemistry. 3 credits, 3 contact hours.
Teaches about drug design, and the molecular mechanisms by which drugs act in the body. Covers pharmacodynamics, pharmacokinetics, molecular targets used by drugs, the interaction of a drug with a target, and the consequences of this interaction. Covers strategies used in discovering and designing new drugs, and surveys the "tools of the trade" involved, e.g., QSAR, combichem and computer aided design. Covers special topics like chlorinergics, analgesics, opiates, antibacterials, antivirals, and antiulcer agents.

CHEM 790. Doctoral Dissertation. 0 credits, 0 contact hours.

CHEM 790A. Doctoral Dissertation. 1 credit, 1 contact hour.

CHEM 790B. Doctoral Dissertation. 3 credits, 3 contact hours.

CHEM 790C. Doctoral Dissertation. 6 credits, 3 contact hours.

CHEM 790D. Doctoral Dissertation. 9 credits, 3 contact hours.

CHEM 790E. Doctoral Dissertation. 12 credits, 3 contact hours.

CHEM 790F. Doctoral Dissertation. 15 credits, 15 contact hours.

CHEM 790G. Doctoral Dissertation. 18 credits, 18 contact hours.

CHEM 791. Graduate Seminar. 0 credits, 0 contact hours.
Required of all chemistry graduate students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

CHEM 792. Pre-Doctoral Research. 3 credits, 3 contact hours.

CHEM 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.

CHEM 792C. Pre-Doctoral Research. 6 credits, 6 contact hours.

ENG 502. English for International Graduate Students. 3 credits, 3 contact hours.
Practice in writing to improve sentence structure, grammar, vocabulary, and organization. For technical writing, see ENG 541. Level: High Intermediate.

ENG 503. Advanced English for International Teaching Assistants. 3 credits, 3 contact hours.
Practice in public speaking for international TAS and other international students who want to improve their oral presentation skills. Also covers teaching techniques and pronunciation. Level: Advanced.

ENG 505. Advanced Spoken English for International Graduate Students. 3 credits, 3 contact hours.
Designed to improve English pronunciation; accent reduction. Level: Advanced.

ENG 507. Advanced Conversation and American Culture. 3 credits, 3 contact hours.
Practice in conversation in English at an advanced level. The goal is to help students gain the cultural knowledge and speaking skills to increase participation in American life. Level: Advanced.

ENG 521. Technical Written and Oral Communication. 3 credits, 3 contact hours.
Develops skill in oral and written technical communication on a professional level. Three areas are emphasized: 1) analyzing professional and technical communication situations; 2) achieving clear, effective oral and written communication; and 3) developing awareness of variations in professional communication across cultures. For some assignments, students will work on projects from courses in their own fields. The approach is practical; course format is that of a workshop. Non-native speakers of English may take this course.

EPS 601. Research Methods for Environment and Sustainability Policy. 3 credits, 3 contact hours.
Introduces the research methods necessary to conduct studies in environmental and sustainability policy. Topics covered include literature review, problem identification, hypothesis testing, and quantitative methods of data analysis and problem solving. Students are required to implement and present their independently designed projects.

EPS 602. Research Analysis for the Social and Policy Sciences. 3 credits, 3 contact hours.
Prerequisite: EPS 601. Distribution of social, political, economic and health-related data in both samples and populations using a general linear model with residuals. Test hypotheses using both the Fisher and Neyman-Pearson criteria. Use of software such as SPSS, Microsoft Excel and Resampling Stats. to develop and test models using correlation, regression and ANOV techniques.

EPS 609. Environmental Risk Assessment. 3 credits, 3 contact hours.
Methodology to assess the social and economic risks to present-day environmental resources of air and water; cost-benefit and trade-off analysis; technical characteristics of materials such as half-life, decomposition rates, and temperature sensitivity; and probabilities of various environmental situations.

EPS 612. Introduction to Environmental Policy Studies. 3 credits, 3 contact hours.
Introduction to six areas essential to a comprehensive understanding of environmental policy: concept of environmental policy; tools (law, economics, planning, science, engineering, ethics) for environmental policy; the U.S. perspective (NEPA, clean air and water acts, CERCLA); the international perspective (Club of Rome models, 1972 UNEP, 1992 Rio); industrial perspective (pollution prevention/life cycle engineering, privatization); and the local perspective (New Jersey DEP, NGOs, local industry, shoreline.) Same as MIP 612.

EPS 613. Environmental History and Policy. 3 credits, 3 contact hours.
Explores the dialogue between humanity and the environment in the United States, as well as its global implications. Surveys fundamental themes of history and policy from an environmental perspective: colonial development, independence, western expansion, industrialization, urbanization, and the rise of a consumer society. Gives special attention to the emergence of an environmental perspective: wilderness appreciation, the conservation movement, public health, the rise of the environmental movement since the 1960s, environmental science, and the legislative and regulatory process.

EPS 614. Environmental Economics and Management. 3 credits, 3 contact hours.
Overviews the complex and dynamic interactions between the economy and the environment from biological, economic, and institutional perspectives and investigates various strategies for resolving conflicts in resource management and pollution control. Topics include the basic principles of risk assessment, cost benefit analysis, and cost-effectiveness analysis in environment management and assessment of contemporary environment politics in air and water pollution control and waste and toxics management.

EPS 622. Sustainable Politics and Policy. 3 credits, 3 contact hours.
Identifies the origins of the concept of sustainability development and institutional efforts to implement strategies at various geopolitical scales: international, national, regional, and local. The course introduces tools to measure progress toward sustainability through the use of metrics such as ecological footprint analysis and life-cycle analysis. Other topics include steady-state economics, sustainable systems of production and consumption, and sustainability transitions.

EPS 638. Physical Geography. 3 credits, 3 contact hours.
Understanding the interaction between humans and the physical environment is important to the formulation of sound environmental policy. The course examines processes that shape the physical environment, the influence of human activities on these processes and the physical environment, and the application of this information to solving environmental problems.

EPS 644. The Rhetoric of Environmental Policy. 3 credits, 3 contact hours.
Introduces students to the major types of rhetorical analysis as well as assures that students can analyze and write technology policy that is informed by core rhetorical principles of that analysis.

EPS 651. Introduction to Urban and Environmental Health. 3 credits, 3 contact hours.
Health problems associated with the social and psychological factors found in urban areas and health problems stemming from contamination of air, water, food, the work place and other special environments. Policies required to promote healthful living behavior and those required to regulate negative externalities.

EPS 660. Ethics and Environmental Policy. 3 credits, 3 contact hours.
Contemporary environmental problems from the perspective of ethics or moral philosophy. Is there a moral obligation to preserve or protect the natural environment? What are the ethical presumptions and values underlying environmental policy? Are traditional theories of moral philosophy applicable to contemporary environmental problems, or is a new conception of the relationship between humanity and nature needed?.

EPS 698. ST:. 3 credits, 3 contact hours.
Course considers advanced topics of special or current interest related to environmental and sustainability policy.

EPS 699. ST:. 3 credits, 3 contact hours.
Course considers advanced topics of special or current interest related to environmental and sustainability policy.

EPS 700. Master'S Project. 0 credits, 0 contact hours.

EPS 700B. Master'S Project. 3 credits, 3 contact hours.

EPS 701. Master'S Thesis. 0 credits, 0 contact hours.
Prerequisite: matriculation for the master's degree, advisor's and departmental approval. Projects involving fieldwork, experimental, or theoretical investigation carried out under the supervision of a designated member of the departmental faculty. The completed thesis should be of a quality as to warrant publication, in whole or in part, in a professional journal. A minimum of 3 credits per semester is required until completion.

EPS 701B. Master'S Thesis. 3 credits, 3 contact hours.
Restriction: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

EPS 701C. Master'S Thesis. 6 credits, 3 contact hours.
Restriction: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

EPS 702. Special Topics. 3 credits, 3 contact hours.
Restriction: Approval of graduate advisor in Environmental Science. Topics of current interest in the field of environmental policy. Doctoral level course.

EPS 712. Advanced Studies in Environmental and Sustainability Policy. 3 credits, 3 contact hours.
Evaluates strategies to reduce energy and material throughput including eco-efficiency relocalization of production and consumption, and green consumerism. Also considered are debates surrounding innovative policies to foster work-time reduction, to develop alternative measures of well-being, and to include societal values shifts.

EPS 714. Environmental and Natural Resources Economics. 3 credits, 3 contact hours.
Examines environmental regulation of firms and natural resource use with emphasis on the theoretical foundations required for public policy. Students focus primarily on the application of economic tools to improve environmental quality.

EPS 725. Independent Study I. 3 credits, 3 contact hours.
Restriction: matriculation for the master's degree, advisor's and departmental approval. Projects not within the scope of existing courses are carried out under the supervision of a designated member of the departmental faculty.

EPS 726. Independent Study II. 3 credits, 3 contact hours.
Restriction: matriculation for the master's degree, advisor's and departmental approval. Projects not within the scope of existing courses are carried out under the supervision of a designated member of the departmental faculty.

EVSC 591. Graduate Work Experience. 3 credits, 3 contact hours.

EVSC 592. Graduate Work Experience. 3 credits, 3 contact hours.
Restriction: permission of the associate chairperson for environmental science and the Division of Career Development Services. Provides on-the-job reinforcement of environmental science assignments. Projects are developed by the co-op office in consultation with the associate chairperson for environmental science. Cannot be used for degree credit.

EVSC 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.
Prerequisite: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

EVSC 600. Environmental Science Seminar. 0 credits, 3 contact hours.
Restriction: graduate standing. Current environmental topics of interest to the environmental professional are presented. Required every semester for environmental science graduate students receiving departmental or research-based awards and for all doctoral students.

EVSC 602. Special Topics in Environmental Science I. 3 credits, 3 contact hours.
Restriction: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

EVSC 603. Hazardous Waste Operations and Emergency Response. 3 credits, 3 contact hours.
Explores the safe operation of hazardous waste sites as well as emergency responses to hazardous releases. Overview of OSHA regulations and NIOSH standards concerning toxicological hazards and medical surveillance requirements. Emphasis on recognition and monitoring of site hazards. A written health and safety plan, and participation in a group problem involving a simulated hazardous site entry using actual protective equipment is required. Course satisfies the regulatory compliance mandates to meet 29 CFR 1910.120 for OSHA, with certification valid for one year.

EVSC 610. Environmental Chemical Science. 3 credits, 3 contact hours.
Restriction: graduate standing. Principles of physical, inorganic and organic chemistry are applied to understanding the origins of environmental pollutants, their transport, distribution and decomposition pathways.

EVSC 611. Hazardous Waste Management. 3 credits, 3 contact hours.
Restriction: graduate standing. An overview of hazardous waste management; case histories; legislation and regulations; treatment, disposal and cleanup technologies; sampling and analysis methodology; persistence and fate in the environment; emergency response procedures.

EVSC 612. Environmental Analysis. 3 credits, 4 contact hours.
Restriction: graduate standing. The analysis of environmental samples is studied from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis, and data treatment.

EVSC 613. Environmental Problem Solving. 3 credits, 3 contact hours.
Restriction: graduate standing. This course is designed to study solutions for current environmental problems. Students are asked to respond to an imaginary Request for Proposal (RFP) in writing and before a team of technical experts at an oral presentation. Solutions proposed in student RFPs must reflect knowledge of environmental science and technology in current use.

EVSC 614. Quantitative Environmental Risk Assessment. 3 credits, 3 contact hours.
Restriction: graduate standing. Applications ofquantitative risk assessment concepts to the management of environmental problems.

EVSC 615. Global Environmental Problems. 3 credits, 3 contact hours.
Restriction: graduate standing. With an understanding that environmental problems are not restricted by geographical boundaries, relationships of the earth's temperature balance, global air circulation patterns, global energy needs, and control and remediation technologies are studied.

EVSC 616. Toxicology. 3 credits, 3 contact hours.
Restriction: graduate standing. The general principles of toxicology are presented and applied to the assessment of acute, subacute and chronic effects of hazardous and toxic chemicals. Qualitative and quantitative measures of toxicity and testing protocols are addressed. The role of toxicology in risk assessment and risk management is discussed.

EVSC 617. Mass Spectrometry and Interpretation of Mass Spectra. 3 credits, 3 contact hours.
Prerequisite: CHEM 125 and CHEM 126 or equivalent. Historical background, fundamentals and mechanics of operation for components incorporated into modern Mass Spectrometers: vacuum system, ion sources, mass filter, ion detection, plus computer operation and data collection. Explanation and interpretation of mass spectra and fragmentation patterns are a fundamental theme throughout the course. Lecture material includes principles of operation and appropriate applications for modern types of mass spectrometers: magnetic sector, quadrupole, time of flight, ion trap, FT-ICR. Theory and applications of electron impact, chemical, electrospray, and other ionization techniques including atmospheric sampling are covered. High resolution analysis using magnetic sector and FT - ion cyclotron instruments. Analytical applications in environmental, petroleum and biochemical analysis and applications and coupling of mass spectrometry with other instruments (GC, LC, AES,) are illustrated.

EVSC 621. Ecological Risk Assessment. 3 credits, 3 contact hours.

EVSC 622. Bioremediation. 3 credits, 3 contact hours.

EVSC 623. Environmental Health. 3 credits, 3 contact hours.

EVSC 624. Environmental Analysis Methods and Laboratory. 3 credits, 4 contact hours.
Basic theory, methods, instruments, and data interpretation for chemical analysis of environmental samples are described in lectures and used in the laboratory; sampling; sample preparation; quality assurance, chain of custody. Instrument methods and uses include: UV-VIS, FTIR, AA, HPLC, GC, Ion Chromatography, and Mass Spectrometry as applied to environmental samples.

EVSC 625. Social Dimensions of Risk. 3 credits, 3 contact hours.
Low-probability/high consequence events involving terrorism, food safety, and extreme weather offer ample evidence the prevalent approaches of economics and statistics are not able to deal with the complex ways that risk permeates modern societies. This course treats risk analysis as a broad interdisciplinary activity and draws on the full range of the social sciences to explore the multifaceted way that risk infuses itself into the fabric of contemporary affairs.

EVSC 626. Hydrogeology. 3 credits, 3 contact hours.
This course covers the principles of ground water flow, advanced water cycle properties, aquifer flow and aquifer recharge. Contaminant migration and remediation methods are discussed. Basic groundwater chemistry and quality is covered.

EVSC 627. Environmental Microbiology. 3 credits, 3 contact hours.
Prerequisite: R120 101, R120 102, (General Biology I and II) or permission of instructor. This course offers an overview of 1) basic microbiology: biochemical principles, cell structure organization, microbial nutrition and growth, 2) the important microbes involved in environmental microbiology and address the environments where they are found, and 3) how they are detected and monitored, and their effects on humans, and the environment. Traditional lectures and exams are supplemented with discussions of current research articles.

EVSC 700. Masters Project. 0 credits, 0 contact hours.
Prerequisite: graduate standing and approval of the graduate advisor in environmental science. Written report requiring experimental or theoretical research, or an extensive literature analysis. Registration must be approved by an advisor. Students must continue to register for 3 credits each semester until completion and a written report is accepted. Only a total of 3 credits will count toward the degree.

EVSC 700B. Masters Project. 3 credits, 3 contact hours.
Restriction: graduate standing and approval of the graduate advisor in environmental science. Written report requiring experimental or theoretical research, or an extensive literature analysis. Registration must be approved by an advisor. Students must continue to register for 3 credits each semester until completion and a written report is accepted. Only a total of 3 credits will count toward the degree.

EVSC 701. Masters Thesis. 0 credits, 0 contact hours.
Prerequisite: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

EVSC 701B. Masters Thesis. 3 credits, 3 contact hours.
Restriction: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

EVSC 701C. Masters Thesis. 6 credits, 3 contact hours.
Restriction: matriculation for a master's degree in environmental science. Approval to register for the thesis must be obtained from the advisor. Original research under the supervision of a designated faculty member. The final product must be a written thesis approved by three faculty members: the student's primary advisor, another from the program and one other faculty member. Once registration for thesis has begun, a student must continue to register for a minimum 3 credits per semester until at least 6 credits have been completed and a written thesis is approved. Only a total of 6 credits will count toward the degree.

EVSC 702. Special Topics in Environmental Science II. 3 credits, 3 contact hours.
Restriction: approval of graduate advisor in environmental science. Topics of current interest in the environmental field.

EVSC 711. Advanced Environmental Analysis. 3 credits, 3 contact hours.
Prerequisite: EVSC 612 or equivalent. Analysis of complex environmental samples is studied, from the acquisition of representative samples, through sample handling, chain of custody, sample storage, analytical method selection, analysis and data handling. Collection and analysis of samples from air, water, soil, and biological systems will be discussed. Emphasis on the study of current literature.

EVSC 712. Hazardous Substance Management. 3 credits, 3 contact hours.
Restriction: Graduate standing. The course material comprises an overview of hazardous materials and hazardous waste management and control in an industrial setting. The course examines the technical approaches utilized in the control, remediation, and prevention of hazardous substances and waste. It also includes the major technical elements of federal regulations that govern operations involving the handling of hazardous materials.

EVSC 715. Energy and Sustainability. 3 credits, 3 contact hours.
This course comprises an interdisciplinary review of energy fundamentals including the basic principles necessary to understand energy systems. The technological and engineered systems for processing and using different energy non-renewable and renewable sources. The social and environmental consequences of energy production, distribution, and use, including a comparison of socioeconomic models of global energy applications.

EVSC 717. Mass Spectrometry and Mass Spectral Interpretation. 3 credits, 3 contact hours.
Prerequisite: CHEM 125 and CHEM 126 or equivalent. CHEM 717 and EVSC 617 are comprised of CHEM 717 and EVSC 617 plus a research project: Research projects usually comprise experimental and mass spectrometry interpretation studies. These can be performed at NJIT or in the students corporate mass spectrometry facility. Projects may also include theory, data interpretation or literature reviews pertinent to a current active area in mass spectrometry research. Projects should be approved or in consult with the instructors.

EVSC 725. Independent Study I. 3 credits, 3 contact hours.
Restriction: written permission from the Associate Chairperson for Environmental Science plus courses prescribed by the supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which are not sufficiently broad to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

EVSC 726. Independent Study II. 3 credits, 3 contact hours.
See description for EVSC 725.

EVSC 790. Doctoral Dissertation. 0 credits, 0 contact hours.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 790A. Doctoral Dissertation. 1 credit, 1 contact hour.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 790B. Doctoral Dissertation. 3 credits, 3 contact hours.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 790F. Doctoral Dissertation. 15 credits, 15 contact hours.
Required of all students working toward the degree of Doctor of Philosophy. A minimum of 36 credits is required. Approval of dissertation advisor is necessary for registration. Candidates must register for at least 6 credits of dissertation per semester until 36 credits are reached, and 3 credits per semester thereafter until a written dissertation is approved.

EVSC 791. Graduate Seminar. 0 credits, 1 contact hour.
Required of all environmental science graduate students receiving departmental or research-based awards and all doctoral students. The student must register each semester until completion of the degree. Outside speakers and department members present their research for general discussion.

EVSC 792. Pre-Doctoral Research. 3 credits, 3 contact hours.

EVSC 792B. Pre-Doctoral Research. 3 credits, 3 contact hours.

HIST 620. City and Disease in History. 3 credits, 3 contact hours.
Explores the dynamic interaction between the growth of cities and changes in the experience and location of disease. Presumes the intertwining of these two historical developments in the birth of a distinctly urban identity, one predicated on the notion that the modern city is somehow inherently diseased. Focuses on the New York and Newark metropolitan areas in the nineteenth and twentieth centuries. Among the topics considered are epidemic outbreaks, quarantines, the technology and organization of sanitation and hygiene, the professional formation of public, industrial and occupational medicine, and medical and popular responses to immigration.

HIST 622. Culture and Science in the History of American Medicine. 3 credits, 3 contact hours.
Provides an overview of American medical history and a familiarity with the theoretical and practical ramifications of different approaches to the complex relationships between medicine, science, and culture. Topics include: the extent to which medicine is or has been scientific; reasons why science has been considered so important to medicine's professional culture; and the degree to which medicine's professional culture has been shaped by science as well as other factors, such as economic and political self-interest, technology, class, race, gender, and other kinds of cultural values.

HIST 624. Technology, Environment and Medicine in World History, 1500-1900. 3 credits, 3 contact hours.
Examines the interrelationship between the emerging modern world system and changes in technology, environment, and medicine, with particular emphasis on European overseas expansion and its impact in non-Western regions.

HIST 626. Social History of American Medicine Since 1800. 3 credits, 3 contact hours.
Topics include the practices of 19th-century regular medicine; the relation between medical concepts and mainstream social thought; the treatment of women's health; antebellum alternative healers and alternative politics; the triumphs of late 19th- and early 20th-century medical therapeutics; the emergence of medicine as big business; medicine and racism; the emergence of nursing as a profession; modern medicine in an international perspective; New Age healing; the AIDS crisis and AIDS activism; and contemporary debates on the future of health care in the United States.

HIST 628. Gender, Science and Technology in the Modern World. 3 credits, 3 contact hours.
Introduction to a wide range of political and cultural analyses of science and technology, with an emphasis on recent feminist critiques of science. Explores the questions of scientific neutrality; the gendering of scientific knowledge; the relationship between science, technology, and capitalism; the role of science in international politics; and why science has not freed women.

HIST 630. History of the Body in Modern Western Culture. 3 credits, 3 contact hours.
Considers medical or scientific history primarily in terms of implications for bodily experience in everyday life. Begins with grand narratives of historical shifts in bodily perceptions and practices, and proceeds to more focused narratives of changing bodily experience, engaging key distinctions between genders, classes, and species as well as perceptions of pain and internal bodily structure. Materials will be drawn from early modern and modern Europe, as well as more recent bodily experience in the United States.

HIST 632. Global Hist of Tech & Culture. 3 credits, 3 contact hours.
Treats the relationship between technology and cultural values in a variety of historical and geographical settings, from early modern Japan to twentieth-century America. Examines the ways in which cultural ideals, conceptions, and preconceptions serve to influence the rate and manner of technological change, as well as the ways in which technology affects social and cultural life.

HIST 634. Environmental History of North America. 3 credits, 3 contact hours.
Explores the dialogue between humankind and the environment in North America over the course of the last four centuries. Examines the latest and most interesting work done in the new field of environmental history to see what such a perspective has to offer.

HIST 635. History of Technology, Environment and Medicine: Theory and Method. 3 credits, 3 contact hours.
A team-taught course which surveys the methods employed in the three fields. Explores the interdisciplinary nature of each field, and the value of interdisciplinary scholarship.

HIST 637. Global Environmental History. 3 credits, 3 contact hours.
This course takes a global view of human interaction with the natural world, mixing broad themes such as colonialism and industrialization with detailed case studies in an effort ot understand the ways that people and the environment have mutually shaped one another. Because environmental change often transcends national boundaries, this course places important subjects in environmental history such as disease, agriculture, pollution, and environmentalism into a global and transnational context.

HIST 638. Social History of Communication. 3 credits, 3 contact hours.
Treats selected themes in the history of communication in different social and cultural contexts, from the ancient world to the twentieth century. Topics include: orality, proto-literacy, and literacy in ancient and medieval cultures; printing and the development of print culture in the early modern world; the ?communication revolution? of the late 19th and early 20th centuries; and historiographical debates over the role of communication technologies in society.

HIST 640. The Urban Environment. 3 credits, 0 contact hours.
Examines the role of the economy, culture, and technology in shaping the urban environment. Makes extensive use of Newark and the New York metropolitan area, including field observations and local research. In addition to other topics, explores in detail spatial relationships, the role of transportation, and the development of suburbia.

HIST 642. The History of Health and International Development. 3 credits, 3 contact hours.
This course examines the history of western efforts to promote health and nutrition in the 'developing world" from the beginnings of tropical medicine. We will trace this history through its many permutations from the establishment of colonial health services to the development of the Global Programme on AIDS. In doing so, we will explore the various economic and political interests and underlying cultural assumptions that have shaped the development of ideas and practices associated with international health and development.

HIST 644. War, Technology and Society, 1500-1914. 3 credits, 3 contact hours.
Examines key themes in the interrelationship between warfare, technology and society from the beginnings of modern warfare until World War I. Primary emphasis placed on the historical connections between violent conflict, the technical means by which it is carried out, and the socio-political environment within which wars take place. The effect of technology upon war and considerations of the effect of war on technological change and development. Samples the rich tradition of thought and ideas produced by philosophers and theorists on these themes.

HIST 645. American Legal History to 1860. 3 credits, 3 contact hours.
Readings and discussion on the legacy of common law after the Revolution; the emergence of legal instrumentalism; and the evolution of tort, contract, and damages in the context of industrialism and economic growth.

HIST 650. History of American Conservatism. 3 credits, 3 contact hours.
This course examines postwar American conservatism through classic works and contemporary studies. Topics include the rise of conservatism, groups under the conservative umbrella, and the rise of the right as related to key events in postwar history (Cold War, McCarthysim, the '60s, the suburbs and urban change). Course interrogates postwar conservatism with respect to American political and intellectual history and in relation to histories of gender, race, class, sexuality, place and religion.

HIST 652. Topics in the History of Technology. 3 credits, 3 contact hours.
Selected topics in the history of technology.

HIST 653. Topics in European Intellectual and Cultural History. 3 credits, 3 contact hours.
Examination of issues and methods in European intellectual and cultural history, with a consideration of some leading problems in the field.

HIST 654. Topics in American Intellectual and Cultural History. 3 credits, 3 contact hours.
Examination of issues and methods in American intellectual and cultural history, with a consideration of some leading problems in the field.

HIST 655. Topics in American Urban and Ethnic History. 3 credits, 3 contact hours.
Examination of issues and methods in American urban and ethnic history, with a consideration of some leading problems in the field.

HIST 656. Topics in the History of Health. 3 credits, 3 contact hours.
Selected topics in the history of Health.

HIST 657. Topics in Environmental History. 3 credits, 3 contact hours.
Selected topics in environmental history.

HIST 658. Topics in American Legal History. 3 credits, 3 contact hours.
Readings and discussion on the growth of legal formalism, the evolution of substantive due process, changes in legal education and the legal profession, and the evolution of private law.

HIST 660. The Enlightenment in Britain. 3 credits, 3 contact hours.
The 18th century was the age of the Enlightenment. Great Britain became a unified polity and the most powerful imperial force in the world. We examine the Enlightenment in Britain against the backdrop of war and empire, imperial consumer culture, the growth and significance of sociability and politeness, representations of gender, the writing of cultural history, social uses of science/technology, print culture, and competition among varying notions of ethnic identity.

HIST 661. Problems and Readings in European History since 1850. 3 credits, 3 contact hours.
Introduction to the major historiographical problems and recent literature in European history since 1850.

HIST 662. Prob. and Read: Hist/US Foreighn Policy and Diplomacy. 3 credits, 3 contact hours.
Examination of issues and methods in American diplomatic history, with a consideration of some leading problems in the field.

HIST 663. Problems and Readings in American History, 1492-1789. 3 credits, 3 contact hours.
Introduction to the major historiographical problems and recent literature in American history rom 1492 to 1789.

HIST 664. Problems and Readings in American History, 1789-1865. 3 credits, 3 contact hours.
Introduction to the major historiographical problems and recent literature in American history from 1789 to 1865.

HIST 665. Problems and Readings in American History, 1865-1914. 3 credits, 3 contact hours.
Introduction to the major historiographical problems and recent literature in American history from 1865 to 1914.

HIST 666. Problems and Readings in American History, 1890-1945. 3 credits, 3 contact hours.
Introduction to the major historiographical problems and recent literatue in American history from 1890 to 1945.

HIST 667. Problems and Readings in American History, 1945-Present. 3 credits, 3 contact hours.
Introduction to the major historiographical problems and recent literature in American history since 1945.

HIST 698. Research in History. 3 credits, 3 contact hours.
This seminar course introduces students to various methods for conducting historical research using primary and secondary source materials, and teaches them how to write a formal research paper. The seminars are on a particular topic chosen by the professor, and can focus on a chronological period or geographic region, on an historical event, cultural movement, or social group, or on a type of history such as environmental history, the history of technology, or the history of health and medicine.

HIST 701. Master'S Thesis. 0 credits, 0 contact hours.
Prerequisite: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

HIST 701B. Master'S Thesis. 3 credits, 3 contact hours.
Restriction: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

HIST 701C. Master'S Thesis. 6 credits, 6 contact hours.
Restriction: permission of graduate history advisor. For students writing a master's thesis in the history of technology, environment and medicine.

HIST 702. Master's Essay. 3 credits, 3 contact hours.
For those who don't write a 6 credit thesis, the 3 credit Master's Essay caps the M.A./M.A.T. A substantial work done with an advisor, may be: 1. Interpretive historical essay based on primary source research. 2. Narrative history based on primary source research. Prereq: R510:504, R510:505, or R510:506. 3. Historiographical essay. 4. Content-focused curriculum design, either a course or significant portion thereof. 5. Design for an historical museum exhibition/other work in public history. Prereq: R510:565.

HIST 725. Independent Study. 3 credits, 1 contact hour.
Restriction: permission of graduate history advisor and course instructor.

HIST 726. Independent Study. 3 credits, 1 contact hour.
Restriction: permission of graduate history advisor and course instructor.

HIST 727. Independent Study. 3 credits, 3 contact hours.
Restriction: permission of graduate history advisor and course instructor.

HIST 791. Seminar in History of Technology, Environment and Medicine. 0 credits, 0 contact hours.
Faculty, students and invited speakers present and discuss current topics of research in history, technology and medicine.

MATH 545. Introductory Mathematical Analysis. 3 credits, 3 contact hours.
Prerequisite: MATH 211 or MATH 213, and departmental approval. Rigorous treatment of the calculus of real-valued functions of one real variable: the real number system, epsilon-delta theory of limit, continuity, derivative, and the Riemann integral. The fundamental theory of calculus. Series and sequences including Taylor series and uniform convergence. The inverse and implicit function theorems.

MATH 546. Advanced Calculus. 3 credits, 3 contact hours.
Prerequisite: MATH 545 or MATH 480. Rigorous treatment of the calculus of real-valued functions of several real variables: the geometry and algebra of n-dimensional Euclidean space, limit, continuity, derivative, and the Riemann integral of functions of several variables, the inverse and implicit function theorems, series, including Taylor series, optimization problems, integration on curves and surfaces, the divergence and related theorems.

MATH 573. Intermediate Differential Equations. 3 credits, 3 contact hours.
Prerequisites: MATH 222, MATH 337, or departmental approval. Methods and applications for systems of ordinary differential equations: existence and uniqueness for solutions of ODEs, linear systems, stability analysis, phase plane and geometrical methods, Sturm-Liouville eigenvalue problems.

MATH 590. Graduate Co-op Work Experience I. 3 credits, 3 contact hours.
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services. Cooperative education/ internship providing on-the-job complement to academic programs in mathematics. Work assignments and projects are developed by the Co-op Office in consultation with the Department of Mathematical Sciences.

MATH 591. Graduate Co-op Work Experience II. 3 credits, 3 contact hours.
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

MATH 592. Graduate Co-op Work Experience III. 3 credits, 3 contact hours.
Prerequisites: Graduate status, departmental approval, and permission of the Division of Career Development Services.

MATH 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

MATH 599. Teaching in Mathematics. 3 credits, 3 contact hours.
Required of all master's and doctoral students in Mathematical Sciences who are receiving departmental or research-based awards. Provides students with the skills needed to communicate effectively and to perform their teaching and related duties. Students are exposed to strategies and methods for communicating and for teaching undergraduate mathematics, and they are required to practice and demonstrate these techniques. Not counted for degree credit.

MATH 604. Mathematical Finance. 3 credits, 3 contact hours.
Prerequisites: FIN 641 Derivatives, MATH 605 Stochastic Calculus, or permission of the instructor. This course will explore the structure, analysis, and use of financial derivative instruments deployed in investment strategies and portfolio risk management. Topics include continuous time dynamics, arbitrage pricing, martingale methods, and valuation of European, American, and path dependent derivatives.

MATH 605. Stochastic Calculus. 3 credits, 3 contact hours.
This course provides an introduction to stochastic calculus. Topics include conditioning, Poisson processes, martingales, Brownian motion, Ito integrals, Ito's formula, stochastic differential equations, Feynman-Kac formula, Girsanov's theorem, and the martingale representation theorem. Financial applications include pricing, hedging, and interest rate models.

MATH 606. Term Structure Models. 3 credits, 3 contact hours.
Prerequisites: MATH 605, or permission of the instructor. Corequisite: MATH 608. This course will develop the mathematical structure of interest rate models and explore the considerable hurdles involved in practical implementation. Short rate models, single and multifactor; the Heath-Jarrow-Morton framework; and modern Libor market models will be examined.

MATH 607. Credit Risk Models. 3 credits, 3 contact hours.
Prerequisites: MATH 604, MATH 605, MATH 606 or permission of the instructor. This course explores mathematical models and methods for credit risk measurement and rating. The nature of credit risk is reviewed through examination of credit instruments, including credit default swaps, collateralized debt obligations, and basket credit derivatives. These instruments, through which risk exposure opportunities and hedging possibilities are created and managed, are explored with respect to dynamics and valuation techniques, applying PDE methods and stochastic processes.

MATH 608. Partial Differential Equations for Finance. 3 credits, 3 contact hours.
This course presents the subject of partial differential equations (PDE's) with a strong emphasis on the PDE's arising in the study of stochastic processes and finance. The focus is on analytical and numerical methods for obtaining solutions in a form useful for solving problems in financial engineering. Topics include modeling with PDE's, classification of PDE's, analytical and numerical methods for PDE's and application to finance.

MATH 609. Projects in Mathematical and Computational Finance. 3 credits, 3 contact hours.
Prerequisites: MATH 604 Mathematical Finance, MATH 605 Stochastic Calculus, MATH 606 Term Structure Models, or permission of the instructor. This project course requires students to demonstrate attained mastery of the material studies in the prerequisite courses. Projects also extend students? knowledge of specific areas beyond that covered in earlier courses into areas such as particle filtering or optimization techniques for term structure model calibration. The aim is to broaden the students? classroom focus to the more unconstrained, open ended and less well defined contexts that are frequently encountered in practice.

MATH 610. Graduate Research Methods. 3 credits, 0 contact hours.
Prerequisite: MATH 614, MATH 671, and MATH 690. Acquaints second-year graduate students with the techniques and vocabulary of a field in applied mathematics. Each student contacts a designated faculty member and is given several basic papers or books on a research topic of current interest. The student prepares two lectures on his/her topic to be given at the end of the semester. A sample list of active fields of research includes acoustics, electromagnetic theory, elasticity, fluid dynamics, combustion, and mathematical biology.

MATH 611. Numerical Methods for Computation. 3 credits, 3 contact hours.
This course provides a practical introduction to numerical methods. Numerical solution of linear systems. Interpolation and quadrature. Interative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial and boundary value problems for ODE's. Introduction to numerical solution of PDE's. Applicatons drawn from science, engineering, and finance.

MATH 613. Advanced Applied Mathematics I: Modeling. 3 credits, 3 contact hours.
Prerequisites: MATH 331 and MATH 337, or departmental approval. Concepts and strategies of mathematical modeling are developed by investigation of case studies in a selection of areas. Consistency of a model, nondimensionalization and scaling, regular and singular effects are discussed. Possible topics include continuum mechanics (heat and mass transfer, fluid dynamics, elasticity), vibrating strings, population dynamics, traffic flow, and the Sommerfeld problem.

MATH 614. Numerical Methods I. 3 credits, 3 contact hours.
Prerequisites: MATH 222, MATH 337, MATH 340, and proficiency in a computer language (FORTRAN, C, or C++), or departmental approval. Theory and techniques of scientific computation, with more emphasis on accuracy and rigor than MATH 611. Machine arithmetic. Numerical solution of a linear system and pivoting. Interpolation and quadrature. Iterative solution of nonlinear systems. Computation of eigenvalues and eigenvectors. Numerical solution of initial- and boundary-value problems for systems of ODEs. Applications. The class includes examples requiring student use of a computer.

MATH 615. Approaches to Quantitative Analysis in the Life Sciences. 3 credits, 3 contact hours.
A graduate seminar-style course based around case studies of common data analytic methods used in the life sciences. The case studies are designed to help students who are interested in applications of statistical thinking to biological sciences appreciate the scope of quantitative methods, their underlying concepts, assumptions and limitations. While the mathematics of specific methods are not covered, students of the course will get an understanding of the diverse approaches to statistical inference in the life sciences.

MATH 630. Linear Algebra and Applications. 3 credits, 3 contact hours.
Prerequisites: (This course is not intended for students in the Master's in Applied Mathematics program or in the doctoral program in Mathematical Sciences.) Math 211 or Math 213, and Math 222. Development of the concepts needed to study applications of linear algebra and matrix theory to science and engineering. Topics include linear systems of equations, matrix algebra, orthogonality, eigenvalues and eigenvectors, diagonalization, and matrix decomposition.

MATH 631. Linear Algebra. 3 credits, 3 contact hours.
Prerequisites: MATH 222 and MATH 337, or departmental approval. Similar in aim and content to MATH 630 but with more emphasis on mathematical rigor. Linear systems of equations, matrix algebra, linear spaces, orthogonality, eigenvalues and eigenvectors, diagonalization, and matrix decomposition. Applications.

MATH 635. Analytical Computational Neuroscience. 3 credits, 3 contact hours.
Prerequisites: MATH 211 or 213, MATH 337, and CS 113 or MATH 240, or departmental approval. This course will provide an intermediate-level mathematical and computational modeling background for small neuronal systems. Models of biophysical mechanisms of single and small networks of neurons are discussed. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, single- and multi-compartmental modeling, synaptic transmission, mathematical treatment of 2-cell inhibitory or excitatory networks. In this course, the students will be required to build computer models of neurons and networks and analyze these models using geometric singular-perturbation analysis and dynamical systems techniques.

MATH 636. Systems Computational Neuroscience. 3 credits, 3 contact hours.
Prerequisites: MATH 635. This course covers mathematical and computational modeling of neuronal networks. Topics covered include central pattern generators, models of visual processes, models of learning and memory, neural coding and mathematics of neural networks, models of oscillations in sensory, thalamic and thalamo-cortical networks, neuronal wave propagation.

MATH 637. Foundations of Mathematical Biology. 3 credits, 3 contact hours.
Prerequisites: MATH 222 and MATH 337, or departmental approval. This course provides an introduction to the use of mathematical techniques applied to solve problems in biology. Models discussed fall into 3 categories: discrete, continuous, and spatially distributed. Biological topics discussed range from the subcellular molecular systems and cellular behavior to physiological problems, population biology and developmental biology.

MATH 639. Mathematical Modeling II. 3 credits, 3 contact hours.
Continuation of MATH 613 (Advanced Applied Mathematics I, Modeling). Concepts and strategies of Mathematical modeling are developed by case studies in a selection of areas. Topics will be complementary to those presented in MATH 613, and include for example, the mathematical theory of elasticity and electromagnetism.

MATH 644. Regression Analysis Methods. 3 credits, 3 contact hours.
Prerequisite: MATH 661. Regression models and the least squares criterion. Simple and multiple linear regression. Regression diagnostics. Confidence intervals and tests of parameters, regression and analysis of variance. Variable selection and model building. Dummy variables and transformations, growth models. Other regression models such as logistic regression. Using statistical software for regression analysis.

MATH 645. Analysis I. 3 credits, 3 contact hours.
Prerequisite: MATH 546 or departmental approval. Review and extension of the fundamental concepts of advanced calculus: the real number system, limit, continuity, differentiation, the Riemann integral, sequences and series. Point set topology in metric spaces. Uniform convergence and its applications.

MATH 646. Time Series Analysis. 3 credits, 3 contact hours.
Prerequisite: MATH 661 or departmental approval. Time series models, smoothing, trend and removal of seasonality. Naive forecasting models, stationarity and ARMA models. Estimation and forecasting for ARMA models. Estimation, model selection, and forecasting of nonseasonal and seasonal ARIMA models.

MATH 647. Time Series Analysis II. 3 credits, 3 contact hours.
Prerequisite: MATH 646. Continuation of MATH 646. Covers methods of time series analysis useful in engineering, the sciences, economics, and modern financial analysis. Topics include spectral analysis, transfer functions, multivariate models, state space models and Kalman filtering. Selected applications from topics such as intervention analysis, neural networks, process control, financial volatility analysis.

MATH 651. Methods of Applied Mathematics I. 3 credits, 3 contact hours.
Prerequisite: MATH 222 or departmental approval. A survey of mathematical methods for the solution of problems in the applied sciences and engineering. Topics include: ordinary differential equations and elementary partial differential equations. Fourier series, Fourier and Laplace transforms, and eigenfunction expansions.

MATH 654. Clinical Trials Design and Analysis. 3 credits, 3 contact hours.
Prerequisites: MATH 665 or equivalent with Departmental approval. Statistical methods and issues in the design of clinical trials and analysis of their data. Topic include clinical trial designs for phases 1-4, randomization principle and procedures, analysis of pharmacokinetic data for bioequivalence, multi-center trials, categorical data analysis, survival analysis, longitudinal data analysis, interim analysis, estimation of sample size and power, adjustment for multiplicity, evaluation of adverse events, and regulatory overview.

MATH 656. Complex Variables I. 3 credits, 3 contact hours.
Prerequisite: MATH 545 or MATH 645 or departmental approval. The theory and applications of analytic functions of one complex variable: elementary properties of complex numbers, analytic functions, elementary complex functions, conformal mapping, Cauchy integral formula, maximum modulus principle, Laurent series, classification of isolated singularities, residue theorem, and applications.

MATH 659. Survival Analysis. 3 credits, 3 contact hours.
Prerequisites: MATH 665 or equivalent with Departmental approval. Introduction to statistical methods for modeling time-to-event data in the presence of censoring and truncation, with emphasis on applications to the health sciences. Topics include survival and hazard functions, censoring and truncation, parametric and nonparametric models for survival data, competing-risks, regression models including Cox proportional hazards model and time-dependent covariates, one and two sample tests, and use of appropriate statistical software for computations.

MATH 660. Introduction to statistical Computing with SAS and R. 3 credits, 3 contact hours.
Prerequisite: Basic knowledge in statistical concepts or instructor approval. This course will study SAS and R programming and emphasize the SAS and R data steps including getting data into the SAS and R environments, working and combining data using control flows, merge and subsets, etc. as well as learning to export data and to generate high resolution graphics. Several SAS and R statistical procedures or functions will also be discussed and illustrated. Finally, interactive statistical software JMP and Minitab are briefly introduced.

MATH 661. Applied Statistics. 3 credits, 3 contact hours.
Prerequisite: MATH 112. Role and purpose of applied statistics. Data visualization and use of statistical software used in course. Descriptive statistics, summary measures for quantitative and qualitative data, data displays. Modeling random behavior: elementary probability and some simple probability distribution models. Normal distribution. Computational statistical inference: confidence intervals and tests for means, variances, and proportions. Linear regression analysis and inference. Control charts for statistical quality control. Introduction to design of experiments and ANOVA, simple factorial design and their analysis. MATH 661 and MATH 663 cannot both be used toward degree credits at NJIT.

MATH 662. Probability Distributions. 3 credits, 3 contact hours.
Prerequisite: MATH 341 or MATH 333, and departmental approval. Probability, conditional probability, random variables and distributions, independence, expectation, moment generating functions, useful parametric families of distributions, transformation of random variables, order statistics, sampling distributions under normality, the central limit theorem, convergence concepts and illustrative applications.

MATH 663. Introduction to Biostatistics. 3 credits, 3 contact hours.
Prerequisites: Undergraduate Calculus. Introduction to statistical techniques with emphasis on applications in health related sciences. This course will be accompanied by examples from biological, medical and clinical applications. Summarizing and displaying data; basic probability and inference; Bayes' theorem and its application in diagonostic testing; estimation, confidence intervals, and hypothesis testing for means and proportions; contingency tables; regression and analysis of variance; logistic regression and survival analysis; basic epidemiologic tools; use of statistical software. Math 661 and Math 663 cannot both be used toward degree credits at NJIT.

MATH 664. Methods for Statistical Consulting. 3 credits, 3 contact hours.
Prerequisite: MATH 661 or departmental approval. Communicating with scientists in other disciplines. Statistical tools for consulting. Using statistical software such as JMP, SAS, and S-plus. Case studies which illustrate using statistical methodology and tools are presented by the instructor and guest speakers from academia and industry. Assignments based on case studies with use of statistical software is required.

MATH 665. Statistical Inference. 3 credits, 3 contact hours.
Prerequisite: MATH 662 or departmental approval. Review of sampling distributions. Data reduction principles: sufficiency and likelihood. Theory and methods of point estimation and hypothesis testing, interval estimation, nonparametric tests, introduction to linear models.

MATH 666. Simulation for Finance. 3 credits, 3 contact hours.
Covers the use of Monte Carlo stochastic simulation for finance applications. Topics include generation of various random variables and stochastic processes (e.g., point processes, Brownian motion, diffusions), simulation methods for estimating quantities of interest (e.g., option prices, probabilities, expected values, quantiles), input modeling, and variance-reduction techniques. Students will write computer programs in C++. Students cannot receive credit for both CS 661 and CS/MATH 666.

MATH 671. Asymptotic Methods I. 3 credits, 3 contact hours.
Prerequisite: MATH 645 or MATH 545, and MATH 656, or departmental approval. Asymptotic sequences and series. Use of asymptotic series. Regular and singular perturbation methods. Asymptotic methods for the solution of ODEs, including: boundary layer methods and asymptotic matching, multiple scales, the method of averaging, and simple WKB theory. Asymptotic expansion of integrals, including: Watson's lemma, stationary phase, Laplace's method, and the method of steepest descent.

MATH 672. Biomathematics I: Biological Waves and Oscillations. 3 credits, 3 contact hours.
Prerequisites: MATH 222, MATH 331, and MATH 337, or departmental approval. Models of wave propagation and oscillatory phenomena in nerve, muscle, and arteries: Hodgkin-Huxley theory of nerve conduction, synchronization of the cardiac pacemaker, conduction and rhythm abnormalities of the heart, excitation-contraction coupling, and calcium induced waves, wave propagation in elastic arteries, models of periodic human locomotion.

MATH 673. Biomathematics II: Pattern Formation in Biological Systems. 3 credits, 3 contact hours.
Prerequisites: MATH 222, MATH 331, and MATH 337, or departmental approval. Emergence of spatial and temporal order in biological and ecological systems: Hopf and Turing bifurcation in reaction-diffusion systems, how do zebras get their stripes, patterns on snake skins and butterfly wings, spatial organization in the visual cortex, symmetry breaking in hormonal interactions, how do the ovaries count. Basic techniques of mathematics are introduced and applied to significant biological phenomena that cannot be fully understood without their use.

MATH 675. Partial Differential Equations. 3 credits, 3 contact hours.
Prerequisite: MATH 690 or departmental approval. A survey of the mathematical theory of partial differential equations: first-order equations, classification of second-order equations, the Cauchy-Kovalevsky theorem, properties of harmonic functions, the Dirichlet principle. Initial- and boundary-value problems for hyperbolic, elliptic, and parabolic equations. Systems of equations.

MATH 676. Advanced Ordinary Differential Equations. 3 credits, 3 contact hours.
Prerequisites: MATH 222, MATH 337, and MATH 545 or MATH 645. A rigorous treatment of the theory of systems of differential equations: existence and uniqueness of solutions, dependence on initial conditions and parameters. Linear systems, stability, and asymptotic behavior of solutions. Nonlinear systems, perturbation of periodic solutions, and geometric theory of systems of ODEs.

MATH 677. Calculus of Variations. 3 credits, 3 contact hours.
Prerequisite: MATH 545 or MATH 645 or departmental approval. Necessary conditions for existence of extrema. Variation of a functional, Euler's equation, constrained extrema, first integrals, Hamilton-Jacobi equation, quadratic functionals. Sufficient conditions for the existence of extrema. Applications to mechanics.

MATH 678. Stat Methods in Data Science. 3 credits, 3 contact hours.
Prerequisite: MATH 661 or MATH 663, or permission by instructor. This course introduces students to concepts in statistical methods used in data science, including data collection, data visualization and data analysis. Emphasis is on model building and statistical concepts related to data analysis methods. The course provides the basic foundational tools on which to pursue statistics, data analysis and data science in greater depth. Topics include sampling and experimental design, understanding the aims of a study, principles of data analysis, linear and logistic regression, resampling methods, and statistical learning methods. Students will use the R statistical software.

MATH 680. Advanced Statistical Learning. 3 credits, 3 contact hours.
Prerequisites: MATH 478 or MATH 678, or permission by instructor. This course builds on the material in MATH 478 or MATH 678 and serves as a second graduate course in data science with emphasis on statistics. It covers many topics in high dimensional data analysis, including LASSO, SCAD and other regularization procedures, sparse PCA, sparse k-means, and asymptotic theory for high dimensional models. This course will provide students with necessary theoretical and computational skills to understand, design, and implement modern statistical learning methods, including ensemble learning (bagging, random forest, and boosting). Students will use the R statistical software.

MATH 683. High Dimensional Stat Inferenc. 3 credits, 3 contact hours.
Prerequisite: MATH 665 or permission by instructor. This course introduces modern statistical inference theory and methods developed as a result of the influence of computing. The course covers statistical thinking, ideas and theory that underlie many of the statistical learning algorithms used in data science, such as bootstrap, EM algorithm, cross-validation, large-scale hypothesis test, false discovery rates, sparse modeling, support vector machines and ensemble learning.

MATH 687. Quantitative Analysis for Environmental Design Research. 3 credits, 3 contact hours.
Prerequisites: MATH 333 and departmental approval. Fundamental concepts in the theory of probability and statistics including descriptive data analysis, inferential statistics, sampling theory, linear regression and correlation, and analysis of variance. Also includes an introduction to linear programming and nonlinear models concluding with some discussion of optimization theory.

MATH 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 3 contact hours.
Prerequisites: MATH 111, MATH 112 and (MATH 211 or MATH 213). The course introduces mathematical methods necessary for materials science with emphasis on practical applications. Topics include power series, complex numbers, linear algebra, partial differentiation, multiple integrals, vector analysis, Fourier series and transformation, ordinary and partial differential equations, functions of complex variables, probability, and statistics.

MATH 689. Advanced Applied Mathematics II: Ordinary Differential Equations. 3 credits, 3 contact hours.
Prerequisites: MATH 545 or MATH 645, MATH 613, and MATH 631. A practical and theoretical treatment of boundary-value problems for ordinary differential equations: generalized functions, Green's functions, spectral theory, variational principles, and allied numerical procedures. Examples will be drawn from applications in science and engineering.

MATH 690. Advanced Applied Mathematics III: Partial Differential Equations. 3 credits, 3 contact hours.
Prerequisite: MATH 689. A practical and theoretical treatment of initial- and boundary-value problems for partial differential equations: Green's functions, spectral theory, variational principles, transform methods, and allied numerical procedures. Examples will be drawn from applications in science and engineering.

MATH 691. Stochastic Processes with Applications. 3 credits, 3 contact hours.
Prerequisite: MATH 662. Renewal theory, renewal reward processes and applications. Homogeneous, non-homogeneous, and compound Poisson processes with illustrative applications. Introduction to Markov chains in discrete and continuous time with selected applications.

MATH 692. MSMCF Forum. 0 credits, 0 contact hours.
Forum comprises informal discussions and debates engaging students in the realities of living and working in the world, with a focus on economics and finance. These realities include broad awareness of contemporary events, ethical implications of decisions, proper implementation and use of models, the research process and the critical skills of communication. Forum meetings are designed to promote understanding and build experience in all these areas.

MATH 698. Sampling Theory. 3 credits, 3 contact hours.
Prerequisite: MATH 662. Role of sample surveys. Sampling from finite populations. Sampling designs, the Horowitz-Thompson estimator of the population mean. Different sampling methods, simple random sampling, stratified sampling, ratio and regression estimates, cluster sampling, systematic sampling.

MATH 699. Design and Analysis of Experiments. 3 credits, 3 contact hours.
Prerequisite: MATH 662. Statistically designed experiments and their importance in data analysis, industrial experiments. Role of randomization. Fixed and random effect models and ANOVA, block design, latin square design, factorial and fractional factorial designs and their analysis.

MATH 700. Master's Project. 0 credits, 0 contact hours.
Prerequisites: Matriculation for the Master of Science in Applied Mathematics or in Applied Statistics and departmental approval. Work must be initiated with the approval of a faculty member, who will be the student's project advisor. Work of sufficient quality may qualify for extension into a master's thesis, see Math 701.

MATH 700B. Master'S Project. 3 credits, 3 contact hours.
Prerequisites: Matriculation for the Master of Science in Applied Mathematics or in Applied Statistics and departmental approval. Work must be initiated with the approval of a faculty member, who will be the student's project advisor. Work of sufficient quality may qualify for extension into a master's thesis, see MATH 701.

MATH 701. Master's Thesis. 0 credits, 0 contact hours.
Prerequisite: Matriculation for the master's degree and departmental approval. Students must register for a minimum of 3 credits per semester until completion. The work is carried out under the supervision of a designated member of the faculty.

MATH 707. Advanced Applied Mathematics IV: Special Topics. 3 credits, 3 contact hours.
Prerequisite: Departmental approval. A current research topic of interest to departmental faculty. Typical topics include: computational fluid dynamics, theoretical fluid dynamics, acoustics, wave propagation, dynamical systems, theoretical and numerical aspects of combustion, mathematical biology, and various topics in statistics.

MATH 712. Numerical Methods II. 3 credits, 3 contact hours.
Prerequisites: MATH 614, MATH 331 or departmental approval, and proficiency in a computer programming language (FORTRAN, C, or C++). Numerical methods for the solution of initial- and boundary-value problems for partial differential equations, with emphasis on finite difference methods. Consistency, stability, convergence, and implementation are considered.

MATH 713. Advanced Scientific Computing: Multi-Dimensional Finite-Difference Schemes and Spectral Methods. 3 credits, 3 contact hours.
Prerequisite: MATH 712 and proficiency in a computer programming language (FORTRAN, C, or C++). Derivation and analysis of finite difference schemes for systems of partial differential equations in two and three spatial dimensions and time. Issues pertaining to efficient implementation of algorithms and to stability of physical and numerical boundary conditions. Pseudo-spectral and spectral methods to solve partial differential equations. Approximation properties of Fourier and Chebyshev series and techniques based on the Fast Fourier Transform (FFT) and on matrix multiplication to numerically compute partial derivatives. Time-discretization techniques suitable for use with pseudo-spectral and spectral methods. Model systems arising in wave propagation, fluid dynamics, and mathematical biology will be considered.

MATH 715. Mathematical Fluid Dynamics I. 3 credits, 3 contact hours.
Introduction to the basic ideas of fluid dynamics, with an emphasis on rigorous treatment of fundamentals and the mathematical developments and issues. The course focuses on the background and motivation for recent mathematical and numerical work on the Euler and Navier-Stokes equations, and presents a mathematically intensive investigation of various model equations of fluid dynamics (e.g., the Korteweg-de-Vries equations).

MATH 716. Mathematical Fluid Dynamics II. 3 credits, 0 contact hours.
Continuation of MATH 715. Further development of the ideas of fluid dynamics, with an emphasis on mathematical developments and issues. A selection of topics will be developed in some detail, for example: Stokes flow and low-Reynolds-number hydrodynamics; flow at high Reynolds number and boundary layers; shock waves and hyperbolic systems; dynamics of interfacial flows; hydrodynamic stability; rotating fluids.

MATH 717. Inverse Problems and Global Optimization. 3 credits, 3 contact hours.
Introduction to inverse problems and global optimization. Linear, quasi-linear, and nonlinear inverse problems are studied with emphasis on regularization techniques. Bayesian statistical approaches and Monte Carlo methods are introduced and discussed in the context of inverse problems. The mathematical foundations of simulated annealing, genetic algorithms, and TABU are presented.

MATH 720. Tensor Analysis. 3 credits, 3 contact hours.
Prerequisite: MATH 613 and MATH 631, or departmental approval. Review of vector analysis in general curvilinear coordinates. Algebra and differential calculus of tensors. Applications to differential geometry, analytical mechanics, and mechanics of continuous media. The choice of applications will be determined by the interests of the class.

MATH 722. Wave Propagation. 3 credits, 3 contact hours.
Derivation of linear wave equations describing acoustic, electromagnetic, elastodynamic and hydrodynamic phenomena. Fundamental solutions and their application to initial value problems. Applications and solution of boundary value problems using Green's functions, image and spectral methods. Related time harmonic problems, including radiation, scattering, diffraction and transmission phenomena. Dispersive waves and the method of stationary phase. Linear waves in anisotropic media.

MATH 725. Independent Study I. 3 credits, 3 contact hours.

MATH 745. Analysis II. 3 credits, 3 contact hours.
Prerequisite: MATH 645. Lebesgue measure and integration, including the Lebesgue dominated convergence theorem and Riesz-Fischer theorem. Elements of Hilbert spaces and Lp-spaces. Fourier series and harmonic analysis. Multivariate calculus.

MATH 756. Complex Variables II. 3 credits, 3 contact hours.
Prerequisite: MATH 656. Selected topics from: conformal mapping and applications of the Schwarz-Christoffel transformation, applications of calculus of residues, singularities, principle of the argument, Rouche's theorem, Mittag-Leffler's theorem, Casorati-Weierstrass theorem, analytic continuation, and applications, Schwarz reflection principle, monodromy theorem, Wiener-Hopf technique, asymptotic expansion of integrals; integral transform techniques, special functions.

MATH 761. Statistical Reliability Theory and Applications. 3 credits, 3 contact hours.
Prerequisite: MATH 662 or departmental approval. Survival distributions, failure rate and hazard functions, residual life. Common parametric families used in modeling life data. Introduction to nonparametric aging classes. Coherent structures, fault tree analysis, redundancy and standby systems, system availability, repairable systems, selected applications such as software reliability.

MATH 763. Generalized Linear Models. 3 credits, 3 contact hours.
Prerequisites: MATH 662 and MATH 665 or departmental approval. Theoretical and applied aspects of generalized linear models. Classical linear models, nonlinear regression models, and generalized estimating equations.

MATH 767. Fast Numerical Algorithms. 3 credits, 3 contact hours.
The course covers state-of-the-art, analysis-based, fast numerical algorithms for computing discrete summations/transforms and for solving differential/integral equations. In particular, this course presents fast multiple methods and their descendants, including fast Fourier transform for nonequispaced data, fast Gauss transform, fast iterative solver and direct solver for elliptic boundary value problems.

MATH 768. Probability Theory. 3 credits, 3 contact hours.
Prerequisite: MATH 645 or departmental approval. Measure theoretic introduction to axiomatic probability. Probability measures on abstract spaces and integration. Random variables and distribution functions, independence, 0-1 laws, basic inequalities, modes of convergence and their interrelationships, Laplace-Stieltjes transforms and characteristic functions, weak and strong laws of large numbers, conditional expectation, discrete time martingales.

MATH 771. Asymptotic Methods II. 3 credits, 3 contact hours.
Prerequisite: MATH 671. Continuation of MATH 671. Asymptotic methods for the solution of PDEs, including: matched asymptotic expansions, multiple scales, the WKB method or geometrical optics, and near-field far-field expansions. Applications to elliptic, parabolic, and hyperbolic problems. Further topics in the asymptotic expansion of integrals and the WKB method. Emphasis on examples drawn from applications in science and engineering.

MATH 786. Large Sample Theory and Inference. 3 credits, 3 contact hours.
Prerequisites: MATH 665 and MATH 768. Limit theorems, central limit theorem, asymptotic expansions and large deviations, limit theorems in martingales and semi-martingales and stochastic differential equations, asymptotic expansions of functions of statistics, linear parametric estimation, asymptotic efficiency, martingale approach to inference: test for homogeneity and goodness of fit, decomposable statistics, inference for counting processes and censored data, inference in nonlinear regression, existence and consistency of least squares estimator (LSE), asymptotic properties of LSE, Von Mises functionals, estimation of parameters of stable laws, empirical characteristics function for inference, generalized least squares for linear models.

MATH 787. Non-Parametric Statistics. 3 credits, 3 contact hours.
Prerequisite: MATH 662. Wilcoxon signed-ranks test, Mann-Whitney U test, binomial sign test for single sample and two dependent samples, McNemar's test, Cochran Q test, Wilcoxon matched-pairs signed-ranks test, Kruskal-Wallis one-way analysis of variance, Friedman two-way analysis of variance, Siegel-Tukey test for equal variability, chi-squared goodness-of-fit test, test for homogeneity and independence, single-sample runs test and other tests of randomness, correlation tests: Spearman's rank-order correlation, coefficient and Kendall's tau, Kendall's coefficient of concordance, and Goodman and Kruskal's gamma, comparing power efficiency.

MATH 790. Doct Dissertation & Res. 0 credits, 0 contact hours.
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

MATH 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

MATH 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

MATH 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

MATH 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

MATH 790E. Doctoral Dissertation. 12 credits, 12 contact hours.
Prerequisite: Excellent performance on the doctoral qualifying examination. A minimum of 36 credits is required of all candidates for the Ph.D. degree. Candidates must register for 6 to12 credits per semester, to be determined by a designated dissertation advisor. After reaching 36 credits, students must continue to register for 3 credits each semester until degree completion.

MATH 791. Graduate Seminar. 0 credits, 1 contact hour.
All master's and doctoral students receiving departmental or research-based awards must register for this course each semester.

MATH 792B. Pre Doctoral Research. 3 credits, 3 contact hours.

MATH 792D. Pre Doctoral Research. 9 credits, 9 contact hours.

OPSE 601. Advanced Topics in Optical Science and Engineering. 3 credits, 3 contact hours.
In small groups or as an individual, students conduct three complete research experiments in the available topics of interest, from preliminary background research through data analysis. Use of modern optical research tools under close guidance of faculty and associated research team members in the faculty member's lab.

OPSE 610. Virtual Instrumentation. 3 credits, 3 contact hours.
Prerequisites: A college level programming course. Intended for all engineering, computer science, and science majors. Covers virtual instrumentation including use of IEEE, GPIB, RS232 interfaces, and data acquisition boards. Interface a computer to various instruments for data acquisition and instrument control using a state-of-the-art software platform, such as, National Instrument's LABVIEW. Emphasis is on the practical aspects of interfacing a computer to various instruments including timing issues, real-time data acquisitions and instrument control, instrument status, and acquisition speed.

PHYS 590. Graduate Coop Work Exp I. 3 credits, 3 contact hours.

PHYS 591. Graduate Coop Work Exp II. 3 credits, 3 contact hours.

PHYS 593. Graduate Co-op Work Experience IV. 0 credits, 0 contact hours.
Prerequisites: One immediately prior 3-credit registration for graduate co-op work experience with the same employer. Requires approval of departmental co-op advisor and the Division of Career Development Services. Must have accompanying registration in a minimum of 3 credits of course work.

PHYS 607. Topics in Astronomy and Cosmology. 3 credits, 3 contact hours.
Prerequisites: college-level physics and mathematics. A survey of recent progress in astronomy, the physical principles involved, and the impact these new discoveries have on our understanding of the universe. Includes results from recent and ongoing planetary probes of our solar system, discovery of planetary systems around other stars, the evolution of stars, exotic objects such as neutron stars and black holes, the formation of galaxies, and current understanding of the birth and final fate of the universe. Observing sessions familiarize students with the sun, moon, and night sky.

PHYS 611. Adv Classical Mechanics. 3 credits, 3 contact hours.

PHYS 621. Classical Electrodynamic. 3 credits, 3 contact hours.

PHYS 641. Statistical Mechanics. 3 credits, 3 contact hours.

PHYS 652. Fund of Optical Imaging. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 (Classical Electricity and Magnetism I) This is designed as a principal course of introducing optical engineering to master students in applied optics. The goal is to help students acquire the practical technical knowledge on optical systems and their design. The general approach throughout the course is to emphasize the application of basic optical principles to practice. Topics include general principles of geometric and physical optics, elemental geometric optics under paraxial ray approximation, aberrations, prisms and mirrors, the eye, stops and apertures, optical materials and interference coating, radiometry and photometry, basic optical devices, optical computation, image evaluation and optical system design, particularly computer aided designs.

PHYS 661. Solid-State Physics. 3 credits, 3 contact hours.
Properties of solid state materials are explained based on principles of physics. Electronic, magnetic, thermal, optical, and lattice properties of materials are studied. Various experimental and theoretical approaches are introduced.

PHYS 681. Solar Phys & Instrumentn. 3 credits, 3 contact hours.

PHYS 682. Introduction To Mems. 3 credits, 3 contact hours.

PHYS 687. Physics of Materials. 3 credits, 3 contact hours.
Prerequisite: PHYS 441 or equivalent (see undergraduate catalog for description). Fundamentals of quantum mechanics; energy bands in crystals; electrical conduction in metals and alloys, semiconductors; optical properties of materials; quantum mechanical treatment of optical properties; magnetic properties of materials; thermal properties, heat capacity, and thermal expansion in solids.

PHYS 688. Mathematical and Statistical Methods in Materials Science. 3 credits, 3 contact hours.
More emphasis on analytical methods and statistics. Course will be required for Ph.D. students in Materials Science.

PHYS 690. Directed Study Appl Phys. 3 credits, 3 contact hours.

PHYS 698. ST:. 3 credits, 3 contact hours.

PHYS 700. Master'S Project. 3 credits, 3 contact hours.
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take Phys 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

PHYS 700B. Master's Project. 3 credits, 3 contact hours.
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics who do not take PHYS 701 Master's Thesis. An extensive paper involving experimental or theoretical investigation of a topic in microelectronics or other applied physics area is required. Cooperative projects with industry or government agencies may be acceptable. The project is carried out under the supervision of a designated physics graduate faculty member.

PHYS 701. Master'S Thesis. 0 credits, 0 contact hours.
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

PHYS 701B. Master'S Thesis. 3 credits, 3 contact hours.
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

PHYS 701C. Master's Thesis. 6 credits, 3 contact hours.
Prerequisite: Written approval from graduate advisor. For students admitted to the Master of Science program in applied physics. Experimental or theoretical investigation of a topic in microelectronics or other applied physics area. Cooperative projects with industry or government agencies may be acceptable. The thesis is written under the supervision of a designated physics graduate faculty member. The completed written thesis should be of sufficient merit to warrant publication in a scientific or technical journal. The student must register for a minimum of 3 credits per semester. Degree credit is limited to 6 credits indicated for the thesis.

PHYS 721. Classical Electrodynamics II. 3 credits, 3 contact hours.
Prerequisite: PHYS 621 or equivalent; basic knowledge of tensor analysis. Simple radiating systems, scattering and diffraction; special theory of relativity; dynamics of relativistic particles and electromagnetic fields; collisions between charged particles, energy loss, and scattering; radiation from accelerated charge, synchrotron radiation, and bremsstrahlung.

PHYS 725. Independent Study. 3 credits, 1 contact hour.
Prerequisites: permission from the graduate advisor (not thesis advisor) in Physics, as well as courses prescribed by a supervising faculty member (who is not the student's thesis advisor). This special course covers areas of study in which one or more students may be interested, but which isn't of sufficiently broad interest to warrant a regular course offering. Students may not register for this course more than once with the same supervising faculty member.

PHYS 726. Independent Study II. 3 credits, 3 contact hours.

PHYS 728. Radio Astronomy. 3 credits, 3 contact hours.
Prerequisites: PHYS 621and PHYS 641 or the equivalent, or approval of the instructor. An introduction to radio emission processes, radiative transfer, radio diagnostics, and radio instrumentation. Topics include radio flux measurements with single antenna, radio imaging with interferometer arrays (Fourier Transform imaging), and image reconstruction techniques (CLEAN, MEM). Application is to astronomical objects with special emphasis on the Sun.

PHYS 731. Quantum Mechanics II. 3 credits, 3 contact hours.
Prerequisite: PHYS 631 or equivalent. Review of quantum mechanics and theory of special relativity; second quantization; relativistic one-particle problem; Klein-Gordon equation and Dirac equation; canonical field theory; relativistic scattering theory; introduction to quantum electrodynamics and quantum field theory; Feynman diagrams and applications.

PHYS 741. Basic Plasma Phys w Space, Lab. 3 credits, 3 contact hours.
Prerequisites: PHYS 611, PHYS 621, other equivalent, or approval of the instructor. The course will introduce students to basic concepts of plasma physics and its applications to laboratory experiments and space research. The course will cover the following topics: particle motions in magnetic field, adiabatic invariants, magnetic traps, radiation belts, electromagnetic waves in plasma, electrostatic oscillations, waves in magnetized plasma, collisional processes in plasma, kinetic effects on plasma waves, Landau damping, wave instabilities, plasma as fluid, magnetohydrodynamics, magnetic configurations of laboratory and space plasma, MHD instabilities, reconnection, helicity, dynamo theories, the origin of cosmic magnetic fields, stochastic processes, Fermi process, particle acceleration, and cosmic rays.

PHYS 747. Intro to Helioseismology. 3 credits, 3 contact hours.
Prerequisites: Phys 611, Phys 621 or other equivalent The course will introduce the physical principles and methods to study wave oscillations, and the interior structure of the Sun. The course covers processes of acoustic and gravity wave excitation and propagation, interaction with turbulence and magnetic fields, oscillation spectrum, sunquakes, inferences of the structure and composition, the differential rotation, large-scale flows and meridional circulation. It includes the theory of normal modes, inversion techniques, wave dispersion analysis, acoustic tomography and holography, applications to the solar dynamo and magnetic activity.

PHYS 751. Applied Optics. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 (Classical Electricity and Magnetism I) The course will introduce students to basic concepts of applied optics, light propagation and light and matter interactions. The course will cover the following topics: light propagation through mirrors and lenses, matrix optics, basic concepts of wave optics, reflection, refraction and transmission, equations governing wave propagation, Gaussian beams, Maxwell's equations, absorption, dispersion, light polarization states, temporal and spatial coherences.

PHYS 753. Light Sources & Photodetectors. 3 credits, 3 contact hours.
Prerequisites: PHYS 621 (Classical Electricity and Magnetism I) and PHYS 631 (Quantum Mechanics I) This is a survey course on theory and practical aspects of light sources and photodetectors. The specific light sources covered will be: black body, discharge tubes, X-ray, light.

PHYS 774. Fundamentals of Spectroscopy. 3 credits, 3 contact hours.
The major objectives of this course are to integrate theory and practice and to bring together different branches of Academic Studies and Industrial Research through the presentation of critical aspects of modern Spectroscopy. The course will provide a valuable theoretical introduction and an overview of modern topics in spectroscopy, which are of current interest and importance in Semiconductor Industry and Biomedicine. A wide range of techniques is considered, including optical Near field spectroscopy, X-ray, Raman, Neutron scattering, and FT-IR spectroscopy.

PHYS 780. Curr Topics Applied Phys. 3 credits, 3 contact hours.

PHYS 787. New Concepts of Semiconductor. 3 credits, 3 contact hours.
Prerequisite: PHYS 687 and ECE 657. This is an advanced course on semiconductor physics targeted at describing polycrystalline materials, e.g. cadmium telluride or copper indium diselenide, that are currently used in thin-gilm photovoltiac panels. An overview of classical semiconductor and solar cell theory is followed by topics such as non-shallow dopants, multi-level defects, defect transition energy level, and metastability. These concepts are applied to examine minority carrier lifetime and carrier collection in devices, and to extend the theories of admittance and deep level transient spectroscopy.

PHYS 789. Physics of Advanced Semiconductor Device Processing. 3 credits, 3 contact hours.
Prerequisites: NJIT: EE 657, R755 687; or equivalent. Intended for doctoral students in applied physics, electrical engineering, and materials science. (Rutgers = R755 789)Silicon and GaAS technologies: crystal growth methods, epitaxy, oxidation, lithography, dry and wet etching techniques, polysilicon, diffusion, ion implantation, metallization (including silicidation), process integration, analytical characterization techniques, assembly and packaging, and yield and reliability.

PHYS 790. Doct Dissertation & Res. 0 credits, 0 contact hours.
Prerequisites: passing grade on departmental qualifying examination and approval of doctoral candidacy. Corequisite: PHYS 791. A minimum of 36 credits is required. The student must register for at least 6 credits of dissertation per semester. Registration for additional credits, up to 12 per semester, is permitted with the approval of the department graduate advisor. Experimental or theoretical investigation of a topic in applied physics, including microelectronics, materials science, and laser physics. Cooperative projects with industry or government agencies may be acceptable. Research and writing are carried out under the supervision of a designated graduate faculty member. The completed written dissertation should be a substantial contribution to the knowledge of the topic under research, and should be of sufficient merit to warrant publication in a leading scientific or technical journal.

PHYS 790A. Doct Dissertation & Res. 1 credit, 1 contact hour.

PHYS 790B. Doct Dissertation & Res. 3 credits, 3 contact hours.

PHYS 790C. Doct Dissertation & Res. 6 credits, 3 contact hours.

PHYS 790D. Doct Dissertation & Res. 9 credits, 3 contact hours.

PHYS 790E. Doct Dissertation & Res. 12 credits, 3 contact hours.

PHYS 790F. Doct Dissertation & Res. 15 credits, 3 contact hours.

PHYS 790G. Doct Dissertation & Res. 18 credits, 3 contact hours.

PHYS 791. Doctoral Seminar. 0 credits, 0 contact hours.

PHYS 792. Pre-Doctoral Research. 3 credits, 0 contact hours.

PTC 601. Advanced Professional and Technical Communication. 3 credits, 3 contact hours.
Provides the foundation and direction for all Professional and Technical Communication coursework. This course introduces students to the profession and the academic discipline of technical/professional communication. Modules include usability analysis; visual information; ethics; global diversity, global communication; report writing; information literacy; communicating with new technologies; and technical writing style. Students begin development of the MSPTC ePortfolio.

PTC 603. Identity, Technology, and Communication. 3 credits, 3 contact hours.
Prerequisite or corequisite: PTC 601. Examines the complex ways in which technology constructs and is constructed by society, with emphasis on interrelationships between technology and communication. Discussions focus on how technological change is expressed in social and political movements, literature, art, architecture, and philosophy and how they, in turn, influence the future direction of technology. Design and updating of the MSPTC ePortfolio will be required in this seminar.

PTC 604. Communication Theory and Research. 3 credits, 3 contact hours.
Prerequisite or corequisite: PTC 601Reviews the major theories of communication and provides strategies for research in the field of Professional and Technical Communication. The course focuses on these research methods: problem statement and hypothesis formulation derived from theory; research design and data generation; existing information sources and their acquisition; and analytic techniques. Students develop analytic methods necessary to create a well-considered thesis proposal. Design and updating of the MSPTC ePortfolio will be required in this seminar.

PTC 605. Elements of Visual Design. 3 credits, 3 contact hours.
Prerequisite or corequisite: PTC 601. Provides an understanding of and competency in the visual presentation of information. Course integrates theories of design, techniques of composition, and technologies of electronic and print publishing. Modules include both design principles and hands-on practice in visual literacy, layout and design, and graphic tools. Design and updating of the MSPTC ePortfolio will be required in this seminar.

PTC 606. Advanced Information Design. 3 credits, 3 contact hours.
Develops online visual communication strategies and community building. The course will cover the design and creation of multimedia objects, usability heuristics, navigation theory, contemporary design practices and online community building. Students will be required to create media-rich multidimensional online projects that encourage and facilitate interaction and team-building in the online environment. Design and updating of the MSPTC ePortfolio will be required for this seminar.

PTC 610. Research Methods for Information Design. 3 credits, 3 contact hours.
Introduces user research methods such as contextual inquiry, ethnographic field studies, card sorting, affinity diagramming, and usability testing that provide the foundation for user- centered interaction design.

PTC 612. Theory and Practice of Text Encoding. 3 credits, 3 contact hours.
Students will learn to identify considerations and methods for efficient text encoding. Topics covered will include text encoding tools, markup languages, document analysis, and workflow design for text delivery. After taking this class, students should be able to analyze processes and technologyies that support the collection, management, and publishing of content in a variety of forms and media.

PTC 620. Proposal Writing. 3 credits, 3 contact hours.
Provides an understanding of and practice in proposal writing for corporations, foundations, and government agencies. Students build skills to create a range of persuasive documents including proposals for research grants, responses to requests for proposal, and government proposals.

PTC 622. Working in Teams: Collaborative and Interpersonal Communications. 3 credits, 3 contact hours.
Introduces interpersonal and collaborative communication topics relating to face-to-face and virtual teams. Covers communication and documentation functions in agile project environments. Examines mobile workplace communication strategies.

PTC 624. Professional and Technical Editing. 3 credits, 3 contact hours.
Prerequisite or corequisite: PTC 601 . Presents the theory and practice of editing professional and technical writing. Topics include correctness and conciseness, hard copy and on-line editing, editing graphics, document management, editor-author relationships, and ethical considerations in editing. Students edit writing samples from a variety of technical fields.

PTC 626. Communication Media Design Studio. 3 credits, 3 contact hours.
This course integrates language and media in a studio approach to multimodal communication projects. Students work with instructor to design individual projects using current media applications.

PTC 628. Analyzing Social Networks. 3 credits, 3 contact hours.
Prerequisite: PTC 601 for MSPTC students; approval of instructor for non-MSPTC students. This course will provide students with an overview of social networks by introducing them to the unique terminology of social networks (centrality, boundary spanners, directional ties, etc.) Positive and negative characteristics of social networks will be discussed, followed by visualizations and analyses of those characteristics. Students will read selected journal articles explaining how social networks relate to communication and the flow of information within organizations. The culmination of the course will be a project in which students will create and analyze their own social network, most likely drawing their data from the popular social media site Facebook and using ORA, a freeware social network analysis application created by Carnegie Mellon University.

PTC 629. Theory and Practice of Social Media. 3 credits, 3 contact hours.
Introduces social media strategies for reading and writing in today's multi-cultural, screen-oriented, networked culture. Students study relationship between mediated communication and human community and gain hands-on experience with chatting, blogging, tagging, wiki writing, tweeting and social media presentation. Students strategize, plan, design and produce social media projects of their own.

PTC 631. Communication and Environmental Problem Solving. 3 credits, 3 contact hours.
Prerequisite or corequisite: PTC 601. Develops critical thinking on ecological issues for problem solving by integrating technical information, human values, and communication with environmental change. Students combine theory, research and models, case studies, visual thinking, and scientific inquiry for application in individual decision-making course project.

PTC 632. Content Management and Information Architecture. 3 credits, 3 contact hours.
Prerequisite or Corequisite: PTC 601. Today's complex systems often produce complex information needs that require new technical communication methods and tools. This course will focus on the use of Information Architecture methodologies (such as, DITA or DocBook) to develop a structure for presenting technical information and on Content Management tools for creating a single source repository for this information. Students will also use theory and practical applications to design and develop a structured online Help module.

PTC 640. Health Communications. 3 credits, 3 contact hours.
This course will focus on the use of communication strategies to inform and influence individual and community decisions regarding health. The course will cover: the multidimensional nature of health communication, research in health communication, behavioral theories in health communication, rhetorical theories in health communication, legal and ethical concerns in health communication, the communication of risk and uncertainty, and the design of health campaigns. Students will be required to (a) research and prepare a health communication strategy for use in a specific context and (b) to design an accompanying print or hypertext document to be used in that context.

PTC 642. Corporate Media and Communication. 3 credits, 3 contact hours.
Introduces the dymanics of communication within complex organizations. Develops communication skills for contemporary global corporate and business markets. Focuses on the efforts of businesses and organizations to communicate and persuade in target audiences. Covers translation issues in developing corporate media.

PTC 644. Communication in Technology Transfer and Innovation. 3 credits, 0 contact hours.
Examine roles of communication in innovation development and technolgy transfer. Students review models of communication in technology transfer in global contexts. Issues such as audience analysis, user experience, participatory design, and knowledge transfer will be investigated.

PTC 650. ELearning Design for Mobile. 3 credits, 3 contact hours.
Designing eLearning for mobile platforms is a critical skill for today's technical communicator. Specific skills and tools are required to ensure a successful implementation. Based on proven user centered design concepts, this course provides the student with the skills necessary to create effective mobile training programs.

PTC 672. Design Instruction Assess Meth. 3 credits, 3 contact hours.
Prerequisite: Students must have a graduate standing and should be enrolled in MSPTC program or the Instructional Design and Educational Assessment certificate. Student must meet these requirements, approval of instructor is required. Examines planning and implementation of instruction to facilitate learning and analysis of methods of data gathering on learner progress and mastery, lessons and learning objects so appropriate instructional strategies with associated methods of formative and summative assessments that can yield data for learner assessment and course evaluation can be selected or develop to suit the instructional style, learner needs, and instructional situations.

PTC 681. Tech in Class & Learning Envir. 3 credits, 3 contact hours.
Prerequisite: Students must have a graduate standing and should be enrolled in MSPTC program or the Instructional Design and Educational Assessment certificate. Student must meet these requirements, approval of instructor is required. This course examines the various types of technology necessary to develop, use, and process the results of assessments as well as facilitate and augment instructional design. This course examines the integration of present and likely future technology into instruction to foster community, collaboration, conceptual development, and exceptional academic performance as well as a more effective and well-understood assessment system.

PTC 691. ePortfolio Capstone Seminar. 0 credits, 0 contact hours.
This course is taken in the student's final semester before graduation. Students complete final revisions of the ePortfolio of work completed in MSPTC seminars (may also include professional and service projects). Student ePortfolios must successfully demonstrate MSPTC core competencies and be presented in an oral presentaiton for faculty and other students.

PTC 698. Selected Topics in Professional and Technical Communication. 3 credits, 3 contact hours.
Prerequisite or corequisite: PTC 601 This is a Special Topics course (does not require CGE approval). It was presented to CGE in an effort to attract more students. Students will learn approaches to understanding and producing the forms of writing central to academic research. They will review literature, peer-review the work of others, prepare conference material, and produce a submission-quality journal or conference paper in their field of study. The current plan is to run the course every Spring.

PTC 700. Master'S Project. 0 credits, 0 contact hours.
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation.

PTC 700B. Master'S Project. 3 credits, 3 contact hours.
Prerequisites: Approval of graduate advisor, and completion of core courses. Requires demonstration of student's ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. Based on experiential research (internship, co-op, work experience) student submits a proposal, develops a project (e.g., guidebook, manual, online documentation, website, video, podcast) and completes a paper describing the theory and methodology supporting the project application. Submission of the MSPTC ePortfolio demonstrating proficiency is required for graduation.

PTC 701. Master'S Thesis. 0 credits, 0 contact hours.
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

PTC 701B. Master'S Thesis. 3 credits, 3 contact hours.
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

PTC 701C. Master'S Thesis. 6 credits, 3 contact hours.
Prerequisites: approval of graduate advisor; completion of core courses. Demonstrates ability to conceive and execute an extended writing project with professional graphics and to make an oral and visual presentation of the work. The completed written thesis should warrant publication in a technical journal. Thesis Committee consists of program-approved faculty advisor, one other faculty member, and external reviewer. A student must register continuously for a minimum of 3 credits per semester until thesis in completed. Total will be limited to 6 credits.

PTC 725. Independent Study in Professional and Technical Communication. 3 credits, 3 contact hours.
Prerequisite: approval of graduate advisor and supervising faculty.Allows development of areas of specialization for Master's Project or for areas of study in communication in which one or more students may be interested but which are not of sufficiently broad interest to warrant a regular course offering.

PTC 726. Independent Study II. 3 credits, 3 contact hours.

R215 510. Conservation Ecology. 1-12 credits, 1-12 contact hours.

R215 520. Landscape Ecology. 3 credits, 3 contact hours.

R215 565. Community Dynamics. 4 credits, 4 contact hours.

R215 575. Quant Ecol & Evol. 3 credits, 3 contact hours.

R215 590. Population Ecology. 4 credits, 4 contact hours.

R215 597. Concpt & Meth Evolution. 4 credits, 4 contact hours.

R215 599. Special Topics. 3 credits, 3 contact hours.

R215 604. ST:. 3-12 credits, 3-12 contact hours.

R460 606. Envir. Geophysics. 3 credits, 0 contact hours.