COURSE DESCRIPTIONS

Aerospace Studies .......................... 172
Biology and Biotechnology .................. 173
Biomedical Engineering ..................... 177
Chemical Engineering ...................... 179
Chemistry and Biochemistry ............... 181
Civil and Environmental Engineering ........ 183
Computer Science ........................ 186
Electrical and Computer Engineering ........ 188
Engineering Science Interdisciplinary ....... 191
Fire Protection Engineering ............... 192
Geosciences ................................ 193
Humanities and Arts ....................... 193
Interdisciplinary .......................... 203
Management .............................. 203
Mathematical Sciences ..................... 206
Mechanical Engineering ................... 209
Military Science .......................... 213
Physical Education ....................... 214
Physics .................................. 215
Social Science and Policy Studies .......... 217
AEROSPACE STUDIES

AS 1001. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE I.
Cat. 1 (1/9 unit)
The AS 1000 sequence of courses are designed to introduce students to the United State Air Force and Air Force Reserve Officer Training Corps. Featured topics include mission and organization of the Air Force, officer assigned duties, professionalism, Air Force officer opportunities, military customs and courtesies, and an introduction to communication skills.

The first course covers the factors leading to the early development of air power and the organizational structure of the Air Force with a focus on the missions of select military organizations. The basic history of the United States military is studied in order to appreciate how military history impacts the Air Force today. The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 100__ Leadership Laboratory continues a study of Air Force customs and courtesies, and preparation for field training.

AS 1002. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE II.
Cat. 1 (1/9 unit)
The AS 1000 sequence of courses are designed to introduce students to the United State Air Force and Air Force Reserve Officer Training Corps. A continuation of AS 1001, the second course in this series emphasizes those communication skills needed in today’s Air Force. It describes the communication systems, discusses common barriers and enhancements to effective communications. The course includes numerous speaking and written exercises using current Air Force topics.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 100__ Leadership Laboratory includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands.

AS 1003. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE III.
Cat. 1 (1/9 unit)
The AS 1000 sequence of courses are designed to introduce students to the United State Air Force and Air Force Reserve Officer Training Corps.

A continuation of AS 1002, the course outlines the origin of the Air Force and the basic history of the United States military is studied in order to appreciate how military history impacts the Air Force today. Written and oral communication skills are practiced.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 100__ Leadership Laboratory continues a study of Air Force customs and courtesies, and preparation for field training.

AS 1004. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE IV.
Cat. 1 (1/9 unit)
The AS 1000 sequence of courses are designed to introduce students to the United State Air Force and Air Force Reserve Officer Training Corps. The final course in the AS 1000 sequence, it introduces students to the Air Force installation and her sister services. Written and oral communication skills are practiced.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 100__ Leadership Laboratory includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands.

Cat. 1 (1/9 unit)
The AS 2000 sequence of courses are designed to examine general aspects of air and space power through a historical perspective. Utilizing this perspective, the course covers a time period from the first balloons and dirigibles to the space-age global positioning systems of the Persian Gulf War. Historical examples are provided to extrapolate the development of Air Force capabilities (competencies), and missions (functions) to demonstrate the evolution of what has become today’s USAF air and space power. As a whole, the AS 2000 sequence of courses provides the student with a knowledge level understanding for the general element and employment of air and space power.

The first course covers the factors leading to the early development of air power through the use of air power during World War II. The development of oral and written communication skills is continued from the AS 1000 classes.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 200__ Leadership Laboratory continues a study of Air Force customs and courtesies, drill and ceremonies, military commands, and preparation for Field Training.

AS 2002. THE EVOLUTION OF USAF AIR AND SPACE POWER II.
Cat. 1 (1/9 unit)
The AS 2000 sequence of courses are designed to examine general aspects of air and space power through a historical perspective. The second course in the series continues with the development of air power from World War II through the development of the Intercontinental Ballistic Missile.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 200__ Leadership Laboratory continues a study of Air Force customs and courtesies, drill and ceremonies, military commands, and preparation for field training.
AS 3003. THE EVOLUTION OF USAF AIR AND SPACE POWER III.  
Cat. I (1/9 unit)  
The AS 2000 sequence of courses are designed to examine general aspects of air and space power through a historical perspective. The third course in the series begins with a study of air power in the Vietnam war through the Gulf war. Oral and written communications skills will be practiced.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 200__ Leadership Laboratory continues a study of Air Force customs and courtesies, drill and ceremonies, military commands, and preparation for field training.

AS 2004. THE EVOLUTION OF USAF AIR AND SPACE POWER IV.  
Cat. I (1/9 unit)  
The AS 2000 sequence of courses are designed to examine general aspects of air and space power through a historical perspective. The course examines several fundamental truths associated with war in the third dimension: e.g. Principles of War and Tenets of Air and Space Power. As a whole, this course provides the students with a knowledge level understanding for the general element and employment of air and space power, from an institutional doctrinal and historical perspective. In addition, the students will continue to discuss the importance of the Air Force Core Values with the use of operational examples and historical Air Force leaders and will continue to develop their communication skills. The final course in the series explores the future of the Air Force through 2025.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 200__ Leadership Laboratory continues a study of Air Force customs and courtesies, drill and ceremonies, military commands, and preparation for field training.

AS 3001. AIR FORCE LEADERSHIP STUDIES I.  
Cat. I (1/6 unit)  
The AS 3000 sequence of courses is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and communication skills required of an Air Force junior officer. Throughout the courses, case studies are used to examine Air Force leadership and management situations as a means of demonstrating and exercising practical application of concepts being studied.

The first course explores different styles of leadership, followership, and management functions. The course includes three hours of class work and three hours of mandatory leadership laboratory per week. The AS 3001 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-type activities and giving students the opportunity to apply leadership and management principles.

AS 3002. AIR FORCE LEADERSHIP STUDIES II.  
Cat. I (1/6 unit)  
The AS 3000 sequence of courses is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and communication skills required of an Air Force junior officer. The second course studies various aspects of leadership, conflict management, counseling, and supervision.

The course includes three hours of class work and three hours of mandatory leadership laboratory per week. The AS 3002 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-type activities and giving students the opportunity to apply leadership and management principles.

AS 3003. AIR FORCE LEADERSHIP STUDIES III.  
Cat. I (1/6 unit)  
The AS 3000 sequence of courses is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and communication skills required of an Air Force junior officer. The third course emphasizes teambuilding, improvement process, and military ethics.

The course includes three hours of class work and three hours of mandatory leadership laboratory per week. The AS 3003 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-type activities and giving students the opportunity to apply leadership and management principles.

AS 3004. AIR FORCE LEADERSHIP STUDIES IV.  
Cat. I (1/6 unit)  
The AS 3000 sequence of courses is a study of leadership, management fundamentals, professional knowledge, Air Force personnel and evaluation systems, leadership ethics, and communication skills required of an Air Force junior officer. The final course explores officer professional development, and personnel and evaluation systems including practical exercises.

The course includes three hours of class work and three hours of mandatory leadership laboratory per week. The AS 3004 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-type activities and giving students the opportunity to apply leadership and management principles.
BB 1030. INTRODUCTION TO BIOLOGICAL MACROMOLECULES.
Cat. I
This course is an introductory biology course for Biology and Biotechnology and health science pre-professional majors. The four classes of biologically important macromolecules (lipids, nucleic acids, proteins, and carbohydrates) will be studied, with particular reference to how their structure is appropriate to their function in cell metabolism and reproduction. Current topics in cell and molecular biology will be used as the basis for small group problem solving.
Recommended background: High School Biology, CH 1010 (concurrent).

BB 1040. PLANT DIVERSITY.
Cat. I
An introductory course stressing general concepts related to the vast array of plant species, taxonomic links, and uses of major plant phyla in both society and industry. Some emphasis will be given to economically important species chosen from agronomic and non-agronomic situations.
Recommended background: High school biology or equivalent.
Students may not receive credit for both BB 2030 and BB 1040.

BB 1050. ZOOLOGY.
Cat. I
This course is a survey of the animal kingdom with an emphasis on its history and organization. Particular attention is paid to special structures and mechanisms evolved by selected representatives of major phyla for solving problems of life in various environments.
Recommended background: BB 1001 and BB 1030.
Students may not receive credit for both BB 2030 and BB 1050.

BB 2002. MICROBIOLOGY.
Cat. I
This course will focus on unicellular organisms with special reference to those of the kingdom Bacteria, and describe their taxonomy, morphology, and physiology. Special attention will be given to those organisms that are of ecological concern or serve a useful industrial purpose. The importance of microbes and viruses in public health will be presented. This course is designed for all biology majors and other students who seek a good general education in modern biology.
Recommended background: A basic understanding of cell biology and elementary biochemical processes is desired.

BB 2040. PRINCIPLES OF ECOLOGY.
Cat. I
This course is designed to give the student a basis for understanding the abundance and distribution of plants and animals from the level of the individual to that of the ecosystem. The course will focus on specific scientific examples of ecological research to elucidate general concepts. The basic concepts covered will be augmented with problem sets designed to get the student comfortable with the mathematics of ecology. The course format will include lectures and discussion sections and may include a field trip to a wildlife sanctuary.

BB 2130. ANATOMY.
Cat. I
The anatomy of the human body will be covered system by system, with histochmical highlights where relevant, e.g., skin, bone structure, smooth vs. skeletal muscle. Discussion will include, but not necessarily be limited to, the following systems: integumentary, nervous, musculoskeletal, circulatory, respiratory, reproductive, endocrine, urinary and digestive.
Recommended background: BB 1050 and BB 2550.
Students may not receive credit for both BB 3130 and BB 2130.

BB 2550. CELL BIOLOGY.
Cat. I
This entry level course, recommended for all BB, BBT, BC, and pre-professional majors, presents the fundamental aspects of cell structure and function, and is the foundation of all fields of modern biology.
Topics include: cell complexity and organizational hierarchy, evolution of the cell, cell surface, plasma membrane, single and double cytoplasmic membrane systems, nuclear fusion and hybridomas, cytoskeleton, cell growth, and differentiation.
Recommended background: BB 1001, BB 1030 or equivalent.

BB 2920. GENETICS.
Cat. I
This course presents the principles and experimental evidence leading to our understanding of the gene concept and the role of DNA as genetic material. Patterns of inheritance, the relationship between genotype and phenotype, and transmission, coding, and expression of genetic information are considered in a variety of organisms. A quantitative, problem-solving approach and the use of genetic analysis as a tool to study biological phenomena are emphasized throughout the course. The course is designed for all biology and pre-professional majors.
Recommended background: BB 1030 or equivalent.

BB 2940. EXPERIMENTAL BIOLOGY I.
Cat. I
The lab exercises in this course have been selected to provide the skills needed to study living organisms at the cellular level, and to emphasize the basic principles of biology. Students will gain experience with procedures, equipment and lab skills common to all Biology fields. Emphasis is on precise data collection, analysis and interpretation of biological data. This course is designed for Biology/Biotechnology majors and other life science preprofessionals. One lecture and lab per week for 2 terms (i.e. 1/3 unit per 14 weeks).
This course may not be taken for less than 1/3 unit of credit except with the prior approval of the instructor.
Recommended background: a college level course in general chemistry and biology, or its equivalent.

BB 2950 EXPERIMENTAL BIOLOGY II
Cat. I
A continuation of Experimental Biology I with lab exercises selected to emphasize the skills needed to study living organisms and their diversity. These exercises will emphasize the principles and techniques of genetics and microbiology, as well as the diversity of the biological flora and fauna. Unique aspects of living organisms will be featured as opportunities for use in Biotechnology. One lecture and lab per week for 2 terms (i.e. 1/3 unit per 14 weeks). This course may not be taken for less than 1/3 unit of credit except with the prior approval of the instructor.
Recommended background: BB 2940.

BB 3020. MODELING OF BIOLOGICAL SYSTEMS.
Cat. II
This course will cover the use of mathematical and computational models to understand biological systems. Examples will be chosen from a number of different areas, including ecology, neurobiology, molecular biology and fermentation. In each topic area, we will address the assumptions of the model, how the model can be used to determine optimum behavior of the system, and the stability of the model parameters. No programming experience is necessary: students will use available computer software to explore these questions.
Recommended background: MA 1021 and 1022, and any 3000 or 4000 level BB course.
Offered in 2002-03 and in alternating years thereafter.

BB 3040. EXPERIMENTAL DESIGN AND DATA ANALYSIS.
Cat. II
This applied course introduces students to the design of experiments and analysis of data. We will cover a number of experimental situations occurring frequently in biology, including testing the fit of data to theoretical distributions, comparisons of groups, and regression analysis. Emphasis will be placed on formulating the hypothesis of interest, designing experiments so that the subsequent analysis will have enough power to test the hypothesis, and choosing the appropriate analysis to perform. We will discuss the importance of pilot studies, and some of the most common errors made in choosing and performing statistical tests. Both parametric and non-parametric tests will be discussed. Students will use computer packages to analyze data from the literature and/or their own experimental data.
Recommended background: MA 2611, and any 3000 or 4000 level BB course.
Offered in 2003-04 and in alternating years thereafter.
Note: Students who have credit for BB 4040 may not receive credit for BB 3040.

BB 3055. MICROBIAL PHYSIOLOGY.
Cat. I
This course will focus on the metabolic (enzymatic) pathways by which microorganisms obtain, process, and store substances and energy used for synthesis; and on the synthetic pathways by which these substances and energy are utilized. The occurrence of biological reactions in the light of the particular organism and its environment will be emphasized, as will those organisms and metabolic schemes of current or potential usefulness in bioprocess technology.
Recommended background: BB 2002, BB 2550, BB 2920, CH 4110 and CH 4120.
Students who have taken BB 4050 for credit will not receive credit for BB 3055.

BB 3080. NEUROBIOLOGY.
Cat. I
An introduction to neurobiology, with emphasis on the cellular and molecular basis of neural development and function. Topics will range from electrical and biochemical signaling between neurons, to higher order functions of the nervous system, such as sensation, movement, and memory. Human neurological diseases and disorders will be discussed. Some guided reading of the primary literature will be included.
Recommended background: BB 2550, BB 2920, and BB 3110.
Students may not receive credit for both BB 4080 and BB 3080.
BB 3110. ANIMAL PHYSIOLOGY.
Cat. I
The functions of the major tissue types and organ systems of multicellular animals will be discussed, with emphasis on human physiology in health and disease. The use of invertebrate and vertebrate animal models in research, and comparisons of functional adaptations in non-human systems will also be covered. Recommended background: BB 1001 and BB 1030. Students who have received credit for BB 3101 may not take BB 3110 for credit.

BB 3120. PLANT PHYSIOLOGY AND CELL CULTURE.
Cat. I
The relationship of structure and function of multicellular plants will be examined at the biochemical level. Topics include (but are not limited to): water relations, mineral nutrition, intra- and inter-cellular transport, hormones, photosynthesis, in vitro culture of plant cells/tissues/organs, and environmental responses.
Recommended background: BB 1040, BB 2550, CH 1020.

BB 3140. EVOLUTION: PATTERN AND PROCESS.
Cat II
We will explore several theoretical constructs of evolutionary processes. Topics will range from microevolutionary patterns to global extinctions and speciation. We will examine the causes of evolutionary trends from the molecular to the group level.
Readings from current research into the units and levels of selection will be included.
Recommended background: BB 2550, BB 2920, at least one of (BB 1040, BB 2040, BB 1050).
This course will be offered in 2003-04 and in alternating years thereafter.

BB 3160. BEHAVIORAL ECOLOGY.
Cat II
This course is an overview of the biological basis of animal behavior. Topics for the course include animal cognition and communication, foraging and orientation, and evolutionary issues of mate selection, territoriality, and group living. Format for the course is largely text readings and lecture with associated video support materials.
Recommended background: BB 1050, BB 2040.
This course will be offered in 2002-03 and in alternating years thereafter.

BB 3170. PLANT MORPHOLOGY AND DEVELOPMENT.
Cat II
This course will focus on the form and function of developing plant structures. Beginning with the unique aspects of plant cells, the course will progress to include tissue and organ anatomy and will cover the phenomena responsible for defining the gross morphology of the organism. Coverage of these topics will culminate in an understanding of the integrated development of the whole plant.
Some guided reading of the primary literature will be included.
Recommended background: BB 1040 or equivalent, and BB 2550.
This course will be offered in 2003-04 and in alternating years thereafter.

BB 3511. NERVE AND MUSCLE PHYSIOLOGY.
Cat I (1/6 unit)
Computer and laboratory studies of nerve and muscle function.
Recommended background: BB 2940.
Concurrent or prior registration in BB 3110 is recommended.

BB 3512. MOLECULAR GENETICS LAB.
Cat I (1/6 unit)
The topic of gene therapy will be used to familiarize the student with computer manipulations of biological sequence information.
Recommended background: BB 2920, BB 2550 and BB 4910/CH 4130.

BB 3513. CELL CULTURE TECHNIQUES FOR ANIMAL CELLS.
Cat I (1/6 unit)
Basic laboratory skills in mammalian cell culture to include cell counting, freezing and thawing cell lines, culture of suspension and attached cells.
Recommended background: BB 2940, BB 2550 and knowledge of aseptic techniques.
Concurrent or prior registration in BB 4008 is recommended.

BB 3514. CIRCULATORY AND RESPIRATORY PHYSIOLOGY.
Cat I (1/6 unit)
Computer and laboratory studies of circulatory and respiratory physiology.
Recommended background: BB 2940.
Concurrent or prior registration in BB 3110 is recommended.

BB 3516. SEPARATION TECHNIQUES IN BIOTECHNOLOGY.
Cat I (1/6 unit)
A laboratory course in chromatographic and electrophoretic separation of proteins; plasmid isolation, restriction digestion and electrophoretic separation of DNA.
Recommended background: BB 2940.
Concurrent or prior registration in Biochemistry (CH 4110) and BB 4910 is recommended.

BB 3517. FERMENTATION.
Cat I (1/6 unit)
An introductory laboratory course in basic fermentation techniques.
Recommended background: BB 2940, BB 2002, or knowledge of aseptic techniques.
Concurrent or prior registration in BB 3055 is suggested.

BB 3518. MOLECULAR BIOLOGY.
Cat I (1/6 unit)
Laboratory investigations of select molecular characteristics of proteins and DNA.
Recommended background: BB 2940, BB 2550, CH 4110 and CH 4120. Concurrent, or prior registration in BB 4910 is recommended.

BB 3519. PROTEIN PURIFICATION.
Cat I (1/6 unit)
A laboratory course in protein purification techniques.
Recommended background: BB 2940, CH 4110.
Concurrent or prior registration in BB 4070 is recommended.

BB 3520. RECOMBINANT DNA TECHNOLOGY.
Cat I (1/6 unit)
A laboratory course in the construction, isolation and mapping of recombinants, and use of the polymerase chain reaction.
Recommended background: BB 2940, BB 2550, CH 4110 and BB 4910. Concurrent or prior registration in BB 4955 is recommended.

BB 3521. MICROSCOPY.
Cat I (1/6 unit)
A laboratory course in the theory and operation of light and electron microscopes, including specimen preparation, operation of equipment, and microphotography.
Recommended background: BB 2940 and BB 2550.

BB 3522. TRANSMISSION ELECTRON MICROSCOPY.
Cat. I (1/6 unit)
This laboratory module will provide the student with the basic theory and practice of transmission electron microscopy. The course will include sample handling and preparation methods, use of the TEM, and photographic recording of observations made with the instrument.
Recommended background: BB 1001 or BB 2550, and BB 2940 or BB 2950.

BB 3620. DEVELOPMENTAL BIOLOGY.
Cat. II
This advanced level course provides a detailed survey of the processes of animal development, including fertilization, cleavage, gastrulation, and organogenesis. These processes are examined in the context of concepts such as differentiation, determination, induction, intercellular signaling, morphogenesis, and pattern formation. Emphasis is placed on current techniques for studying development, such as genetic analysis of mutations, recombinant DNA technology, molecular probing of gene expression, and gene transfer. The experimental focus is on model organisms such as nematodes, fruit flies, frogs, and mice.
Offered in 2002-03 and alternate years.
Recommended background: BB 2002, BB 2550, BB 2920.

BB 3920. IMMUNOLOGY.
Cat. I
This is a survey course in immunology which assumes a background in cell biology, genetics and biochemistry. Topics to be covered will include cells of the immune system, antigen/antibody immunochemistry, immunogenetics and immune responses. Readings from research literature will be assigned.
Recommended background: BB 2550, BB 2920, CH 4110, and CH 4120.

BB 4008. CELL CULTURE THEORY AND APPLICATIONS.
Cat. I
The use of cultured animal cell systems for research and production will be explored. Concepts, including media design, the effects of extracellular matrices, scaling up of cell cultures, and biochemical and morphologic assessment of cell function, will be discussed as a basis for readings from the literature.
Recommended background: BB 2550, BB 2920, CH 4110, and CH 4120.
Students who have received credit for BB 4007 may not take BB 4008 for credit.

BB 4010. ADVANCED MOLECULAR GENETICS.
Cat. I
Topics in molecular genetics are presented using microbial systems as models. The structure, function and synthesis of DNA and the results of mutation, recombination and repair are emphasized. Simple bacteria and their plasmids, transposable elements and phages are discussed as experimental models.
Recommended background: BB 2002, BB 2550, BB 2920, BB 4910.
DNA and protein sequence analysis, gene mapping, evolutionary analysis, various methods of computational genetic analysis. Students will learn about providing a summary of population genetics concepts, the course will cover view of biological data as DNA and protein sequence, genetic markers and ecosystems and of developing original models. Knowledge of a programming language is assumed.

This course presents a detailed survey of state-of-the-art methods employed by the biotechnology industry for the purification of products, proteins in particular, from fermentation processes. Focus is on methods which offer the best potential for scale-up. Included are the theory of the design as well as the operation of these methods at the laboratory scale. It is intended for bioLOGY/biotechnolOgy majors, chemical engineering and biochemistry students.

Recommended background: knowledge of the topics in CH 4110 and CH 4120. Students who have received credit for BB 4060 may not take BB 4070 for credit.

BB 4410. ECOLOGICAL MANAGEMENT.
Cat II
We will take an in-depth look at the development of a management scheme for a natural area. The course focuses on the biological issues of ecological management rather than socio-economic ones. Format will vary from week to week and will include lectures, group discussions, workshops and field trips to a wildlife sanctuary with an established ecological management plan. Basic concepts of population ecology and field techniques of ecological research will be explored to give the student a working knowledge of the biological basis for ecological management.

Recommended background: BB 1040, BB 1050 and BB 2040.

This course will be offered in 2003-04 and in alternating years thereafter.

BB 4150. POPULATION AND COMMUNITY ECOLOGY.
Cat II
This course presents a detailed exploration of problems in population change and the interaction between populations and the environment. Topics covered will include single-and multiple-species population models, age/stage structured population growth, metapopulation growth, island bio-geography, community diversity and stability and the evolution of life history strategies.

Format will include lectures and group discussion.

Recommended background: BB 1040 or BB 1050, BB 2040, MA 1021, MA 1022.
Suggested background: BB 3020, MA 2071.
Offered in 2002-03 and in alternating years thereafter.

BB 4250. ECOLOGICAL SIMULATION MODELING.
Cat II
This course will cover computer simulation models of populations, bioenergetics, behavior of individuals, and ecosystem dynamics. Modeling techniques covered will range from simple linear models of populations and interactions between ecosystem components to individual-based models of populations in complex environments. Students successfully completing the course should be capable of understanding models used in today’s study of populations and ecosystems and of developing original models. Knowledge of a programming language is assumed.

Recommended background: BB 2040, BB 3020, MA 1021, MA 1022, CS 1005.
Offered in 2003-04 and in alternating years thereafter.

BB 4440. BIOINFORMATICS.
Cat I
This course will focus on the field of bioinformatics. After providing and overview of biological data as DNA and protein sequence, genetic markers and providing a summary of population genetics concepts, the course will cover various methods of computational genetic analysis. Students will learn about DNA and protein sequence analysis, gene mapping, evolutionary analysis, molecular biology databases, analysis of expression data and microarray analysis.

Recommended background: BB 2920, MA 2611 and MA 2612 or BB 3040.

BB 4550. ADVANCED CELL BIOLOGY.
Cat I
This advanced-level course uses a seminar format based on research articles to discuss current topics related to the molecular biology of cellular function. Particular emphasis is placed on biological mechanisms of autoimmune disorders, cancer, Alzheimer’s disease, thrombosis, haemostasis, neurotropic factors, and gene therapy.

Recommended background: BB 2550.

BB 4910. ADVANCED MOLECULAR BIOLOGY.
Cat I
This advanced level course explores the molecular mechanisms by which cells use genetic information to produce RNAs and proteins. Mechanisms to the regulation of transcription in both prokaryotes and eukaryotes will be studied with an emphasis on protein-protein and protein-DNA interactions. The structure, organization, evolution and expression of the eukaryotic genome will be emphasized. This course is intended for students who seek an in-depth understanding of gene function.

Recommended background: BB 2550, BB 2920, BB 4955, CH 4110, 4120 and 4130.

BB 4955. RECOMBINANT DNA PRINCIPLES AND APPLICATIONS.
Cat I
This course surveys both theory and applications in recombinant DNA methodology. Topics covered include enzymology of DNA manipulation; construction and isolation of recombinants; plasmid and bacteriophage vectors; structural analysis of cloned DNA.

Recommended background: prior knowledge of BB 2002, BB 2550, BB 2920, BB 4010, and basic molecular biology will be assumed.

BS 44. SPECIAL TOPICS.
Cat I
Experimental courses, special conferences and seminars are offered by advance arrangement only.
BIOMEDICAL ENGINEERING COURSES

BB 544. BIOINFORMATICS.
This course will focus on the field of Bioinformatics. After providing an overview of biological data such as DNA and protein sequences, genetic markers and providing a summary of population genetics analysis. Students will learn about DNA and protein sequence analysis, gene mapping, evolutionary analysis, molecular biology databases, analysis of expression data and microarray analysis.

BB 545. ADVANCED CELL BIOLOGY.
This advanced-level course uses a seminar format based on research articles to discuss current topics related to the molecular biology of cellular function. Particular emphasis is placed on biological mechanisms of autoimmune disorders, cancer, Alzheimer’s disease, thrombosis, haemostasis, neurotrophic factors, and gene therapy.

BB 549. MOLECULAR BIOLOGY.
Synthesis of biologically important macromolecules. Selected readings from the scientific literature are used to illustrate the milestones of molecular biology and the development of techniques and experiments. Protein synthesis and ribosome structure lead into a discussion of RNA and finally DNA synthesis, with the chemistry of DNA molecules receiving significant attention.

BB 550. RECOMBINANT DNA BIOCHEMISTRY.
This course presents the theory of recombinant DNA methodology. Topics covered include enzymology of DNA manipulation; construction and isolation of recombinants; plasmid and bacteriophage vectors; structural analysis of cloned DNA.

BB 560. SEPARATION OF BIOLOGICAL MOLECULES.
This course provides a detailed hands-on survey of state-of-the-art methods employed by the biotechnology industry for the purification of products, proteins in particular, from fermentation processes. Focus is on methods which offer the best potential for scale-up. Included are the theory of the design as well as the operation of these methods both at the laboratory scale as well as scaled up. It is intended for biotechnology, chemical engineering, and biochemistry students. A knowledge of basic biochemistry is assumed.

BB 565. VIROLOGY.
This advanced-level course uses a seminar format based on research articles to discuss current topics related to the molecular/cell biology of viral structure, function, and evolution. Particular emphasis is placed on pathological mechanisms of various human disorders, especially emerging diseases, and the use of viruses in research.

BB 570. SPECIAL TOPICS.
Specialty subjects are offered using the research expertise of the department faculty. Content and format varies to suit the interest and needs of the faculty and students. This course may be repeated for different topics covered.

BIOMEDICAL ENGINEERING

The second digit for Biomedical Engineering course numbers is coded as follows:

- 0 — Bioinstrumentation, Biosignals, Introduction
- 1 — Physiology
- 2 — Bioelectric, Bioimaging
- 3 — Design
- 4 — Biomechanics, Biological Systems
- 5 — Biofluids
- 8 — Biomaterials

BE 2000. BIOMEDICAL ENGINEERING DESIGN.
Cat. I
Students are guided through the open-ended, real-world, design process starting with the project definition, specification development, management, team interactions and communication, failure and safety criteria, progress reporting, marketing concepts, documentation, and technical presentation of the final project outcome. The course will include a significant writing component, will make use of computers, and hands-on design explorations.

BE 2504. FOUNDATIONS IN BIOMECHANICS.
Cat. I
This course is an introduction to the analysis of the musculoskeletal systems using principles of engineering mechanics. Basic principles of mechanics, stress, strain, deformation in beams are presented and used to characterize the material properties of tissues such as tendon, ligament, bone and cartilage. Principles of biomechanics are also applied to the design of medical devices and bioengineered tissues. Topics include forces, moments of forces, free body diagrams, principal stresses, transverse shear stresses and beam loading. Recommended background: BB 2550 or equivalent, MA 2051, PH 1110 or PH 1111.

Students who have previously received credit for BE 4504 may not receive credit for BE 2504.

BE 2604. FOUNDATIONS IN BIOLOGICAL TRANSPORT PHENOMENA.
Cat. I
This course is an introduction to the analysis of complex biological systems using principles of transport phenomena. Basic theories of momentum transport, mass transport and energy transport are presented and applied to cellular and mammalian physiology. Principles of transport phenomena are also applied to the design of medical devices and bioengineered tissues. Topics include differential and integral balances, rheology of Newtonian and non-Newtonian fluids, diffusion in reacting systems and homogeneous vs. heterogeneous reaction systems.

Recommended background: BB 2550 or equivalent, MA 2051, PH 1110 or PH 1111.

Students who have received credit for BE 3101 may not receive credit for BE 2604.

BE 3011. BIOMATERIALS AND BIOSENSORS.
Cat. I
A study of the basic principles of biomedical electronics and measurement with emphasis on the operational performance and selection of transducers, instruments and systems for biomedical data acquisition and processing. Biopotential electrodes. Analysis and selection of physical, optical, electrical, mechanical, thermal transduction mechanisms which form the basis of the sensor design. Clinical laboratory instrumentation. Electrical safety problems in the clinical environment.

Recommended background: MA 2051, EE 3601, or equivalent.

BE 3110. EXPERIMENTAL PHYSIOLOGY FOR ENGINEERS.
Cat. I
A laboratory-based course providing an introduction to experimental physiology for engineers interested in a hands-on exploration of physiologic principles. Emphasis is placed on developing the student’s ability to make measurements on and interpret data from living systems. This is achieved with laboratory projects and computer-based physiology simulators. Students are expected to apply relevant mathematical equations, models, and statistics when interpreting data collected in the laboratories. Laboratory projects include: animal care and anesthesia, muscle and nerve physiology, electrophysiology, circulatory physiology, respiratory physiology, and renal physiology. The principles of writing and maintaining a laboratory notebook are also developed and used.

Recommended background: MA 2051, and MA 2051.

BE 4011. BIOMEDICAL SIGNAL ANALYSIS.
Cat. II
Introduction to biomedical signal processing and analysis. Fundamental techniques to analyze and process signals that originate from biological sources: ECGs, EMGs, EEGs, blood pressure signals, etc. Course integrates physiological knowledge with the information useful for physiologic investigation and medical diagnosis and processing. Biomedical signal characterization, time domain analysis techniques (transfer functions, convolution, auto- and cross-correlation), frequency domain (Fourier analysis), continuous and discrete signals, deterministic and stochastic signal analysis methods. Analog and digital filtering.

Recommended background: EE 2311, BE 3011, or equivalent.

This course will be offered in 2002-03, and in alternating years thereafter.

BE 4025. BIOMEDICAL INSTRUMENTATION DESIGN I.
Cat. II
This course builds on the fundamental knowledge of bioinstrumentation and biosensors presented in BE 3011. Lectures and hands-on laboratory experiments cover the principles of designing, building and testing analog instruments to measure biologic events. Design laboratories will include bioelectric techniques and bioinstrumentation systems for the measurement of physiological parameters.

Recommended background: BE 2204, and BE 3011.

This course will be offered in the 2002-2003 academic year and alternate years.
BIOMEDICAL ENGINEERING COURSES

BE 4025. BIOMEDICAL INSTRUMENTATION DESIGN II.
Cat. II
This course builds on the fundamental knowledge of bioinstrumentation and biosensors presented in BE3011. Lectures and hands-on laboratory experiments cover the principles of biosensor interfacing, low-level measurements, analog-to-digital and digital-to-analog signal conversion, microprocessor and microcontroller based biomedical instrumentation, and programming.

Recommended background: BE2024, and BE3011.
This course will be offered in the 2003-2004 academic year and alternate years thereafter.

BE 4201. BIOMEDICAL IMAGING.
Cat. II
This course is a practical introduction to biomedical imaging processing using examples from various branches of medical imaging. Topics include: point operations, filtering in the image and Fourier domains, image reconstruction in computed tomography and magnetic resonance imaging, and data analysis using image segmentation. Review of linear-systems theory and the relevant principles of physics. Course work uses examples from microscopy, computed tomography, X-ray radiography, and magnetic resonance imaging. A working knowledge of undergraduate signal analysis and linear algebra is desirable.

Facility with a high-level programming language is recommended.
The course will be offered in 2002-03, and in alternating years thereafter.

BE/ME 4504. BIOMECHANICS.
Cat. II
This course emphasizes the applications of mechanics to describe the properties of living tissues. It concerns the description and measurements of these properties as related to their physiological functions. Emphasis on the interrelationship between biomechanics and physiology in medicine, surgery, body injury and prostheses.

Topics covered include: Review of basic mechanics, stress, strain, constitutive equations and the field equations, viscoelastic behavior, and models of material behavior. The measurement and characterization of properties of tendons, skin, muscles and bone. Biomechanics as related to body injury and the design of prosthetic devices.

Recommended background: Mechanics (ES 2051, ES 2052, ME 3501), Mathematics (MA 2051).
The course will be offered in 2003-04, and in alternating years thereafter.

BE 4541. BIOLOGICAL SYSTEMS.
Cat. II
Review of control theory with applications to biological control systems. Analysis and modeling of physiological systems. Physiological systems identification. Formulation of mathematical models of biological systems and the application of computer techniques in the simulation of these systems. Recommended background: Laplace transforms, transient response, frequency response and system stability analysis.

This course will be offered in 2003-04, and in alternating years thereafter.

BE/ME 4606. BIOFLUIDS.
Cat. II
This course emphasizes the applications of fluid mechanics to biological problems. The course concentrates primarily on the human circulatory and respiratory systems. Topics covered include: blood flow in the heart, arteries, veins and microcirculation and air flow in the lungs and airways. Mass transfer across the walls of these systems is also presented.

Recommended background: ME 3901 and fluid mechanics equivalent to ES 3004.
The course will be offered in 2002-03, and in alternating years thereafter.

BE 4814. BIOMATERIALS.
Cat. I
A course discusses various aspects pertaining to the selection, processing, testing (in vitro and in vivo) and performance of biomedical materials. The biocompatibility and surgical applicability of metallic, polymeric and ceramic implants and prosthetic devices are discussed. The physico-chemical interactions between the implant material and the physiological environment will be described. The use of biomaterials in maxillofacial, orthopedic, dental, ophthalmic and neuromuscular applications is presented.

Recommended background: BB 3130 or equivalent introduction to Human Anatomy, ES 2001 or equivalent introduction to Materials Science and Engineering.

BE 4828. BIOMATERIALS-TISSUE INTERACTIONS.
Cat. I
This course examines the principles of materials science and cell biology underlying the design of medical devices, artificial organs and scaffolds for tissue engineering. Molecular and cellular interactions with biomaterials are analyzed in terms of their cellular features such as matrix synthesis, degradation and contraction. Principles of wound healing and tissue remodeling are used to study biological responses to implanted materials and devices. Case studies will be analyzed to compare tissue responses to intact, biodegradable and bioerodible biomaterials. Additionally, this course will examine criteria for evaluating physiological function of tissue and organs and investigate strategies to design implants and prostheses based on control of biomaterial-tissue interactions.

Recommended background: BE 2040, BB 2550 or equivalent, ES 2001 or equivalent, PH 1110 or PH 1111.

Graduate Biomedical Engineering Courses of Interest to Undergraduates

BE 523. BIOMEDICAL INSTRUMENTATION.
Origins and characteristics of bioelectric signals, recording electrodes, amplifiers, chemical pressure and flow transducers, noninvasive monitoring techniques, and electrical safety. (Prerequisite: Circuits and electronics, control engineering or equivalent.)

BE 525. MICROPROCESSOR-BASED BIOMEDICAL INSTRUMENTATION.
This course provides hands-on laboratory experience with common biomedical transducers and instrumentation used in physiological and clinical evaluation. Lectures and laboratory experiments cover electronic circuit design and construction, analog/digital signal acquisition and processing, and microprocessor-based biomedical instrumentation. The basic principles of hardware and software designs for interfacing biomedical sensors to a general purpose IBM-PC are emphasized. (Prerequisite: Analog and digital electronics.)

BE 541. BIOLOGICAL SYSTEMS.
Review of control theory with applications to biological control systems. Development of mathematical models of selected biological control systems and the application of computer techniques in the simulation of these systems.

BE/ME 550. TISSUE ENGINEERING.
This biomaterials course focuses on the selection, processing, testing and performance of materials used in biomedical applications with special emphasis upon tissue engineering. Topics include: material selection and processing, mechanisms and kinetics of material degradation, cell-material interactions and interfaces; effect of construct architecture on tissue growth; and transport through engineered tissues. Examples of engineering tissues for replacing cartilage, bone, tendons, ligaments, skin and liver will be presented. (Recommended preparation: A first course in biomaterials equivalent to BE/ME 4814 and a basic understanding of physiology and cell biology.)

BE 551. BIOLOGICAL SIGNAL PROCESSING.
Basic principles of digital processing of biological signals, and its application on PC-compatible computers. The theoretical fundamentals and practical examples of signal processing. The major emphasis is on linking the theoretical knowledge with easy to comprehend practical examples. (Prerequisites: Basic signal analysis.)

BE/ME 552. TISSUE MECHANICS.
This biomechanical course focuses on advanced techniques for the characterization of the structure and function of hard and soft tissues and their relationship to physiologic processes. Applications include: tissue injury, wound healing, the effect of pathological conditions upon tissue properties and design of medical devices and prostheses. (Recommended preparation: A first course in biomechanics equivalent to BE/ME 4504.)

BE 554. COMPOSITES WITH BIOMEDICAL AND MATERIALS APPLICATIONS.
Introduction to fiber/particulate reinforced, engineered and biologic materials. This course focuses on the elastic description and application of materials that are made up of a combination of submaterials, i.e., composites. Emphasis will be placed on the development of constitutive equations that define the mechanical behavior of a number of applications, including: biomaterial, tissue, and materials science. (Prerequisites: understanding of stress analysis and basic continuum mechanics.)

BE/ME 558. BIOFLUIDS AND BIOTRANSPORT.
The emphasis of this course is on modeling fluid flow within the cardiovascular and pulmonary systems and the transport processes that take place in these systems. Applications include artificial heart valves, atherosclerosis, arterial impedance matching, clinical diagnosis, respiration, aerosol and particle deposition. Depending upon class interest, additional topics may include: reproductive fluids, animal propulsion in air and water and viscoelastic testing. (Recommended preparation: A first course in biofluids equivalent to BE/ME 4606.)

BE 560. PHYSIOLOGY FOR ENGINEERS.
An introduction to fundamental principles in cell biology and physiology designed to provide the necessary background for advanced work in biomedical engineering. Quantitative methods of engineering and the physical sciences are stressed. Topics include cell biology, DNA technology, and the physiology of major organ systems.

BE 562. LABORATORY ANIMAL SURGERY.
A study of anesthesia, surgical techniques, and postoperative care in small laboratory animals. Anatomy and physiology of species used included as needed. Class limited to 15 students. Approximately 15 surgical exercises are performed by each student.
This course builds on prior work in material and energy balances, chemical engineering thermodynamics, and stage separation processes to facilitate student mastery and design of more complex processes. Topics covered include chemical reaction equilibria, material and energy balances for non-steady state systems, combined material and energy balances, humidification, and batch distillation.

Recommended background: Elementary college chemistry and calculus and some familiarity with the topics listed in CM 2011, CM 2012, and CM 2013.

Students may not receive credit towards CM distribution requirements for both CM 2014 and CM 2002.

CM 3201. KINETICS AND REACTOR DESIGN. Cat. I

Techniques for experimentally determining rate laws for simple and complex chemical reactions, the mechanisms and theories of chemical reactions, the function of catalysts, and the design of isothermal, adiabatic, batch and flow reactors. The course is intended to provide chemists and chemical engineers with the conceptual base needed to study reactions and perform in the design and analysis of reactors.

Recommended background: differential equations, thermodynamics and some organic chemistry.

CM 3501. APPLIED MATHEMATICS IN CHEMICAL ENGINEERING. Cat. I

The consolidation of the methods of mathematics into a form that can be used for setting up and solving chemical engineering problems. Mathematical formulation of problems corresponding to specific physical situations such as momentum, energy and mass transfer, and chemical reactions. Analytical and numerical techniques for handling the resulting ordinary and partial differential equations and finite difference equations.

Recommended background: ordinary differential equations, partial derivatives and vectors, momentum heat and mass transfer.

CM 3601. CHEMICAL MATERIALS ENGINEERING. Cat. II

This course is designed to provide a working knowledge in the solving of materials problems encountered by chemical engineers and in the engineering of new and improved materials used in chemical processes. The approach used is the correlation of engineering properties with atomic and microstructures, utilizing the diagnostic techniques of X-ray diffraction and spectrometry, microscopy, and phase relationships.

Topics include surface active materials such as catalysts, sorbents, filtering and separation agents, corrosion resistant materials, metals, refractories and polymers used in construction materials, particularly for pollution control.

Recommended background: basic knowledge of chemistry.

This course will be offered in 2003-04, and in alternating years thereafter.

CM 3910. CHEMICAL AND ENVIRONMENTAL TECHNOLOGY. Cat. II

Day trips to industrial plants provide an insight into the real world of the chemical industry. Advanced technologies for commercially producing major organic chemicals and the monomers and polymers derived from them are described. Petroleum refining, catalytic and thermal petrochemical processes, soaps and detergents, specialty chemicals, and antibiotic production processes are presented at the industrial level. Large scale unit operations and processes are seen on the plant trips. Students see how plant layout is integrated with process and product control and environmental protection at each facility.

Particular attention is paid to plant scale processes and equipment for control of chemical spills, hazards, and environmental pollution, for safety and accident prevention, and for compliance with local and national laws.

Recommended background: general understanding of Organic Chemistry and Material Balances is assumed.

CM 3920. AIR QUALITY MANAGEMENT. Cat. II

This course discusses the sources, sinks, ambient concentrations and effects of major gaseous and particulate air pollutants. The course is problem oriented and applied engineering methods to develop strategies for managing air quality on a local, regional and global scale. Topics include: indoor air quality, regional and national air shed modelling, global atmospheric change and design and efficiencies of air pollution control devices.

Recommended background: knowledge of chemistry, mathematics and engineering principles.
CM 4401. UNIT OPERATIONS OF CHEMICAL ENGINEERING I.

Cat. 1

Laboratory-application of fundamental theories to practical chemical engineering operations. Emphasis is on building the student’s understanding and ability to approach the problems of design and operations of large scale chemical processing equipment.

The course is a combination of lectures and laboratory projects in the area of unit operations. Laboratory projects include experiments in fluid-flow phenomena through various media such as: friction in conduits, filtration, pressure drop in packed towers, fluidization of solids, and spray drying.

Students are expected to carry out the planning and execution of experimental work as well as the analysis and reporting of experimental results in both written and oral format.

Recommended background: knowledge of chemistry, mathematics and engineering principles.

CM 4402. UNIT OPERATIONS OF CHEMICAL ENGINEERING II.

Cat. 1

Overall format and procedure are essentially the same as in Unit Operations of Chemical Engineering I.

Laboratory projects include experiments in heat and mass transfer such as: heat transfer in two heaters and a cooler, climbing film evaporation, multiple effect evaporation, absorption, extraction, distillation and rotary drying of solids.

Recommended background: familiarity with techniques and procedures emphasized in CM 4401.

CM 4403. CHEMICAL ENGINEERING DESIGN.

Cat. 1

Design of equipment, systems and plants; discussion of factors important in chemical plant design such as: economics, cost estimation, profitability, process selection, materials of construction, process control, plant location and safety. Introduction to optimization and computer-aided design. Principles are illustrated with short industrial-type problems.

Recommended background: thermodynamics; heat, mass and momentum transfer; inorganic and organic chemistry; chemical kinetics and reactor design.

CM 4404. CHEMICAL PLANT DESIGN PROJECT.

Cat. 1

Application of Chemical Engineering design principles to the design of a major chemical plant. Students work in groups to produce a preliminary practical process flowsheet, equipment and plant design, and economic analysis.

Recommended background: familiarity with techniques and procedures emphasized in CM 4403.

CM 4405. CHEMICAL PROCESS DYNAMICS AND CONTROL LABORATORY.

Cat. 1

This course is intended to provide laboratory application of fundamental principles of chemical process dynamics and feedback control. This includes open-loop dynamics of typical chemical engineering processes such as distillation, fluid flow, chemical reactors and heated stirred tanks. Closed-loop experiments will involve control loop design, controller tuning, multivariable, and computer control.

Students will be required to design and execute their own experiments based on supplied objectives. Analysis and presentation of the results will be done through oral and written reports.

Recommended background: knowledge of fluid flow and heat transfer, mathematics and chemical engineering principles.

Graduate Chemical Engineering Courses of Interest to Undergraduates

CM 504. MATHEMATICS ANALYSIS IN CHEMICAL ENGINEERING.

Methods of mathematical analysis selected from such topics as vector analysis, matrices, complex variables, Eigenvalue problems, Fourier analysis, and transforms. Laplace transformation, solution of ordinary and partial differential equations, integral equations, calculus of variations, perturbation and asymptotic methods and numerical analysis. Emphasis on application to the solution of chemical engineering problems.

CM 506. KINETICS AND CATALYSIS.

Theories of reaction kinetics and heterogeneous catalysis are developed for both simple and complex reactions. The kinetics and mechanisms of both catalyzed and uncatalyzed reactions are explored, as well as the effects of bulk and pore diffusion. Techniques for experimentation, reaction data treatment, and catalyst preparation and characterization are related to developing a sound approach to studying a chemical reaction.

CM 507. CHEMICAL REACTOR DESIGN.

A review of the design of ideal reactors. Main course topics include: deviations from ideal reactor behavior; transport effects in reacting systems; steady state multiplicity and stability analysis; optimization of reactors; analysis of heterogeneous reactors.

CM 508. CATALYSIS AND SURFACE SCIENCE OF MATERIALS.

The major factors which distinguished catalytic processes for chemicals and fuels from one another are the structure and composition of the materials used as catalysts.

This course examines the detailed structures and reactivities of solid catalysts like oxides, solid state inorganics, supported metals and metal-support interactions, carbon catalysts, anchored catalysts and others. Several important spectroscopic techniques used in surface science such as X-ray photoelectron spectroscopy (ESCA), electron microprobe, AUR, scanning electron microscopy, EXAFS, Mossbauer, Fourier-transform infrared, enhanced laser Raman spectroscopy and photoacoustics spectroscopy will be described for characterization of the catalytic surfaces.

The relationship between the structures and reactivities of important catalysts used in hydrocarbon oxidation and functionalization and syngas reactions will be examined to rationalize how they accomplish specific catalytic transformations.

CM 510. DYNAMICS OF PARTICULATE SYSTEMS.

Systems of discrete particles which grow in size or some other characteristic variable (e.g., age, molecular weight, etc.) are analyzed. Both reaction engineering and population balance analyses are introduced for batch and continuous systems. Steady state and transient system dynamics are explored.

Depending on class interest, specific topics may include: crystallization, latex synthesis, polymer molecular weight distribution, fermentation/ecological systems and gas-solid systems.

CM 521. BIOCHEMICAL ENGINEERING.

The course emphasizes the basic concepts of biological systems which are relevant to study by chemical engineers. Topics covered include ligand binding and membrane transport processes; growth kinetics of microorganisms; kinetics of interacting multiple populations; biological reactor design and analysis; soluble and immobilized enzyme kinetics; optimization and control of fermentation; and biological product recovery and separation.

CM 543. MOLECULAR SIEVES.

The structure, natural occurrence, synthesis, properties, and uses of the microporous crystals known as molecular sieves are examined. Emphasis is placed on understanding the relationship of their internal structures and their use as absorbants and catalysts.

CM 561. ADVANCED THERMODYNAMICS.

An examination of the fundamental concepts of classical thermodynamics and presentation of existence theorems for the thermodynamic properties with study of relations among them. The inequality of Clausius as a criterion for equilibrium in both chemical and physical systems. Examination of thermodynamic equilibrium for a variety of restraining conditions. Applications to fluid mechanics, process systems and chemical systems. Computation of complex equilibria.

CM 571. INTERMEDIATE TRANSPORT PHENOMENA.

Mass, momentum and energy transport; analytic and approximate solutions of the equations of change. Special flow problems such as creeping, potential and laminar boundary-layer flows. Heat and mass transfer in multiphase systems. Estimation of heat and mass transfer rates. Transport with chemical reaction.

CM 572. MASS AND ENERGY TRANSFER.

Advanced treatment of heat and mass transfer. Topics from: forced and natural convection; high-speed and rarefied gas flows; film and dropwise condensation, spray cooling, boiling and two-phase flow; packed and fluidized bed heat and mass transfer; the heat pipe; radiant transfer within enclosures, including radiation from gases and flames; ionic transport and electrochemical systems; combustion and mass transfer; drying and diffusion in porous materials, mass transfer adsorption; design of heat and mass transfer equipment.

CM 573. SEPARATION PROCESSES.

Thermodynamics of equilibrium separation processes such as distillation, absorption, adsorption and extraction. Multi-staged separations. Principles and processes of some of the less common separations.

CM 574. FLUID MECHANICS.

Advanced treatment of fluid kinematics and dynamics. Stress and strain rate analysis using vectors and tensors as tools. Incompressible and compressible, one-dimensional flows in channels, ducts and nozzles. Nonviscous and viscous flow fields. Boundary layers and turbulence. Flow through porous media such as fixed and fluidized beds. Two-phase flows with drops, bubbles and/or boiling. Introduction to non-Newtonian flows.

CM 580. TRANSFORMATION AND TRANSPORT IN THE ENVIRONMENT.

This course will focus on the transformation and transport of pollutant chemi- cals, nutrients and colloids in natural and engineered environmental systems. The first part of the course deals with the transfer of chemicals between different environments (water and air, water and solid phases). The second part of the course deals with processes by which a compound is chemically or biologically transformed into one or more products. Research – as arranged
CHEMISTRY AND BIOCHEMISTRY

GENERAL CHEMISTRY SEQUENCE

The general chemistry sequence, CH 1010—1040, is a unified sequence of courses in which areas of major importance in chemistry are discussed in depth from both the empirical and theoretical viewpoints. Each of the four courses develops a theme, or core idea, of chemistry. The sequence is designed for biology, science and engineering majors.

The format of each course includes four 1-hour classroom meetings and one 3-hour laboratory meeting per week. For reasons of safety, contact lenses may not be worn in the chemical laboratories. Prescription glasses meeting the ANSI standard Z87.1 will be accepted as affording adequate eye protection in the laboratory. Otherwise, goggles meeting these standards must be worn at all times.

CH 1010. MOLECULARITY.
Cat. I
The theme of CH 1010 is the idea of molecularity: that all matter in the universe is composed of atoms bonded together in a limited number of ways. Molecularity is one of a small number of fundamental themes of chemistry (and of all science); it is important for us to address it immediately because it permeates all of chemistry.
Specific concepts that we will discuss are presented below.
Introduction to the Molecular View
Structures of Simple Molecules
Types of Compounds: The Periodic Table
Chemical Calculations
Types of Reactions
The Quantum Structure of the Atom

CH 1020. FORCES AND BONDING.
Cat. I
The theme of CH 1020 is forces and bonding. We will examine the origin and strength of electrical forces within molecules (covalent bonds), between positive and negative ions in a lattice (ionic bonds), and between atoms or molecules of a pure substance (intermolecular forces). Energy changes accompanying the rupture or formation of such bonds will be discussed.
Specific concepts that we will discuss are presented below.
Molecular Structure and Shape
Gases
Solids
Intra- and Intermolecular Forces
Liquids
Energy (First Law of Thermodynamics)

CH 1030. EQUILIBRIUM.
Cat. I
The theme of CH 1030 is equilibrium. We will examine the nature of dynamic equilibrium at the molecular level, and will develop an understanding of the mathematical aspects of equilibrium. Phase equilibrium, further aspects of thermodynamics (entropy, free energy), equilibrium of chemical reactions in the gas phase, and equilibrium of chemical reactions in solution will be discussed.
Specific concepts that we will discuss are presented below.
Phase Equilibrium
Chemical Equilibrium of Gas Phase Reactions
Solutions
Chemical Equilibrium of Reactions in Solution
Entropy and Free Energy

CH 1040. DYNAMICS.
Cat. I
The theme of CH 1040 is dynamics. We will examine the nature of molecular motions and their interaction with light, which provides us with all of our structural information about molecules. Various types of molecular spectroscopy will be discussed. Then we will turn to the dynamics of interactions between molecules, examining the rates of chemical reactions, and discussing the detailed molecular pathways by which they occur.
Specific concepts that we will discuss are presented below.
NMR Spectroscopy
Vibrational Spectroscopy
Electronic Spectroscopy
Dynamics of Physical Processes (Diffusion, phase changes, phase distribution)
Dynamics of Chemical Processes

ORGANIC CHEMISTRY SEQUENCE

The following four courses provide a full-year laboratory program. The purpose of this sequence is to train students in the most essential laboratory techniques, procedures and instrumentation of experimental chemistry. It aims to develop the skills needed for effective work on future chemical laboratory projects such as the Major Qualifying Project. The work of the year develops sequentially.

CH 2310. ORGANIC CHEMISTRY I.
Cat. I
A systematic survey of the major reaction types and functional groups in organic chemistry. The course will provide a representative collection of characteristic reactions and transformations of a variety of types of organic molecules. Most of the examples will be drawn from aliphatic chemistry. Some theoretical models will be introduced with a view toward establishing a general overview of the material.
The course is intended for chemists, chemical engineers, pre-medical students and all those interested in the biosciences. A familiarity with the material presented in the general chemistry courses is assumed.

CH 2320. ORGANIC CHEMISTRY II.
Cat. I
Modern theories of aromaticity, including a general assessment of delocalized bonding. The chemistry of some significant functional groups not surveyed in Organic Chemistry I, and the meaning of acidity and basicity in organic chemistry, will be more fully explored. The course will provide an introduction to the systematic synthesis of polyfunctional organic compounds.
Recommended background: CH 2310. The course is intended for chemists, chemical engineers and bio-science majors.

CH 2330. ORGANIC CHEMISTRY III.
Cat. I
The course will continue the coverage of aromatic chemistry. New topics to be introduced include the chemistry of heterocycles, carbohydrates, amino acids and lipids. Particular attention will be paid to naturally occurring polymers such as polysaccharides, proteins and nucleic acids, as well as to industrial polymers.
This course is concerned with the physical and chemical properties of biomolecules, but not their biochemical behavior. It is therefore a good preparation for but distinctively different from CH 4110.
Recommended background: CH 2310 and CH 2320 topics.
The course is intended for biochemists, chemists, chemical engineers and bio-science majors.

CH 2360. ORGANIC LABORATORY.
Cat. I
Laboratory experience in the preparation and characterization of organic substances. The course will also contain sufficient training in laboratory technique and data handling so that no previous laboratory experience beyond that of general chemistry will be assumed. (To be taken concurrently or following studies in organic chemistry.) Recommended for chemical engineers, pre-medical students, BB majors, and other nonchemists desiring chemical laboratory experience. One lecture and three three-hour labs.

EXPERIMENTAL CHEMISTRY SEQUENCE

The experiments to be performed this term have been chosen to illustrate important principles and experimental techniques of physical chemistry. Students will gain experience with many of the instruments that they are likely to use in any chemical laboratory setting. These include optical spectrometers, vacuum lines, electrochemical cells and the bomb calorimeter.
Recommended background: CH 2460 and CH 3510.

CH 2460. EXPERIMENTAL CHEMISTRY II.
Cat. I
The emphasis in CH 2460 is on basic techniques essential for the synthesis, isolation, and characterization of inorganic and organic compounds. These include isolation and purification by solvent extraction, crystallization, distillation, and chromatographic techniques, followed by the determination of physical properties and characterization by infrared and nuclear magnetic resonance.
getics, the role of ATP, and its production through glycolysis and the TCA cycle.

INORGANIC AND PHYSICAL CHEMISTRY COURSES

CH 3410. PRINCIPLES OF INORGANIC CHEMISTRY.

Cat. 1
This course offers a unique approach to the descriptive chemistry of the elements. The Lewis acidity of positive centers is the starting point for the development of a series of ideas that includes Bronsted acidity, solubility, and the properties of the oxides of the elements. Redox properties are discussed in terms of Fouriers diagrams. The often-complex structures of the oxides and halides of the elements are rationalized in terms of radius of the "cation" and "anion." The Lewis acid-base concept is extended in discussions of coordination compounds and the theory of hard and soft acids and bases. Finally, the descriptive chemistry of the compounds of the elements with halogens, sulfur, and nitrogen are discussed.

CH 3530. QUANTUM CHEMISTRY.

Cat. 1
An introduction to quantum mechanics with applications to atomic and molecular spectra. The course will be developed systematically beginning with the postulates of quantum mechanics. The Schroedinger equation will be applied to systems such as the particle in a box, the rigid rotor, the harmonic oscillator and the hydrogen atom. Emphasis will be given to a quantum mechanical description of multielectron atoms, molecular bonding and spectroscopy.

Recommended background: a solid foundation in elementary physics and calculus.

CH 4420. INORGANIC CHEMISTRY II.

Cat. II
Recommended background: CH 2310, CH 2320, and CH 2330.

ADVANCED CHEMISTRY COURSES

CH 4330. ORGANIC SYNTHESIS.

Cat. II
A discussion of selected modern synthetic methods including additions, condensations and cyclizations. Emphasis is placed on the logic and strategy of organic synthesis. This course is intended to follow CH 2330.

Recommended background: CH 2310, CH 2320, and CH 2330.

CH 4420. INORGANIC CHEMISTRY II.

Cat. II
Recommended background: CH 1010 - CH 1040, CH 2640 - CH 2670, CH 3410, CH 3530, and CH 3550.

This course will be offered in 2002-03 and in alternate years thereafter.

BIOCHEMISTRY COURSES

CH 4110. BIOCHEMISTRY I.

Cat. I
The principles of protein structure are presented. Mechanisms of enzymatic catalysis, including those requiring coenzymes, are outlined in detail. The structures and biochemical properties of carbohydrates are reviewed. Bioenergetics, the role of ATP, and its production through glycolysis and the TCA cycle are fully considered.

Recommended background: CH 2310, CH 2320.

Suggested background: CH 2330.
Recommended background: knowledge of the material covered in one of the following is recommended: (a) CH 4110 and CH 4120, or (b) BB 3100, or (c) CH 538 plus an understanding of protein and membrane structures.

CH 552. STATISTICAL MECHANICS.
Application of the results of the quantum theory to achieve an atomistic physical understanding of the common thermodynamic variables. Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein distribution functions are defined using the concepts of phase space and the exclusion principle, and the thermodynamic functions are developed in terms of the distribution functions. Application of the partition function and the theory of fluctuations to common physical systems.

CH 554. MOLECULAR MODELING.
This course is intended to train students in the area of molecular modeling using a variety of quantum mechanical and force field methods. The approach will be towards practical chemists who want to answer specific questions about molecular geometry, transition states, reaction paths, and photoexcited states. No experience in programming is necessary; however, a background at the introductory level in quantum mechanics is highly desirable. Methods to be explored include Extended Hückel Theory, Molecular Mechanics, Semiempirical Molecular Orbital Methods, Ab initio and DFT Methods, Graphical Display of Molecules.

CH 555. ADVANCED TOPICS.
A course of advanced study in selected areas whose content and format to suit the interest and needs of faculty and students.

CH 556. EXPERIMENTAL PHOTOCHEMISTRY.
This course has been designed to illustrate how modern spectroscopic techniques can be used to learn more about the photo-induced chemistry of organic materials. The principles of time-resolved and steady-state spectroscopic methods will be discussed in lectures and then applied in the laboratory to a variety of chemical systems. The aim will be to show how it is possible to fully describe the ground and excited state photochemical behavior of a chemical system using these techniques. Aspects of the following techniques will be covered:
- Fluorescence emission spectroscopy, including solvent effects, quantum yields, quenching behavior, singlet lifetime determinant, excited singlet state energies and the origin of temperature dependence.
- Phosphorescence emission spectroscopy, including triplet state energies, distinguishing between n and π.
- Laser-flash photolysis, including generation, detection and identification of transient reaction intermediates, quenching, sensitization, triplet state lifetimes, properties of free radicals and other photochemically-generated reactive species, and the consequences of multiple photon excitation.
- Steady-state irradiation coupled with end product analysis and how these studies compliment time-resolved measurement.
- Students will gain hands-on experience with the use of UV-visible absorption and fluorescence emission spectrometers as well as the laser flash photolysis research facility. Also, as part of the course, students will submit a short research proposal based on one or more of the techniques used.
- Although there is no formal requirement for this course, some background and an interest in photochemistry would be an asset.

CIVIL AND ENVIRONMENTAL ENGINEERING

CE 1030. CIVIL ENGINEERING AND COMPUTER FUNDAMENTALS.
Cat. I
This course introduces students to basic fundamentals of civil engineering, group dynamics, oral presentation skills, engineering report writing techniques, and uses of the computer. Basics of structural engineering, geotechnical engineering, environmental engineering, surveying, materials, and construction engineering and management are presented in this course through a collaborative group teaching approach. Background is provided to gain competence in operating systems, editors, and spreadsheets. Student groups complete weekly computer laboratory projects and develop oral presentations and written reports.
- No previous computer use skills are required or assumed. This course is recommended for freshman or sophomore students.

CE 2000. ANALYTICAL MECHANICS I.
Cat. I
This fundamental civil engineering course provides an introduction to the analysis of structures in static equilibrium. The focus of this course is a classical analysis of concurrent and non-concurrent equilibrium. A variety of engineering problems including trusses, machines, beams, rigid frames, and hydraulic structures involving concentrated and distributed loading systems are analyzed for external reactions and internal forces.
CE 3022. LEGAL ASPECTS IN DESIGN AND CONSTRUCTION. Cat. II.
This course addresses legal aspects that underpin the planning, design and construction of a project. The principle focus is on the contracts, laws, specifications, and design documents needed to conduct civil engineering practice in the United States. Labor, safety, and environmental laws are reviewed, as well as the role of ethics and professional relationships with the client, other professional organizations and groups, the public, and the regulatory system.
Recommended background: CE 3020.
Offered in 2003-04 and in alternating years thereafter.

CE 3023. ARCHITECTURAL ENGINEERING SYSTEMS. Cat. I.
This course introduces the fundamental concepts associated with the design and construction of a building. Major building components, such as foundations, structures, envelopes and environmental systems are presented as subsystems to be integrated. The systems approach is utilized to describe the functional interdependence of building components and the interdisciplinary nature of the design of contemporary buildings. Building components are analyzed in terms of design details and constructability implications. AutoCAD representation and building design exercises as well as case studies are used to illustrate the topic.

CE 3024. CONTROL SURVEYING. Cat. II.
This course presents the principles and field procedures required in the design of vertical and horizontal control networks for large building and construction projects.
Recommended background: CE 2020.
Offered in 2002-03 and in alternating years thereafter.

CE 3026. MATERIALS OF CONSTRUCTION. Cat. I.
This course provides an understanding of the use and acquisition of engineering properties of construction materials. Topics include relationships between the structure of materials, their engineering properties, and the selection of suitable materials for applications involving strength, durability, and serviceability. Experimental laboratory procedures including design of experiments, data collection, analysis, and representation, and report writing are an integral part of the work.
Recommended background: CE 1030 and CE 2001.

CE 3030. FUNDAMENTALS OF CIVIL ENGINEERING AUTOCAD. Cat. I.
This course introduces Civil Engineering students to fundamental uses of the AutoCAD software package. Basic two dimensional drawing techniques are covered. Advanced topics that may be covered include three dimensional drawing, rendering and animation. Students are required to become familiar with AutoCAD.
Knowledge of the subject matter in at least two civil engineering design courses is expected background for this course.

CE 3041. SOIL MECHANICS. Cat. I.
This is an introductory course dealing with the science and technology of earth materials with an emphasis on fundamental concepts of particulate mechanics. The topics which are discussed include fluid flow through porous media, deformation and shear characteristics of soil, consolidation, lateral earth pressure, and slope stability.
Suggested background: GE 2341.

CE 3044. FOUNDATION ENGINEERING. Cat I.
Foundation engineering is a study of the applications of the principles of soil mechanics and structural theory to the analysis, design and construction of foundations for engineering works with the emphasis on the soil engineering aspects of soil structure interaction. Subsurface exploration techniques, design of rigid and flexible retaining structures, and design of, shallow and deep foundations are considered. Although the course deals mainly with aspects of the design of buildings and bridges, certain parts of the course (design of temporary trench bracing, for example) are very relevant to construction engineering.
Recommended background: CE 3041.
Suggested background: CE 3008.

CE 3050. INTRODUCTION TO TRANSPORTATION ENGINEERING. Cat I.
This course provides an introduction to the field of transportation engineering with particular emphasis on traffic engineering and highway design. Topics covered include a description of the transportation industry and transportation modes; characteristics of drivers, pedestrians, vehicles and the roadway; traffic engineering studies, highway safety, principles of traffic flow, intersection design and control, capacity analysis, level of service analysis; geometric design of highways; paving materials and pavement design.
CE 3051. INTRODUCTION TO PAVEMENT MATERIALS, DESIGN AND MANAGEMENT.
Cat. I
This course provides an introduction to concepts required for design construction and management of pavements. Topics include: reinforced concrete, bituminous materials, rigid and flexible pavements, and pavement management. Knowledge of the subject matter in CE 3050 is helpful but not required.

CE 3054. ASPHALT TECHNOLOGY.
Cat. I
This laboratory-based course introduces the field of asphalt technology, providing an understanding of characterization tests for hot mix asphalt and understanding of production of hot mix asphalt, illustrates typical problems of hot mix asphalt pavements, and helps in developing an interest in asphalt technology. Instruction is provided through lecture, laboratory work and field trips. Students work in groups for preparation of laboratory reports and a term project.
Recommended background: CE 1030 and CE 2001.

CE 3059. ENVIRONMENTAL ENGINEERING.
Cat. I
This is an introductory course in the area of environmental engineering. The course should also be of interest to students who require an overall understanding of environmental engineering problems. Topics include: environmental impact of population growth and energy demand, water resources, water chemistry, water quality standards, environmental microbiology, waste-water characteristics, receiving water quality and dissolved oxygen budgets, water pollution abatement, sludge management, solids and hazardous waste management, and an introduction to air and water pollution.
Recommended background: CH 1010 and CH 1020 or equivalent.

CE 3060. WATER TREATMENT.
Cat. I
This course provides in-depth coverage of processes used in water treatment. Topics include: review of water chemistry and drinking water standards, impurities in natural waters, aeration, water softening coagulation, flocculation, sedimentation, filtration, disinfection, taste and odor control, corrosion control, and iron and manganese removal.
Recommended background: CE 3059 and ES 3004.

CE 3061. WASTE WATER TREATMENT.
Cat. I
This course provides in-depth coverage of processes used in wastewater treatment. Topics include: review of wastewater standards, wastewater characteristics, application of biochemical oxygen demand, sources and effects of pollution, physical, chemical, and biological wastewater treatment processes, and waste sludge management.
Recommended background: CE 3059 and ES 3004.

CE 3062. HYDRAULICS IN CIVIL ENGINEERING.
Cat. I
This course provides a basic background for designing hydraulic systems used in water supply and wastewater transport systems. It is a basic course for students in the sanitary engineering and water resources area. Topics include: open channel flow, pipe flow, pumps, sewer design and water supply network design.
Recommended background: ES 3004.

CE 3070. URBAN AND ENVIRONMENTAL PLANNING.
Cat. I
This course introduces the student to the social, economic, political, and environmental factors that affect the population growth and distribution patterns, and the impact of such patterns to the natural environment. By using the principles and procedures of planning, the optimal growth pattern may be examined, and the infrastructure (roads, water supply systems, waste-water treatment systems, shopping malls, etc.) necessary to support present and future growth patterns may be determined.
The information necessary in planning, which involves conscious procedures of analysis, formulation of alternative solutions, rational assessment and deliberate choice in accordance with evaluation criteria, is obtained through extensive reading. As such the course introduces a variety of topics of concern to engineers and environmentalists. The course is intended not only for civil engineering majors, but also for students preparing for an IQP in areas of urban or environmental concerns.

CE 3074. ENVIRONMENTAL ANALYSIS.
Cat. I
This course provides a background in the principles and techniques of assessing areas of natural environment and the application of this assessment to evaluate the inherent suitability for urban and resource based uses and facilities. The techniques developed in this course will be useful for land use planning, site design, and the impact of engineering projects on the environment.
Suggested background: CE 3070.

CE 4007. MATRIX ANALYSIS OF STRUCTURES.
Cat. I
This course presents the principles of matrix analysis of structural elements and systems; fundamentals of matrix algebra, solution of simultaneous equations, matrix inversion; analysis of plane trusses, method of joints; displacement method; principle of virtual work, analysis of continuous beams, analysis of plane frames, plate trusses, analysis of building frames and bridges; computer aided structural analysis and principles of software development.
Recommended background: CE 2002.

CE 4017. PRESTRESSED CONCRETE DESIGN.
Cat. I
This course covers analysis and design aspects of prestressed concrete structural elements and systems; principles of prestressing, materials for prestressing, high strength steel, flexural analysis and design methods; allowable stress and strength design methods; design of beams, load balancing, partial prestressing and cracking moment; design for shear, partial loss of prestress; deflections of prestressed concrete and precast construction; connections.
Recommended background: CE 2002 and CE 3026.
Suggested background: CE 3008.

CE 4024. REAL ESTATE DEVELOPMENT.
Cat. II
This course introduces real estate development with an emphasis on the decision-making process from initial concept to final acceptance; organizations, and professions in the development process; time frame for development; capital and operating budget construction; debt and equity finance; principle of planning, scheduling and managing the process.
Suggested background: CE 3024.
Offered in 2003-04 and in alternating years thereafter.

CE 4046. EXPERIMENTAL SOIL MECHANICS.
Cat. II
The standard laboratory soil testing procedures generally encountered in civil engineering are introduced in this course. It further includes a limited discussion of soil behavior primarily based on the effect of soil's physical and chemical properties on laboratory test results. The tests which are performed include: grain size analysis, Atterberg limits, specific gravity, permeability, compaction, compression and consolidation, and direct and triaxial shear. The student's results of the various tests are integrated within an engineering problem.
Recommended background: CE 3041.
Offered in 2002-03 and in alternating years thereafter.

CE 4048. EARTH STRUCTURES.
Cat. II
This course provides in-depth study of the geotechnical principles applied to design earth structures including earth dams, waste containment facilities, soil slopes, highway cuts and embankments, and slurry trenches. It includes fundamentals of analysis of flow through porous media by graphical and digital techniques, slope stability, use of geosynthetics, soil stabilization and the design of preloads and drain installations.
Recommended background: CE 3041.
Offered in 2003-04 and in alternating years thereafter.

CE 4060. ENVIRONMENTAL ENGINEERING LABORATORY.
Cat. I
This course familiarizes students with the laboratory studies used to obtain the design parameters for water and wastewater treatment systems. The tests include laboratory experiments dealing with physical, chemical, and biological treatment systems.
Recommended background: CE 3060 and CE 3061.

CE 4061. HYDROLOGY.
Cat. I
This course provides a quantitative description of the rainfall and runoff process for use in design of water resource related projects. Topics include: the review of the hydrologic cycle, precipitation, evaporation, transpiration, infiltration, stream flow measurements, flow routing, runoff analysis, show hydrology and development of drainage estimates for development plans. The course involves a stream measurement laboratory and application of model for hydrological and hydraulic engineering applications.
Recommended background: ES 3004.

CE 4071. LAND USE DEVELOPMENT AND CONTROLS.
Cat. I
The purpose of this course is to provide an understanding of how land use controls may be used to effectively shape our physical, social, and economic development. The quality of our environment depends upon the development which is permitted to take place and the controls which direct that development. Through this course, the student will learn the principles, methods, and techniques which a planner may use to plan the uses and development of land. In particular, the use and limits of zoning, special permits, hammerhead lots, subdivision control, comprehensive permits, and other tools with which a developer of plan board member should be familiar will be examined in detail.
CS 1001. INTRODUCTION TO COMPUTERS.

Cat. II
This course introduces computer systems to students who may need to write or use computer programs in their undergraduate engineering, science, or management courses.
Topics include problem-solving and algorithm development, the program development cycle, structured programming design, coding, debugging and documentation. Students will be expected to implement a variety of programs using the FORTRAN programming language.
Intended audience: noncomputer science majors desiring a practical introduction to programming. This course is not sufficient background for MQPs or IQPs involving extensive computer science or nonadvanced computer science or computer engineering courses. Such background may be obtained by taking CAT 105 or CAT 106 followed by CS 2005.
Recommended background: none.
This course will be offered in 2002-03 and in alternating years thereafter.

CS 1005. INTRODUCTION TO PROGRAMMING.

Cat. 1
This course introduces structured programming with emphasis on modular design and functional decomposition.
Topics include problem solving and algorithm development, the syntax and semantics of sequential, iterative, and conditional control structures, functions, arrays, pointers, and simple I/O.
Students will be expected to design and implement programs in C++.
Intended audience: computer science and computer engineering students and those students desiring a background in computer programming.
Recommended background: none.
Note: Either CS 1005 or CS 1006 will provide sufficient background for further study in Computer Science, including CS 2005.

CS 1006. OBJECT-ORIENTED INTRODUCTION TO PROGRAMMING.

Cat. 1
This course introduces computer programming, with emphasis on object-oriented programs.
Topics include: Problem solving, algorithm development, and debugging; the syntax and semantics of sequential, iterative, and conditional control structures; functions, arrays, pointers, and simple I/O.
Outcomes: Students will be expected to design and implement programs as applications and applets in an object-oriented programming language, such as Java.
Intended audience: All students with little or no programming experience who desire to learn an object-oriented programming language.
Recommended background: None.
Note: Either CS 1005 or CS 1006 will provide sufficient background for further study in Computer Science, including CS 2005.

CS 2005. DATA STRUCTURES AND PROGRAMMING TECHNIQUES.

Cat. 1
This course continues the development of discipline in programming design, style, expression, debugging and testing. It provides sufficient programming background for other 2000, 3000, and 4000 level computer science courses.
Topics include object-oriented programming, abstract data types, dynamic memory allocation, elementary data structures, algorithm analysis, recursion, internal sort/search methods, and step-wise refinement of both functions and data.
Students will be expected to design and implement reasonably large and complex programs in C++. Students will learn how to use appropriate high-level tools for program development.
Intended audience: computer science majors who do not have a strong background in these topics and noncomputer science majors who desire further programming experience or who intend to pursue upper-level computer science courses.
Recommended background: CS 1005 or CS 1006 or its equivalent.

CS 2011. INTRODUCTION TO MACHINE ORGANIZATION AND ASSEMBLY LANGUAGE.

Cat. 1
This course introduces students to the structure and behavior of digital computers at several levels of abstraction. Starting with a high-level view of functional components, the course progresses through the system from the point of view of assembly language programming, microprogramming, and logic circuits.
Topics include: Problem solving, algorithm development, and debugging; the syntax and semantics of sequential, iterative, and conditional control structures, functions, arrays, pointers, and simple I/O.
Students will be expected to write programs in an assembly language.
Intended audience: computer science and computer engineering students, and those desiring a deeper understanding of the low-level functionality of a computer.
Recommended background: CS 2005.

CS 2022/MA 2201. DISCRETE MATHEMATICS.

Cat. 1
This course serves as an introduction to some of the more important concepts, techniques, and structures of discrete mathematics, providing a bridge between computer science and mathematics.
Topics include functions and relations, sets, countability, groups, graphs, propositional and predicate calculus, and permutations and combinations.
Students will be expected to develop simple proofs for problems drawn primarily from computer science and applied mathematics.
Intended audience: computer science and mathematical sciences majors.
Undergraduate credit may not be earned both for this course and for MA 2201.
Recommended background: none.

CS 2135. PROGRAMMING LANGUAGE CONCEPTS.

Cat. 1
This course introduces the student to the fundamental concepts of programming languages, models of programming languages, and the basic concepts of language translation.
Topics include syntactic structure, binding, scope, parameter passing, control structures, and run-time environments. Different programming paradigms will be examined to illustrate these principles.
Students will be expected to acquire competence in functional programming.
Intended audience: computer science and computer engineering students, and those desiring a deeper understanding of computer programming.
Recommended background: CS 2005.

CS 2136. PARADIGMS OF COMPUTATION.

Cat. 1
This course introduces students to advanced concepts in computational systems and programming languages and builds upon the functional approach to programming acquired in CS 2135.
Topics covered include object-oriented programming, logic programming, stream programming, and parallel systems and programming.
Students will be expected to write programs in object-oriented and logic-based programming languages.
Intended audience: computer science and computer engineering students, and those desiring a deeper understanding of advanced computational paradigms.
Recommended background: CS 2135.

CS 2223. ALGORITHMS.

Cat. 1
Building on a fundamental knowledge of data structures, data abstraction techniques, and mathematical tools, a number of examples of algorithm design and analysis, worst case and average case, will be developed.
Topics include greedy algorithms, divide-and-conquer, dynamic programming, heuristics, and probabilistic algorithms. Problems will be drawn from areas such as sorting, graph theory, and string processing. The influence of the computational model on algorithm design will be discussed.
Students will be expected to perform analysis on a variety of algorithms.
Intended audience: computer science and computer engineering students, and those desiring a deeper understanding of algorithm design and analysis.
Undergraduate credit may not be earned both for this course and for CS 507.
Recommended background: CS 2005 and CS 2022.

CS 3013. OPERATING SYSTEMS.

Cat. 1
This course provides the student with an understanding of the basic components of a general-purpose operating system.
Topics include processes, process management, synchronization, input/output devices and their programming, interrupts, memory management, resource allocation, and an introduction to file systems.
Students will be expected to design and implement a large piece of system software.
Intended audience: computer science majors and others interested in studying the software and hardware components of computer systems.
Undergraduate credit may not be earned both for this course and for CS 502.

CS 3041. HUMAN-COMPUTER INTERACTION.

Cat. 1
This course develops in the student an understanding of the nature and importance of problems concerning the efficiency and effectiveness of human interaction with computer-based systems.
Topics include the design and evaluation of interactive computer systems, basic psychological considerations of interaction, interactive language design, interactive hardware design, and special input/output techniques.
Students will be expected to complete two projects. A project might be a software evaluation, interface development, or an experiment.
Intended audience: computer science majors, especially juniors.
Recommended background: CS 2005.
CS 3043. SOCIAL IMPLICATIONS OF INFORMATION PROCESSING.
Cat. I
This course makes the student aware of the social, moral, ethical, and philosophical impact of computers and computer-based systems on society, both now and in the future. Topics include major computer-based applications and their impact, human-machine relationships, and the major problems of controlling the use of computers. Students will be expected to contribute to classroom discussions and to complete a number of writing assignments.
Intended audience: students interested in the impact of a computer-oriented technology on his or her future way of life and well-being. This course is highly recommended for juniors.
Undergraduate credit may not be earned both for this course and for CS 505.
Recommended background: a general knowledge of computers and computer systems.

CS 3133. FOUNDATIONS OF COMPUTER SCIENCE.
Cat. I
This course introduces the theoretical foundations of computer science. These form the basis for a more complete understanding of the proficiency in computer science.
Topics include computational models, formal languages, and an introduction to compatibility and complexity theory, including NP-completeness.
Students will be expected to complete a variety of exercises and proofs.
Intended audience: computer science majors and others desiring an understanding of the theoretical foundations of computer science.
Undergraduate credit may not be earned both for this course and for CS 503.
Recommended Background: CS 2022 and CS 2223.
Students who have credit for CS 4121 cannot receive credit for CS 3133.
Students graduating under the pre-1996 distribution requirements may satisfy the Theory area requirement by taking this course, although it does not count as a 4000-level course.

CS 3431. DATABASE SYSTEMS I.
Cat. I
This course introduces the student to the design, use, and application of database management systems.
Topics include the relational data model, relational query languages, design theory, and conceptual data design and modeling for relational database design. Techniques that provide for data independence, and minimal redundancy will be discussed.
Outcome: Students will be expected to design and implement database system applications.
Intended audience: computer science majors and others interested in studying the development of software applications with large data management requirements.
Undergraduate credit may not be earned both for this course and for CS 4431 or CS 542.
Recommended background: CS 2005 and CS 2022.

CS 3733. SOFTWARE ENGINEERING.
Cat. I
This course introduces software design topics pertinent to the waterfall life cycle model.
Topics include requirements analysis and specification, architectural design, module testing, and system integration.
Student groups will be expected to specify, design, partially implement and test a project.
Intended audience: computer science majors and others who expect to design software systems. This course should be taken before any course requiring a large programming project.
Undergraduate credit may not be earned both for this course and for CS 509.
Recommended background: CS 2005.

CS 4032/MA 3527. NUMERICAL METHODS FOR LINEAR AND NONLINEAR SYSTEMS.
Cat. I
This course provides an introduction to modern computational methods for linear and nonlinear equations and systems and their applications.
Topics covered include: solution of nonlinear scalar equations, direct and iterative algorithms for the solution of systems of linear equations, solution of nonlinear systems, the eigenvalue problem for matrices. Error analysis will be emphasized throughout.
Recommended background: MA 2071. An ability to write computer programs in a scientific language is assumed.

CS 4033/MA 3457. NUMERICAL METHODS FOR CALCULUS AND DIFFERENTIAL EQUATIONS.
Cat. I
This course provides an introduction to modern computational methods for differential and integral calculus and differential equations.
Topics covered include: interpolation and polynomial approximation, approximation theory, numerical differentiation and integration, numerical solutions of ordinary differential equations. Error analysis will be emphasized throughout.
Recommended background: MA 2051. An ability to write computer programs in a scientific language is assumed. Undergraduate credit may not be earned for both this course and for MA 3255/CS 4031.

CS 4120. ANALYSIS OF ALGORITHMS.
Cat. II
This course develops the skill of analyzing the behavior of algorithms.
Topics include the analysis, with respect to average and worst case behavior and correctness, of algorithms for internal sorting, pattern matching on strings, graph algorithms, and methods such as recursion elimination, dynamic programming, and program profiling.
Students will be expected to write and analyze programs.
Intended audience: computer science majors.
Undergraduate credit may not be earned both for this course and for CS 504.
Recommended background: CS 2223 and some knowledge of probability.
This course will be offered in 2002-03 and in alternate years thereafter.

CS 4123. THEORY OF COMPUTATION.
Cat. II
Building on the theoretical foundations from CS 3133, this course addresses the fundamental question of what it means to be "computable," including different characterization of computable sets and functions.
Topics include the halting program, the Church-Turing thesis, primitive recursive functions, recursive sets, recursively enumerable sets, NP-completeness, and reducibilities.
Students will be expected to complete a variety of exercises and proofs.
Intended audience: computer science majors and others desiring an understanding of the nature of computation.
Undergraduate credit may not be earned both for this course and for CS 553.
Recommended Background: CS 3133.
This course will be offered in 2003-04 and in alternate years thereafter.

CS 4233. OBJECT-ORIENTED ANALYSIS AND DESIGN.
Cat. II
This Software Engineering course will focus on the process of Object-Oriented Analysis and Design. Students will be expected to complete a large number of exercises in Domain Modeling, Use Case Analysis, and Object-Oriented Design. In addition, the course will investigate Design Patterns, which are elements of reusable object-oriented software designs. This course will survey a set of design patterns and consider how these patterns are described and used to solve design problems.
Recommended Background: CS 3733.
This course will be offered in 2002-03 and in alternate years thereafter.

CS 4241. WEBWARE: COMPUTATIONAL TECHNOLOGY FOR NETWORK INFORMATION SYSTEMS.
Cat. I
This course explores the computational aspects of network information systems as embodied by the World Wide Web (WWW). Topics include: languages for document design, programming languages for executable content, scripting languages, design of WWW based human/computer interfaces, client/server network architecture models, high level network protocols (e.g., http), WWW network resource discovery and network security issues.
Students in this course will be expected to complete a substantial software project (e.g., Java based user interface, HTML/Cgi based information system, WWW search mechanisms, etc.).
Recommended background: CS 2005.
Suggested background: CS 2136 or CS 3041.

CS 4341. INTRODUCTION TO ARTIFICIAL INTELLIGENCE.
Cat. I
This course studies the problem of making computers act in ways which we call "intelligent".
Topics include major theories, tools and applications of artificial intelligence, aspects of knowledge representation, searching and planning, and natural language understanding.
Students will be expected to complete projects which express problems that require search in state spaces, and to propose appropriate methods for solving the problems.
Intended audience: computer science majors.
Undergraduate credit may not be earned both for this course and for CS 534.
Recommended background: CS 2136 and CS 2223.
Suggested background: CS 3133.

CS 4432. DATABASE SYSTEMS II.
Cat. II
This course concentrates on the study of the internals of database management systems.
Topics include: principles and theories of physical storage management, advanced query languages, query processing and optimization, index structures for relational databases, transaction processing, concurrency control, distributed databases, and database recovery, security, client server and transaction processing systems.
Outcome: Students may be expected to design and implement software components that make up modern database systems.
CS 4732. COMPUTER ANIMATION.
Cat. II
This course provides an in-depth examination of the algorithms, data structures, and techniques used in modeling and rendering dynamic scenes. Topics include animation hardware and software, parametric blending techniques, modeling physical and articulated objects, forward and inverse kinematics, key-frame, procedural, and behavioral animation, and free-form deformation.

Students will be expected to develop programs to implement low-level animation algorithms as well as use commercial animation tools to design and produce small to moderate sized animations.

Intended audience: computer science majors.
Recommended background: CS 4731.
This course will be offered in 2003-04 and in alternate years thereafter.

ELECTRICAL AND COMPUTER ENGINEERING

The second digit in electrical engineering course numbers is coded as follows:
0 — Circuits
1 — Fields
2 — Electronic Circuits and Systems
3 — Signals and Communication Systems
4 — Available for Future Use
5 — Machines, Power Systems
6 — Professional and Miscellaneous
7 — Projects, Laboratory, Independent Study
8 — Computers
9 — Electronic Devices

EE 2011. INTRODUCTION TO ELECTRICAL AND COMPUTER ENGINEERING.
Cat. I
The objective of this course is to expose new electrical engineering students (including first year students) to the broad field of electrical engineering, introducing basic concepts of circuits and systems and their applications. Experiments based on practical devices are used to reinforce basic concepts and develop laboratory skills, as well as to provide system-level understanding.

The use of circuit simulation tools for analysis and design is introduced.

EE 2022. INTRODUCTION TO DIGITAL CIRCUITS AND COMPUTER ENGINEERING.
Cat. I
The objective of this course is to expose students (including first year students) to basic electrical and mathematical concepts that underlie computer engineering while continuing an introduction to basic concepts of circuits and systems in a hands-on environment. Experiments representing practical devices introduce basic electrical engineering concepts and skills which typify the study and practice of electrical and computer engineering. In the laboratory, the students construct, troubleshoot, and test analog and digital circuits that they have designed. They will also be introduced to the nature of the interface between hardware and software in a typical microprocessor based computer.

Topics: Sets, functions, Boolean algebra, digital switching logic, the transistor as switch, circuit design of logic gates, design of combinational logic circuits, software and hardware interfacing including analog/digital and digital/analog conversion.

Recommended background: EE 2011 and MA 1022 (concurrent).

EE 2111. PHYSICAL PRINCIPLES OF ECE APPLICATIONS.
Cat. I
In this course students will learn the practical aspects of electromagnetics and their relation to basic DC and AC circuit theory.

The meaning of the electric and magnetic field concepts is explained and placed in context with capacitive and inductive circuits. Exploiting those concepts leads to a host of practical devices such as transformers, motors, and generators. In addition, measures to minimize the influence of stray electric and magnetic fields are analyzed as part of various shielding and grounding strategies.

The electric and magnetic circuit aspects are then presented as linear first order systems in the time and frequency domains. Issues such as time constants, impedance, and superposition are explained in detail. Building upon these basic concepts, second order systems consisting of mixed capacitive and inductive systems are analyzed in terms of their resonance effects. The second order system description will then be applied to develop the basic transmission line theory as required in high-speed digital design.

Recommended background: EE 2111, introductory physics courses such as PH 1120 or PH 1121, MA 1024, MA 2051 (concurrent).
EE 2112. ELECTROMAGNETIC FIELDS.

Cat. I

The object of this course is a comprehensive treatment of electromagnetic engineering principles covering the entire application spectrum from static to dynamic field phenomena.

The starting point will be the basic electric and magnetic field definitions of Coulomb and Biot-Savart leading to Gauss’s and Ampere’s laws. They form the foundation of the electro- and magnetostatics fields. Students will examine capacitive and inductive systems and relate them to lumped element circuit models. By introducing temporal and spatial magnetic flux variations, Faraday’s law is established. The engineering implications of this law are investigated in terms of transformer and motor actions. Incorporation of the displacement current density into Ampere’s law and combining it with Faraday’s law will then culminate in the complete set of Maxwell’s field equations. As a result of these equations, students will develop the concept of wave propagation in the time and frequency domain with practical applications such as wireless communication, radar, global positioning systems, and microwave circuits.

Recommended background: EE 2111.

EE 2201. MICROELECTRONIC CIRCUITS I.

Cat. I

This course is the first of a two-course sequence in electronic circuit design. It begins with a substantive treatment of the fundamental behavior of semiconductor materials and moves on to the semiconductor diode, the bipolar transistor, and the field-effect transistor. Laboratory exercises are provided to reinforce the theory of operation of these devices. Numerous circuit applications are considered, including: power supplies, transistor amplifiers, and FET switches.

Topics include: the junction, diode operation, transducers, rectification, voltage regulation, limiting and clamping circuits, transistor operation, biasing, small-signal and large-signal models, transistors amplifiers, and switching applications.

Recommended background: EE 2201.

EE 2311. CONTINUOUS-TIME SIGNAL AND SYSTEM ANALYSIS.

Cat. I-A

This course provides an introduction to time and frequency domain analysis of continuous time signals and linear systems. Topics include signal characteristics and operations; singularity functions; impulse response and convolution; Fourier series; the Fourier transform and its applications; frequency-domain characterization of linear, time-invariant systems such as filters; and the Laplace transform and its applications.

Recommended background: EE 2011, MA 1022.

Suggested background: MA 2051.

EE 2312. DISCRETE-TIME SIGNAL AND SYSTEM ANALYSIS.

Cat. I

This course provides an introduction to the time and frequency domain analysis of discrete-time signals and linear systems. Topics include sampling and quantization, characterization of discrete-time sequences, the discrete-time Fourier transform, the discrete Fourier transform and its applications, the Z transform and its applications, and the analysis and design of discrete-time filters. Projects include topics such as sampling and quantization; application of the DFT to signal and system analysis and design; and digital filter design and simulation.

Recommended background: EE 2311.

EE 2799. ELECTRICAL AND COMPUTER ENGINEERING DESIGN.

Cat. I

The goal of this course is to provide experience with the design of a system, component, or process. Basic sciences, mathematics, and engineering sciences are applied to convert resources to meet a stated objective. Fundamental steps of the design process are practiced, including the establishment of objectives and criteria, synthesis, analysis, manufacture, testing, and evaluation. Student work in small teams and are encouraged to use creativity to solve specific, open-ended problems, and then present their results.

EE 2799 is strongly recommended for all students as a preparation for the design element of the MQP. It is anticipated that EE 2799 will be of most benefit to students when taken well in advance of the MQP (late sophomore year or early junior year).

Recommended background: EE 2022, EE 2111, and EE 2311; and at least one of EE 2112, EE 2201, EE 2312, EE 2801.

EE 2801 FOUNDATIONS OF EMBEDDED COMPUTER SYSTEMS.

Cat. I

This course introduces the assembly language programming concepts that are needed to develop microprocessor and microcontroller-based computer systems. Beginning with the fundamentals of computer architecture and organization, students learn assembly language and how assembly language programs running on a microprocessor are used to solve problems between a computer and the physical world. Students in this course will also learn about the hardware and software structure of a modern computer system and how hardware, software, and the passage of time must be managed in an embedded system design. Other issues that will be addressed as appropriate include overall embedded system development, software maintenance, programming for reliability, and product safety.

Topics: Number systems, basic graph theory and directed graphs, software flow diagrams, models for system state and state transitions, microprocessor and microcontroller architecture and assembly language programming, program development and test tools, operating system interfaces, hardware/software dependencies, and time and resource management.

Recommended background: EE 2002 (for ECE students, CS 2011 is acceptable for CS students), MA 1022, and an introductory physics course such as PH 1110 or PH 1111.

EE 3131. INTRODUCTION TO RF CIRCUIT DESIGN.

Cat. I

This course is designed to provide students with the basic principles of radio frequency (RF) circuit design. It concentrates on topics such as designing tuning and matching networks for analog and digital communication, satellite navigation, and radar systems.

After reviewing equivalent circuit representations for RF diodes, transistors, FETs, and their input/output impedance behavior, the course examines the difference between lumped and distributed parameter systems. Characteristics impedance, standing waves, reflection coefficients, insertion loss, and group delay of RF circuits will be explained.

Within the context of Maxwell’s theory the course will then focus on the graphical display of the reflection coefficient (Smith Chart) and its importance in designing matching circuits. Students will learn the difference between SPICE and monolithic and microwave integrated circuit design, and design (MMICAD) modeling. Biasing and matching networks for single and multistage amplifiers in the 900 to 2,000 MHz range are analyzed and optimized in terms of input/output impedance matching, insertion loss, and groups delays.

Recommended background: EE 2111, EE 3204.

Suggested background: EE 2112.

EE 3204. MICROELECTRONIC CIRCUITS II.

Cat. I

This course is the second of a two-course sequence in electronic circuit design. More complex circuits are analyzed and the effects of frequency and feedback are considered in detail. The course provides a comprehensive treatment of operational amplifier operation and limitations. The use of Bode plots to describe the amplitude and phase performance of circuits as a function of operating frequency is also presented.

In addition, the concepts of analog signal sampling, analog-to-digital conversion and digital-to-analog conversion are presented along with techniques for interfacing analog and digital circuits. Laboratory exercises are provided to reinforce student facility with the application of these concepts to the design of practical circuits.

Topics include: transducers; differential amplifiers, inverting/non-inverting amplifiers, summers, differentiators, integrators, passive and active filters, the Schmitt trigger, monostable and a-stable oscillators, timers, sample-and-hold circuits, A/D converters, and D/A converters.

Recommended background: Introductory electronic-circuit design and analog-signal analysis as found in EE 2201 and EE 2311.

EE 3305. AEROSPACE AVIONICS SYSTEMS.

Cat. I

This course is intended for students interested in obtaining a systems-level perspective of modern aerospace communications, navigation, and radar systems. The fundamental theory of operation of these systems is presented along with current-day applications of them.

Topics: The functional operating principles and techniques of communications, navigation (including GPS) and radar systems; performance expectations for antenna, transmitter, receiver, and transmission-line components; error sources and their effect in combination on both individual component and system-level system performance; earth-shape approximations and their influence on system design and operation; tropospheric and ionospheric effects of radio-wave propagation; and achievable overall system accuracies.

Recommended background: MA 1022 and PH 1120 or equivalent, and EE 2311. With extra work, this course can be successfully completed by non-EE students. The basic concepts of electromagnetic-wave propagation and antennas will be introduced as needed.

EE 3306. AUDIO ENGINEERING.

Cat. I

Intended to provide an advanced student a thorough understanding of the theory and practice of electronic systems used for the recording and reproduction of speech and music, and of the nature and control of acoustic noise.


Recommended background: EE 2201, EE 2311, EE 3204 or equivalent.

EE 3311. PRINCIPLES OF COMMUNICATION.

Cat. I

This course provides an introduction to analog and digital communications systems. The bandpass transmission of analog data is motivated and typical systems are analyzed with respect to bandwidth considerations and implementation techniques. Baseband and passband digital transmission systems are introduced and investigated in detail and important criteria are developed in relation to the pulse rate transmission limits of bandlimited channels. Finally, digital carrier systems and line coding are introduced in conjunction with applications to modern modern transmission schemes.

Recommended background: EE 2311 and EE 2312.
EE 3501. ELECTRICAL ENERGY CONVERSION.
Cat. 1
This course is designed to provide a cohesive presentation of the principles of electrical energy conversion for industrial applications and design. The generation, transmission and conversion of electric energy, as well as basic instrumentation and equipment associated with electric energy flow and conversion are analyzed.
Recommended background: EE 2111.
EE 3503. POWER ELECTRONICS.
Cat. 1
This course is an introduction to analysis and design of power semiconductor circuits used in electric motor drives, control systems, robotics and power supply. Topics: characteristics of thyristors and power transistors. Steady-state performance and operating characteristics, device rating and protection, commutation, gating circuits, ac voltage controllers, controlled rectifiers, dc/dc converters and dc/ac inverters. Laboratory exercises.
Recommended background: EE 2201, EE 2311 or equivalent.
EE 3601. PRINCIPLES OF ELECTRICAL ENGINEERING.
Cat. 1
Intended for students other than electrical engineers, this course is oriented towards developing competence in electrical engineering concepts on the level that the technology interfaces directly with their own discipline. The course is designed specifically to help students meet that challenge through the development of a broad systems perspective and an understanding of the principal elements of electrical engineering technology. The expectation is that students completing the course will be able to handle adequately the electrical aspects of a broad range of application topics. In addition, and most important, they will be prepared to work effectively with electrical engineers on the joint solution of complex problems.
Topics covered during the course include: direct current (DC) circuit analysis and design, alternating current (AC) circuit analysis and design, circuit design using operational amplifiers, and electric machines and power systems. Selected laboratory projects are included to emphasize the direct application of the information presented in lectures.
Recommended background: MA 1021-1023, MA 2051, PH 1120/1121 or equivalent.
EE 3703. REAL-TIME DIGITAL SIGNAL PROCESSING
Cat. 1
This course provides a basic introduction to the principles of real-time digital signal processing (DSP). Topics include: structural analysis of real-time systems, design of real-time DSP architectures, sampling and quantization of continuous time signals, design and implementation of FIR and IIR digital filters, and theory and application of the Fast Fourier Transform (FFT). The emphasis of the course is on the design and implementation of DSP algorithms. The algorithms are implemented on personal, portable DSP boards that the students can either program in the lab or purchase for use on their home computers. This course features an interactive studio format with mini-lectures and labs integrated into two-hour sessions. This format allows the students to try out the algorithms and methods shown in class immediately, with the instructor nearby to lend assistance and advice.
Recommended background: EE 2312, EE 2801, CS 1005 or equivalent.
EE 3801. ADVANCED LOGIC DESIGN.
Cat. 1
This course introduces students to the design of the complex logic systems underlying or supporting the operation of computer systems and interfaces. Students learn how to use advanced computer-aided design tools to develop and simulate logic systems consisting of MSI components such as adders, multiplexers, latches, and counters. The concept of synchronous logic is introduced through the design and implementation of Mealy and Moore machines. Students will also learn how to use programmable logic devices to implement customized designs.
Topics: Review of logic gates and design and simplification of combinational circuits. Arithmetic circuits, MSI devices, analysis and design of sequential circuits, synchronous state machines and programmable logic.
Lab exercises: Design, analysis and construction of combinational and sequential circuits, use of computer-aided engineering software for schematic entry and digital analysis, introduction to hardware description languages and programmable logic devices.
Recommended background: EE 2022 (for ECE students) or CS 2111.
EE 3803. MICROPROCESSOR SYSTEM DESIGN (FORMERLY INTRODUCTION TO MICROPROCESSOR SYSTEMS).
Cat. 1
This course builds on the computer architecture material presented in EE 2801. It covers the architecture, organization and instruction set of simple 16-bit microprocessors. The interface to memory (RAM and EPROM) and I/O peripherals is described with reference to bus cycles, bus timing, and address decoding. Emphasis is placed on the design, programming and implementation of interfaces to microprocessor systems.
Topics: bus timing analysis, memory devices and systems, IO and control signaling, bi-directional bus interfaces, instruction execution cycles, interrupts and polling, addressing, programmable peripheral devices, interface design issues.
Laboratory exercises: Use of the PC and BIOS/DOS for program design exercises. Use of the PC ISA bus for advanced IO design and programming, advanced use of BIOS/DOS and mixed language programming, standard bus timing, and interface design and implementation.
Recommended background: EE 2801 and EE 3801 or an equivalent background in advanced logic design, microprocessor architecture, and programming.
EE 3815. DIGITAL SYSTEM DESIGN WITH VHDL.
Cat. 1
This is an introductory course on the use of VHDL for the design, synthesis, modeling, and testing of VLSI devices. VHDL is an IEEE standard that is used by engineers to efficiently design and analyze complex digital designs. The course will show how to write VHDL models that can be automatically synthesized into integrated circuits such as FPGAs (Field Programmable Gate Arrays).
Topics include: hardware description languages, VHDL, system modeling and synthesis of digital circuits, VLSI, field programmable gate arrays, simulation and testing.
Laboratory Exercises: Exercises will include writing VHDL models of combinational and sequential circuits, synthesizing these models to FPGAs by automatic place and route, simulating the design, and developing and writing test benches in VHDL.
Recommended background: EE 3801 and experience with programming in a high-level language such as C (CS 1005 and/or CS 2005) or Pascal.
EE 3901. SEMICONDUCTOR DEVICES.
Cat. 1
The purpose of this course is to introduce students to the physics of semiconductor devices and to show how semiconductor devices operate in typical linear and nonlinear circuit applications. This material complements the electronics sequences of courses and will develop illustrative examples of electronic circuit applications from other courses.
Topics: Carrier transport processes in semiconductor materials. Carrier life-time. Theory of p-n junctions. Bipolar transistors internal theory, dc characteristics, charge control, Ebers-Moll relations; high frequency and switching characteristics, hybrid-pi model; n- and p-channel MOSFETs, CMOS.
Recommended background: EE 2201.
EE 3902. INTRODUCTION TO VLSI DESIGN.
Cat. 1
This course provides an introduction to the fundamental principles of VLSI circuit design. Emphasis is placed on the design of basic building blocks of large-scale digital integrated circuits and systems, where students will acquire hands-on design experience using a professional design platform.
Topics: Overview of VLSI fabrication technology, basic CMOS digital circuits, transistor-level and mask-level design, complex logic gates, modular building blocks, adder arrays, serial and parallel multipliers, data path components, register arrays, clock signal generation and distribution, timing, ASIC design guidelines, system integration, IC testing and testable design strategies.
Laboratory exercises will concentrate on designing full-custom digital building blocks, integrating the modules into functional chip designs, and standard-cell based ASIC design flow.
Recommended background: EE 3801. Suggested background: EE 3901.
EE 4304. COMMUNICATION SYSTEMS ENGINEERING.
Cat. 1
This course introduces the theory and performance analysis of communication in noise. The mathematical treatment of noise as a random process is developed in the context of baseband and passband transmission systems. The performance of analog transmission systems is developed and the tradeoff between bandwidth and performance is examined. The optimum PCM receiver is derived and introduces the general concept of decision theory and signal space representation of decision systems. A treatment of coding theory for error detection, correction and compression leads to the development of Shannon’s information theory and the ultimate performance of digital transmission systems. Finally, concepts that underly modern digital data computer network systems are introduced.
Recommended background: EE 3311 and MA 3613.
EE 4502. ANALYSIS OF LARGE SCALE ELECTRIC POWER SYSTEMS.
ISP
This course is designed to provide an introduction to network analysis and optimization techniques that are used in operation and planning for electric power systems.
Students may not receive credit for both EE 4501 and EE 4502.
Recommended background: EE 3501.
EE 4801. ADVANCED COMPUTER SYSTEM DESIGN.
Cat. I
This course continues the development of microprocessor and microcontroller-based systems. This course focuses on the design of standalone embedded and high-performance microprocessor systems. Students are introduced to advanced concepts in microprocessor architecture and will design, implement, and program a complete embedded computer system. The importance of designing a system suitable for production will be covered, including issues such as Design for Manufacture (DFM), design for test, reliability, and regulatory compliance including product safety.
Topics: advanced microprocessor architecture, microprocessor timing, hardwares, embedded systems, interrupts, DMA, CACHE and memory system controllers, real-time system design issues, high-performance system and peripheral buses, DFM, reliability.
Laboratory exercises: Design of a complete, standalone microcontroller based-system, mixed language programming, embedded system debugging, design of systems with real-time requirements.
Recommended background: EE 3903 or equivalent.

EE 4902. ANALOG INTEGRATED CIRCUIT DESIGN.
Cat. I
This course introduces students to the design and analysis of analog integrated circuits such as operational amplifiers, phase-locked loops, and analog multipliers.
Recommended background: familiarity with the analysis of linear circuits and with the theory of bipolar and MOSFET transistors. Such skills are typically acquired in EE 3204.
Suggested background: EE 3901 and EE 3902.

ENGINEERING SCIENCE INTERDISCIPLINARY

ES 1020. INTRODUCTION TO ENGINEERING.
Cat. I
This course is designed for first-year students. Teams of students are assigned several engineering projects of the type typically encountered early in an engineering career. The projects generally involve engineering design concepts, mathematics and physics, such as Newton’s Laws of Motion and Kirchhoff’s Laws. Students will learn to use a general strategy for solving engineering problems. Software for creating technical drawings, plotting data, report writing and equation solvers for performing calculations will be introduced. This course does not require any prior engineering background.
Note: This course can be used towards the Engineering Science and Design distribution requirement in IE, ME and MFE.

ES 1310. INTRODUCTION TO COMPUTER AIDED DESIGN.
Cat. I
This basic course in engineering graphical communications provides a background for all engineering disciplines. The ability to create and interpret standard, well-integrated detail and assembly drawings is a necessity for engineers to communicate ideas. Computer Aided Design software will be used as a tool for creating these engineering design drawings. Multiview and pictorial graph- ics techniques are integrated with standards for dimensioning, sectioning, and generating detailed engineering drawings. Emphasis is placed on relating drawings to the required manufacturing processes. The design process and aids to creativity are combined with graphics procedures to incorporate functional design requirements in the geometric model.
No prior engineering graphics or software knowledge is assumed.

ES 2001. INTRODUCTION TO MATERIAL SCIENCE.
Cat. I
A beginning course in understanding the structures and properties of metals, ceramics and plastics, in the selection and in the working and heat treating of materials. A course of interest to any engineer, scientist or person involved with materials. The underlying fundamental theme of materials science is structure-property relationship. Structures covered range from the subatomic, or nuclear level, through the microscopic world to the macroscopic, or gross point of view. Properties investigated may be chemical, mechanical, thermal, nuclear, electrical or optical. The selection, working and thermal treatments of materials are also related to structural changes and thus property alterations. No formal laboratory. Appropriate background for the student to experiment with the fundamentals presented on a voluntary basis.
Recommended background: prior knowledge of college-level chemistry.

ES 2011. INTRODUCTION TO NUCLEAR TECHNOLOGY.
Cat. II
Overview of the basic phenomena which form the foundation of the field of nuclear engineering, including radiotope production and utilization, and controlled chain reactions. Familiarization with nuclear laboratory techniques and instrumentation is emphasized.
Topics covered include: structure of the atom and nucleus, decay laws, properties of decay emanations, and nuclear interactions.
Recommended background: Differential and Integral Calculus (MA 1022).

ES 2501. INTRODUCTION TO STATIC SYSTEMS.
Cat. I
This is an introductory course in the engineering mechanics sequence that serves as a foundation for other courses in mechanical engineering. In this course, students will learn to solve for forces and couples in systems that are not accelerating and which are statically determinate. They will also learn to draw shear and bending moment diagrams for beams and how to calculate the central and the moment of inertia for areas.
This course qualifies as one of the three courses that mechanical engineering students must complete in the mechanical systems stem.
Topics normally covered include: forces, moments of forces and couples; free body diagrams; equilibrium; friction; distributed loadings; pin trusses; beams and beam loading; suspended cables; first and second moment of area. Force analysis of submerged bodies is addressed in this course.
Recommended background: Differential and Integral Calculus (MA 1022) and elementary vector algebra.

ES 2502. STRESS ANALYSIS.
Cat. I
The first course in engineering mechanics that addresses stress analysis of mechanical and structural elements.
Topics covered include: stresses, strains and deformations in bars, beams, and torsional elements; principal stresses, transverse shear stresses, buckling.
Recommended background: Statistics (ES 2501) and elementary vector algebra.

ES 2503. INTRODUCTION TO DYNAMIC SYSTEMS.
Cat. I
Engineers should be able to formulate and solve problems that involve forces that act on bodies which are moving. This course deals with the kinematics and dynamics of particles and rigid bodies which move in a plane.
Topics covered include: kinematics of particles and rigid bodies, equations of motion, work-energy methods, and impulse and momentum. In this course a basic introduction to mechanical vibration is also discussed. Basic equations will be developed with respect to translating and rotating coordinate systems.
Recommended background: Statistics (ES 2501 or CE 2000).

ES 3001. INTRODUCTION TO THERMODYNAMICS.
Cat. I
This course emphasizes system and control volume modeling using the First and Second Laws of Thermodynamics.
Topics include: properties of simple substances, an introduction to availability, cycle analysis.

ES 3002. MASS TRANSFER.
Cat. I
This course introduces the student to the phenomena of diffusion and mass transfer. These occur in processes during which a change in chemical composition of one or more phases occurs. Diffusion and mass transfer can take place in living systems, in the environment, and in chemical processes. This course will show how to handle quantitative calculations involving diffusion and/or mass transfer, including design of process equipment.
Topics may include: fundamentals of diffusional transport, diffusion in thin films; unsteady diffusion; diffusion in solids; convective mass transfer; dispersion; transport in membranes; diffusion with chemical reaction; simultaneous heat and mass transfer; selected mass transfer operations such as absorption, drying, humidification, extraction, crystallization, adsorption, etc.
Recommended background: fundamentals of chemical thermodynamics, fluid flow and heat transfer; ordinary differential equations (MA 2051 or equivalent).

ES 3003. HEAT TRANSFER.
Cat. I
To provide an understanding of fundamental concepts of heat fluxes, to develop understanding of the coupling of fluid mechanics and thermodynamics, and to provide experience in modeling engineering systems and predicting their behavior.
Recommended background: Ordinary Differential Equations (MA 2051).

ES 3004. FLUID MECHANICS.
Cat. I
A study of the fundamental laws of statics, kinematics and dynamics applied to fluid mechanics. The course will include fluid properties, conservation of mass, momentum and energy as applied to real and ideal fluids. laminar and turbulent flow, fluid resistance and basic boundary layer theory will also be included.
Recommended background: basic physics, basic differential equations and vectors; third year students.
ES 3011. CONTROL ENGINEERING I.
Cat. I

This sequence of courses in the field of control engineering (ES 3011 and ES 4012) is generally available to all juniors and seniors regardless of department. A good background in mathematics is required. Familiarity with Laplace transforms, complex variables and matrices is desirable but not mandatory. All students taking Control Engineering I should have an understanding of ordinary differential equations (MA 2051, or equivalent), and basic physics through electricity and magnetism (PH 1120/1121). Control Engineering I may be considered a terminal course, or it may be the first course for those students wishing to do extensive work in this field. Students taking the sequence of two courses will be prepared for graduate work in the field.

Recommended background: Ordinary Differential Equations (MA 2051) and Electricity and Magnetism (PH 1120, PH 1121).

ES 3323. ADVANCED COMPUTER AIDED DESIGN.
Cat. I
This course exposes the student to computer aided engineering design and geometric modeling using Unix based graphic workstations. The use of geometric models for applications in computer aided mechanical design, engineering analysis and manufacturing is emphasized. Topics may include mechanical design, solid and feature based modeling, variational and parametric design, physical properties, assembly modeling, numerical control, mechanisms, and other analytical methods in engineering design.

Recommended background: familiarity with drafting standards (ES 1310), mechanical systems (ES 2501 or CE 2000, ES 2503) and kinematics (ME 3310) is assumed. Additional background in strength of materials (ES 2502 or CE 2001), machine design (ME 3200, ME 3202), machining and manufacturing methods (ME 1800) and higher level programming capability (CS 1001 or CS 1005) is helpful.

FIRE PROTECTION ENGINEERING

FP 3070. FUNDAMENTALS OF FIRESAFETY ANALYSIS.
Cat. I
This course introduces students of different technical disciplines to analytical methods and techniques to address problems of fire, explosions, or hazardous incidents. Emphasis will be placed on understanding the physical concepts of the problem and their interactions. Quantification will adapt existing procedures to appropriate levels of theoretical and empirical methods in the field of fire science and engineering. Computer applications will be incorporated.

Recommended background: mathematics through differential equations; engineering science; fluid mechanics.

Graduate Fire Protection Engineering Courses of Interest to Undergraduates

FPE 510. FLAMMABILITY TESTS, CODES AND STANDARDS.
Cat. I
Code-related fire test standards will be presented at a level appropriate for fire protection engineers in a format which includes background on perceived need to regulate, analysis of the value and limitation of test methodology and effectiveness of code requirements to control combustible materials and mitigate particular fire hazards.

Fire test standards selected for discussion provide data and results which relate to surface flaming, flame spread, smoke obscuration, toxic potency of combustion products and rate of heat release for products and systems including interior finish, wall and floor assemblies, thermal insulation, furniture, bedding and draperies.

FPE 520. FIRE MODELING.
Cat. II
(Prerequisite: FPE 521 or special permission of the instructor.) Advanced topics in fire dynamics, combustion and compartment fire behavior will be discussed within a framework of modeling fire and its effects. Topics include computer modeling of pre-flashover and post-flashover compartment fires, burning characteristics of polymers and other fuels, the effect of fire retardants, products of combustion generation, flame spread models, flame and ceiling jet models, and overall toxicity assessment. Some familiarity with computer programming is recommended.

Offered 2003-04 and alternating years thereafter.

FPE 521. FIRE DYNAMICS I.
Cat. I
(Prerequisites: Undergraduate chemistry, thermodynamics or physical chemistry, fluid mechanics and heat transfer.) This course introduces students to fundamentals of fire and combustion and is intended to serve as the first exposure to fire dynamics phenomena. The course includes fundamental topics in fire and combustion such as thermodynamics of combustion, fire chemistry, premixed and diffusion flames, solid and liquid burning, ignition, plumes and ceiling jets. These topics are then used to develop the basic for introducing compartment fire behavior, pre and post-flashover conditions and smoke movement.

FPE 533. FIRE PROTECTION SYSTEMS.
Cat. I
(Prerequisites: Undergraduate courses in chemistry, fluid mechanics and either thermodynamics or physical chemistry.) This course provides an introduction to automatically activated fire suppression and detection systems. A general overview is presented of relevant physical and chemical phenomena and commonly used hardware in automatic sprinkler, gaseous agent, foam and dry chemical systems. Typical contemporary installations and current installation and approval standards are reviewed.

FPE 554. ADVANCED FIRE SUPPRESSION.
Cat. II
(Prerequisite: FPE 553 or special permission of the instructor.) Advanced topics in suppression systems analysis and design are discussed with an aim toward developing a performance based understanding of suppression technology. Automatic sprinkler systems are covered from the standpoint of predicting actuation times, reviewing numerical methods for hydraulic analyses of pipe flow networks and understanding the phenomenon involved in water spray suppression. Special suppression systems are covered from the standpoint of two phase and non-Newtonian pipe flow and simulations of suppression agent discharge and mixing in an enclosure.

Offered 2002-03 and alternating years thereafter.

FPE 555. DETECTION, ALARM AND SMOKE CONTROL.
Cat. II
(Prerequisites: FPE 553. Also FPE 521 and FPE 571 which can be taken concurrently.) Principles of fire detection and using flame, heat and smoke detector technology are described. Fire alarm technology and the electrical interface with fire/smoke detectors are reviewed in the context of contemporary equipment and installation standards. Smoke control systems based on buoyancy and HVAC principles are studied in the context of building smoke control for survivability and safe egress. Offered 2002-03 and alternating years thereafter.

FPE 563 (MG 527). RISK MANAGEMENT.
Cat. I
Risk Management is highly interdisciplinary drawing upon systems engineering and managerial decision making and finance. The basics of risk management including hazard analysis, risk assessment, risk control and risk financing are covered. The course is self-contained and includes material from engineering economy, risk assessment and decision analysis. Group projects can draw from fire protection engineering, hazardous waste management and product liability. The projects serve to emphasize the importance of techniques for quantifying risk and the challenge of integrating risk assessment with managerial decision making.

FPE 565. FIRESAFETY ENGINEERING EVALUATION.
Cat. II
(Prerequisites: FPE 521, FPE 553 and FPE 570.) This course develops techniques to evaluate the fire safety performance of a variety of facilities of the built environment and to produce management plans for decision making. The framework for this course is a fire safety engineering method which decomposes the firesafety system into discrete elements that can be used for quantitative evaluation using a variety of fire protection engineering and fire science materials. Offered 2002-03 and alternating years thereafter.

FPE 570. BUILDING FIRESAFETY I.
Cat. I
This course focuses on the presentation of qualitative and quantitative means for firesafety analysis in buildings. Fire test methods, fire and building codes and standards of practice are reviewed in the context of a systematic review of firesafety in proposed and existing structures.

FPE 571. PERFORMANCE-BASED DESIGN.
Cat. I
(Prerequisites: FPE 553, FPE 521 and FPE 570 or special permission of instructor.) This course covers practical applications of fire protection engineering principles to the design of buildings. Both compartmented and non-compartmented buildings will be designed for criteria of life safety, property protection, continuity of operations, operational management and cost. Modern analytical tools as well as traditional codes and standards are utilized. Interaction with architects, code officials and an awareness of other factors in the building design process are incorporated through exercises and a design studio.
FPE 572. FAILURE ANALYSIS.  
Cat. I  
(Prerequisites: FPE 570, FPE 521 and FPE 553 or special permission of the instructor.) Development of fire investigation and reconstruction as a basis for evaluating, and improving firesafety law, use of standard test methods, warnings and safe product design. Application of course materials is developed through projects involving actual case studies.

FPE 573. INDUSTRIAL FIRE PROTECTION.  
Cat. I  
(Prerequisites: FPE 553, FPE 521 or special permission of instructor.) Principles of fire dynamics, heat transfer and thermodynamics are combined with a general knowledge of automatic detection and suppression systems to analyze fire protection requirements for generic industrial hazards. Topics covered include safe separation distances, plant layout, hazard isolation, smoke control, warehouse storage and flammable liquid processing and storage. Historical industrial fires influencing current practice on these topics are also discussed.

FPE 574 (CM 594). PROCESS SAFETY MANAGEMENT.  
Cat. I  
(Prerequisite: An undergraduate engineering or physical science background.) This course provides basic skills in state-of-the-art process safety management and hazard analysis techniques including Hazard and Operability Studies (HAZOP), Logic Trees, Failure Modes and Effects Analysis (FMEA) and Consequence Analysis. Both qualitative and quantitative evaluation methods will be utilized. Following a case study format, these techniques along with current regulatory requirements will be applied through class projects addressing environmental health, industrial hygiene, hazardous materials, fire or explosion hazard scenarios.

FPE 575. EXPLOSION PROTECTION.  
Cat. II  
Principles of combustion explosions are taught along with explosion hazard and protection applications. Topics include a review of flammability limit concentrations for flammable gases and dusts; thermochemical equilibrium calculations of adiabatic closed vessel deflagration pressures and detonation pressures and velocities; pressures development as a function of time for closed vessels and vented enclosures; the current status of explosion suppression technology; and vapor cloud explosion hazards.

Offered 2003-04 and alternating years thereafter.

FPE 580. SPECIAL PROBLEMS.  
Individual or group studies on any topic relating to fire protection may be selected by the student and approved by the faculty member who supervises the work.

FPE 581. SEMINAR.  
Reports on current advances in the various branches of fire protection.

FPE 587. FIRE SCIENCE LABORATORY.  
Cat. II  
(Prerequisite: FPE 521.) This course provides overall instruction and hands-on experience with fire science related experimental measurement techniques. The objective is to expose students to laboratory-scale fire experiments, standard fire tests and state-of-the-art measurement techniques. The Lateral Ignition and Flame Transport (LIFT) apparatus, state-of-the-art smoke detection systems, closed-up flashpoint tests and gas analyzers are among the existing laboratory apparatus. Fire related measurement techniques for temperature, pressure, flow and velocity, gas species and heat fluxes, infrared thermometry, Laser Doppler Velocimetry (LVD) and Laser Induced Fluorescence (LIF) will be reviewed.

Offered 2002-03 and alternating years thereafter.

FPE 590. M. S. THESIS.  
FPE 592. GRADUATE PROJECT.  
This activity requires the student to demonstrate the capability to integrate advanced firesafety science and engineering concepts into the professional practice environment. The work may be accomplished by individuals or small groups of students working on the same project. This practicum requires the student to prepare detailed, written technical reports and make oral presentations to communicate the results of their work.

FPE 690. PH.D. DISSERTATION.
English

EN 1221. INTRODUCTION TO DRAMA: THEATRE ON THE PAGE AND ON THE STAGE.
Cat. I
This course introduces the student to the art of drama, the styles of theatre performance and production, and the emergence of new forms and styles. Types of drama studied include Greek Tragedy and Comedy, Roman Comedy, Cycles and Pageants of the Middle Ages, Shakespeare, Restoration, Romanticism, Neo-Classicism, French Comedy, Realism, Naturalism, and the eclectic forms in the Twentieth Century. Discussions, research and writing projects, and performance activities will offer the student experience in the theory and practice studied in the course.

EN 1222. SHAKESPEARE IN THE AGE OF ELIZABETH.
Cat. I
This course is an introduction to Shakespeare, his theatre, and some important concepts of his world. Students will have the opportunity to sample representative Shakespearean tragedies, comedies, and histories. In addition to class discussions and scene work, students will be able to enhance their readings by analyzing video recordings of the plays.

EN 1231. AMERICAN LITERATURE: BEGINNINGS THROUGH HAWTHORNE.
Cat. I
This survey course covers American literature from its beginnings in the colonial period through the works of Nathaniel Hawthorne in the early nineteenth century. Students will read literary works in a variety of genres (narratives, poems, sermons, plays, stories, and novels) that reflect the emerging nation’s struggle for cultural self-definition. Topics will include the literature of travel and discovery, the faith of the colonial founders, the quest for a distinctive national literature, and the rise of early American fiction.

EN 1242. INTRODUCTION TO ENGLISH POETRY.
Cat. I
This course surveys the poems of our language. From the Anglo-Saxon poems to the popular verse of Tennyson, the songs and the poets are legion: Chaucer, Spenser, Marlowe, Shakespeare, Jonson, Donne, Herrick, Milton, Blake, Wordsworth, Coleridge, Byron, Keats, Tennyson, Browning, and Hopkins. The England that nourished these writers will be viewed through their ballads, lyrics, sonnets, epigrams, and epics. “Not marble nor the gilded monuments of princes shall outlive this powerful rhyme.”

EN 1251. INTRODUCTION TO LITERATURE.
Cat. I
This course introduces the student to a variety of critical perspectives necessary to an understanding and appreciation of the major forms, or genres, of literary expression (e.g., novel, short story, poetry, drama, and essay). Writing and class discussion will be integral parts of this course.

EN 1257. INTRODUCTION TO AFRICAN AMERICAN LITERATURE AND CULTURE.
Cat. II
This course examines the formation and history of the African American literary tradition from slave narratives to contemporary forms in black popular culture. The course will explore some genres of African American writing and their relation to African American literature and to black cultural expression.

EN/WR 2211. ELEMENTS OF WRITING.
Cat. I
This course is designed for students who wish to work intensively on their writing. The course will emphasize the processes of composing and revising, the rhetorical strategies of expository prose, and the interaction between writer and audience. In a workshop setting, students will write a sequence of short papers and complete one longer writing project. Learn to read critically and respond helpfully to each other’s writing, and make oral presentations from written texts.

EN 2221. AMERICAN DRAMA.
Cat. I
An investigation into the development of American drama from its beginnings to the present. The history of the emergence of the legitimate theatre in this country will be followed by reading important plays, including the works of O’Neill, Williams, Mamet, Norman, Henley, and others. Discussion of the growth of regional theatres and their importance to the continuation of theatre as a serious and non-profit art form will be included in the course. The student will investigate the importance of theatre practice in the evolution of the dramatic literature of the country.

EN 2222. THEATRE WORKSHOP.
Cat. I
A workshop course which offers the student the opportunity to explore theatre through creative involvement with playwrighting, design, performance, production, and criticism. Students will work in a laboratory situation functioning as a micro-professional theatre which could develop a production that would be staffed and dramaturged from the group.

EN 2223. SHAKESPEARE: THE UNTUNED STRING.
Cat. II
A study of the political and moral conflicts in such plays as Hamlet, King Lear and Richard III. The course examines the chaos that results in a society lacking moral and political leadership.

EN 2224. SHAKESPEARE: NOTHING BUT LOVE.
Cat. II
In this course students will be asked to analyze the relationship between love and tragedy in such plays as Romeo and Juliet, Othello, and Antony and Cleopatra.

EN 2225. MODERN AMERICAN NOVEL.
Cat. I
This final survey course in American literature covers the modern and contemporary periods, from World War I to the present. The wide-ranging material includes selected works of fiction, drama, poetry, and essays by such writers as William Faulkner, Toni Morrison, Thornton Wilder, Sylvia Plath, Allen Ginsberg, Joy Harjo, and Michael Harper.

EN 2233. AMERICAN LITERATURE: MODERNISM TO THE PRESENT.
Cat. I
In this survey course, students will be introduced to the major trends in modernist literature, the influence of jazz and the Harlem Renaissance, and the emergence of new literary forms. The course will also cover the impact of World War I and the Jazz Age on American literature.

EN 2234. MODERN AMERICAN NOVEL.
Cat. II
Selected works of fiction which appeared after World War I will be the focus of this course. F. Scott Fitzgerald, Ernest Hemingway, William Faulkner, or other authors of the early modern period will be studied, but significant attention will also be given to contemporary novelists, such as Alice Walker and Kurt Vonnegut. The cultural context and philosophical assumptions of the novels will be studied as well as their form and technique.

EN 2235. THE AMERICAN DREAM: MYTH IN LITERATURE AND THE POPULAR IMAGINATION.
Cat. I
American writers from our beginnings have been preoccupied with “The American Dream” as a benchmark for measuring the attainment of our highest ideals as a people. The course examines the political, economic, religious, and cultural roots of the concept, assessing its popular and commercial manifestations, and explores the ironies, paradoxes, and ambiguities that have shaped this national self-image for almost 400 years. Readings include works by Puritan and Revolutionary writers, Native American leaders, Horatio Alger, Jr., William Dean Howells, F. Scott Fitzgerald, Martin Luther King, Jr., Adrienne Rich, Stads Terkel, and Archibald MaLeish.
EN 2237. AMERICAN LITERATURE AND THE ENVIRONMENT.
Cat. II
This course will examine the many ways in which American essayists, novelists, dramatists, and poets have responded to the natural world, and especially to ecological concerns voiced in contemporary times. Among the topics to be discussed in class and in papers are the changing attitudes towards the wilderness, the effects of technology on the environment, and the presence of the spiritual in nature. Readings may include works by such authors as Ernest Hemingway, Wendell Berry, Mary Oliver, Loren Eiseley, and Gary Snyder.
(Offered in 2002-03 and in alternate years thereafter.)

EN 2238. AMERICAN REALISM.
Cat. I
By examining authors who reacted against the so-called “gentleman tradition,” this course attempts to show how various subjects (death, sex, war, slum life and racial prejudice) were treated more honestly in short stories and novels after the Civil War. Authors may include Mark Twain, Stephen Crane, W. D. Howells, Edith Wharton, Kate Chopin, and Theodore Dreiser.
(Formerly EN 3236. Students who have received credit for this course may not receive credit for EN 2238.)

EN 2241. ENGLISH LITERATURE AFTER SHAKESPEARE.
Cat. II
Participants in this course will examine outstanding works of eighteenth- and nineteenth-century English literature as these works raise the question: Who is man, and what is his relationship to God, nature, and to his fellow creatures? Writers covered may include Swift, Pope, Keats, Browning, and Dickens. This course will be offered in 2002-03 and in alternate years thereafter.
(Formerly EN 3245.)

EN 2242. POPULAR FICTION: READING IN INSTALLMENTS.
Cat. I
Students in this course will have the opportunity to read two major masterpieces of English fiction the way they should be read: slowly, carefully, and with relish. Victorian novels are long and the term is short, but by reading novels in the way in which they were read by their original readers—serially—we can experience masterworks by Charles Dickens and George Eliot at comparative leisure, examining one serial installment per class session.

EN 2243. MODERN BRITISH LITERATURE.
Cat. II
A survey of major modern British authors. The works of many of these writers reflect the political, religious, and social issues of the twentieth century. New psychological insights run parallel with experiments in the use of myth, stream of consciousness, and symbolism. Authors studied may include Hardy, Conrad, Owen, Joyce, Lawrence, Woolf, Eliot, Yeats, and Orwell.
This course will be offered in 2003-04 and in alternate years thereafter.

EN 2251. MORAL ISSUES IN THE MODERN NOVEL.
Cat. I
This course focuses on the problem of how to live in the modern world. Emphasis will be placed on the way moral issues evolve within the complications of individual lives, as depicted in fiction. Such authors as Conrad, Kesey, Camus and Ellison show characters struggling with the questions of moral responsibility raised by love, religion, death, money, conformity.

EN 2252. SCIENCE AND SCIENTISTS IN MODERN LITERATURE.
Cat. I
This course surveys the ways in which modern literature has represented science and scientists. Beginning with Mary Shelley’s Frankenstein, the origin of what Isaac Asimov calls the “damned Frankenstein complex” is examined. More complex presentations of science and scientists occur in twentieth-century works like Broch’s Galileo, Huxley’s Brave New World, and Pirsig’s Zen and the Art of Motorcycle Maintenance.
The course covers major modern works of fiction and drama, including such literary forms as the play, the novel of ideas, and the utopian novel. Attention is focused on the themes (ideas) in, and the structure of, these works.

EN/WR 3011. PEER TUTORING IN WRITING.
Cat. I
Peer Tutoring in Writing introduced students to the theory and practice of composition. In this course, students research, read, and write about their own and others’ literacy practices. Through reading and writing assignments, peer reviews, interviews, presentations, and a tutoring internship in the CCAC, students hone their communication skills while increasing their ability to examine critically the role of communication in the production of knowledge.

EN/WR 3214. WRITING ABOUT DISEASE AND PUBLIC HEALTH.
Cat. I
This writing workshop focuses on the purposes and genres of writing about disease and public health. We will consider how biomedical writers communicate technical information about disease and public health to general audiences; how writers capture the human experience of disease and health care; how writers treat the public policy implications of disease; and how writers design publicity to promote public health. We will examine such genres as the experimental article, news reports, medical advice, profiles, commentary, and public health messages.
Recommended background: EN 2211 or equivalent writing courses. Students who have taken EN 3215 may not receive credit also for EN/WR 3214.

EN/WR 3216. WRITING IN THE PROFESSIONS.
Cat. I
Studies show that engineers spend 80-90% of their professional time engaged in various kinds of communication. This course emphasizes the management contexts of writing in the professions. Focus is on making informed decisions about approaches, styles, problems, issues, sources, strategies, and human-aspects of writing in business, industry, and other institutional settings. Special attention is given to business editing and proposal and grant writing.
Recommended background: EN 2211 or equivalent writing course.

EN/WR 3217. CREATIVE WRITING.
Cat. I
The purpose of this course is to help students develop or improve the skills of written expression. Small groups are formed in which participants present and discuss their original work in either fiction or poetry.

EN 3222. FORMS IN WORLD DRAMA.
Cat. II
The study of the major forms of world drama beginning with the Greeks and ending with contemporary forms. The student will develop the skills to analyze form and structure through dramatic content. The course may include the works of Sophocles, Euripides, Aristophanes, the Renaissance, the Restoration, Moliere, Ibsen, Strindberg, Shaw, Pirandello, and others.
This course will be offered in 2003-04 and in alternate years thereafter.

EN 3223. FORMS IN MODERN DRAMA.
Cat. II
The study of the forms of modern drama and their development from the forms of world drama. Contemporary playwrights studied could include Brecht, Bond, Schaeffer, Handke, and others, and the course will devote some concentration to theatre movements of the twentieth century that have operated with textual revision, minimal text, or no texts. Thus, theatre companies studied might include the work of the Living Theatre, the Open Theatre, and the theatre of Grodowsky and Brook.
This course will be offered in 2002-03 and in alternate years thereafter.

EN 3224. SHAKESPEARE SEMINAR.
Cat. II
This course would allow for the study of various Shakespearean topics in different years. Some representative subjects could include: “Shakespeare and the Arts,” “Shakespeare’s Contemporaries,” “Shakespeare and Science,” “Shakespearean Tragedy,” “Shakespeare’s Roman Plays,” “Shakespeare’s Histories,” “Shakespeare on Film.” The topics will be announced before the seminar meets.
This course will be offered in 2003-04 and in alternate years thereafter.

EN 3231. NEW ENGLAND SUPERNATURALISM.
Cat. II
From the colonial period to the 20th century, New England writers have endowed the region’s people and its settings (fields, forests, buildings, factories, cities) with shapes of fear. This course will explore New England’s fascination with the supernatural from Puritan writings to the contemporary tale of terror. A primary focus of the course will be the genre of New England Gothicism and its literary conventions. Authors studied may include Hawthorne, Longfellow, Whittier, Freeman, Wharton, Jackson, Lovecraft, and King.
(Offered in 2003-04 and in alternate years thereafter.)

EN 3232. THE CONCORD WRITERS.
Cat. II
Rural, mid-19th-century Concord, Massachusetts, witnessed an unprecedented flowering of important and influential American literature. Why Concord? We sample writings of Ralph Waldo Emerson, Henry D. Thoreau, Nathaniel Hawthorne, Bronson Alcott, and Louisa May Alcott to explore matters of cultural background, biography, contemporary events, uses of the past, literary vocation, and sense of place. Emphasis is on these writers’ friendships and their creative responses to intellectual and social forces of the day—factors that made Concord a community of highly individualistic writers.
(Offered in 2003-04 and in alternate years thereafter. Students who have received credit for EN 2236 (New England Writers: Concord) may not receive credit for EN 3232.)
EN 3233. WORCESTER BETWEEN THE COVERS: LOCAL WRITERS AND THEIR WORKS.
Cat. II
Worcester has had a rich and varied literary history from Isaiah Thomas’s founding of the American Antiquarian Society in the early 1800s to the works of S. N. Behrman, Robert Benchley, Elizabeth Bishop, Esther Forbes, Stanley Kunitz, and Charles Olson in the 20th century. This course will examine selections from Worcester area writers in a number of genres (e.g., fiction, drama, poetry, essay, nonfiction memoir). Attention will be given to the local contexts of these writings as well as to each writer’s contributions to the larger continuum of American Literature.
(Offers in 2002-03 and in alternate years thereafter. Students who have received credit for EN 2236 (New England Writers: Worcester) may not receive credit for EN 3233.)

EN 3234. MODERN AMERICAN POETRY.
Cat. II
This course is a study of selected American poets and their reactions to the ferment of the modern period. A thematic approach to poetry will be emphasized. Included in the course are modern poets such as Robert Frost, T. S. Eliot, E. E. Cummings, and Marianne Moore, as well as contemporary poets such as Rita Dove, Li-Young Lee, and Robert Pinsky.
This course will be offered in 2002-03 and in alternate years thereafter.
(Formerly EN 2323.)

EN 3237. PURSUING MOBY-DICK.
Cat. II
Since 1851, readers of Herman Melville’s masterpiece have joined in the chase for the “meaning” of the White Whale. After briefly examining the philosophical context of Emersonian idealism and the literary example of Hawthorne, the course is devoted solely to a close reading of Moby-Dick—one of the most innovative and mysterious novels in the English language. “Whose” book is it, anyway? Captain Ahab’s? Ishmael’s? The Whale’s? The reader’s? We conclude by surveying major critical approaches to the novel.
(Offers in 2002-03 and in alternate years thereafter.)

EN 3248. THE ENGLISH NOVEL.
Cat. I
Participants in this seminar will examine the English novel from its origins in the eighteenth century to its twentieth-century forms, exploring the rich variety of ways a writer may communicate a personal and social vision. The novels treat love, travel, humor, work, adventure, madness, and self-discovery; the novelists may include Fielding, Austen, Dickens, Eliot, Conrad, and Woolf.

EN ----. DRAMA/THEATRE PERFORMANCES.
TH: IS/P
One-sixth unit of credit will be awarded at the conclusion of two successive terms of participation. Performance activities currently receiving credit are:
TH 1225 Theatre Production Practicum
TH 2225 Acting
TH 2227 Advanced Acting
TH 2229 Advanced Theatre Production Practicum
TH 2225 Directing
TH 3227 Advanced Directing
TH 3229 Dramaturgy
TH 4225 Theatre Technology Design
TH 4227 Advanced Theatre Technology Design
TH 4229 Advanced Dramaturgy
Credit would be given on the condition that the performance takes place in a WPI performance directed or advised by a part- or full-time WPI instructor.
Note: A maximum of two one-sixth credits, or a total of one-third unit, may be applied toward the five courses, or five one-third units, taken prior to the final sufficiency term.

IS 1811. WRITING FOR NON-NATIVE SPEAKERS OF ENGLISH.
Cat. 1
This course offers, through conferences, tutorial sessions and extensive writing practice, a review of English composition principles for international students.
The following topics are included: the motivation of the writer; basic grammar; organization of the paragraph, sentence, and overall essay or report; vocabulary and word choice; spelling hints; and style. Much emphasis is given to the development of effective revising techniques. This is a course for those electing the “Basic Sufficiency for International Students.”

IS 1812. SPEECH FOR NON-NATIVE SPEAKERS OF ENGLISH.
Cat. I
This course focuses on developing international students’ ability to speak effectively, organize ideas logically, improve voice and diction, and use visual aids. Television and audiocassettes are used to record competence and poise. This is a course for those electing the “Basic Sufficiency for International Students.”

German

GN 1511. ELEMENTARY GERMAN I.
Cat. I
An intensive language course designed to teach concise expression of ideas in writing and speaking. Basic grammar and significant cultural aspects are introduced through the aid of readings, audio-recordings, video, and oral group interaction. (Formerly GN 2616.)

GN 1512. ELEMENTARY GERMAN II.
Cat. I
A continuation of Elementary German I.
Recommended background: GN 1511.

GN 2511. INTERMEDIATE GERMAN I.
Cat. I
A continuation of Elementary German II, with increased emphasis on oral and written expression. Basic textbook is supplemented by a collection of simple literary texts by the Grimm brothers, Brecht, and Bichsel.
Recommended background: Elementary German II.

GN 2512. INTERMEDIATE GERMAN II.
Cat. I
A continuation of Intermediate German I.
Recommended background: GN 2511.

GN 3511. ADVANCED GERMAN I.
Cat. I
Reading and in-class discussion of a wide variety of contemporary nonfictional and fictional texts. Some video viewing. Weekly brief writing assignments and continued expansion of vocabulary. Weekly vocabulary quiz. Review of grammar and introduction to advanced stylistic problems.
Recommended background: Intermediate German II.

GN 3512. ADVANCED GERMAN II.
Cat. I
A continuation of Advanced German I.
Recommended background: GN 3511.

GN 3513. SURVEY OF GERMAN CIVILIZATION AND CULTURE FROM 1571 TO THE PRESENT.
Cat. II
Conducted entirely in German, the course presents an overview of the development of modern Germany and its culture since the founding of the Second Empire. Background readings in German and English provide the basis for in-class discussion of selected authentic German texts of various kinds: literary works, official documents, political manifestos, letters, and diaries. At least one film will be shown. A number of recurring themes in German culture will inform the content of the course: authoritarianism versus liberalism, idealism versus practicality, private versus public life.
This course will be offered in 2002-03 and in alternate years thereafter.
Recommended background: BN 3511 (Advanced German I) and GN 3512 (Advanced German II) or equivalent.

GN 3514. SEMINAR ON SELECTED TOPICS IN GERMAN LITERATURE.
Cat. II
The content of the seminar will change from time to time. The course will focus either on an author (e.g., Goethe, Heine, Kafka, Gunter Grass, Christa Wolf), a genre (e.g., lyric poetry, drama, narrative prose), a literary movement (e.g., Romanticism, expressionism), or a particular literary problem (e.g., literature and technology, writing and the Holocaust, writing and the city). The seminar will be conducted entirely in German.
The course will be offered in 2003-04 and in alternate years thereafter.
Recommended background: BN 3511 (Advanced German I) and GN 3512 (Advanced German II) or equivalent.

History

HI 1311. INTRODUCTION TO AMERICAN URBAN HISTORY.
Cat. I
An introduction to the history of the American city as an important phenomenon in itself and as a reflection of national history. The course will take an interdisciplinary approach to study the political, economic, social, and technological patterns that have shaped the growth of urbanization. In addition to reading historical approaches to the study of American urban history, students may also examine appropriate works by sociologists, economists, political scientists and city planners who provide historical perspective. (Formerly HI 3123.)
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Cat.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI 1312. INTRODUCTION TO AMERICAN SOCIAL HISTORY.</td>
<td>I</td>
<td>An introduction to the historical study of American society. It addresses two questions: What is social history? And how do social historians work?</td>
</tr>
<tr>
<td>HI 1313. INTRODUCTION TO THE STUDY OF FOREIGN POLICY AND DIPLOMATIC HISTORY.</td>
<td>I</td>
<td>An introduction to the various components of U.S. foreign policy decision-making and the basic techniques of diplomatic history. The course will focus on one or two topics in the history of American foreign relations, using a variety of primary documents and secondary sources.</td>
</tr>
<tr>
<td>HI 1314. INTRODUCTION TO EARLY AMERICAN HISTORY.</td>
<td>I</td>
<td>An introduction to historical analysis through selected periods or themes in the history of America before the Civil War. A variety of readings will reflect the various ways that historians have attempted to understand the development of America.</td>
</tr>
<tr>
<td>HI 1321. INTRODUCTION TO EUROPEAN SOCIAL HISTORY.</td>
<td>I</td>
<td>An introduction to the study of modern European social history since the Industrial Revolution. Topics will include industrialization in Britain and Europe; class formation, gender and the condition of women, technology and economy, culture and society. Students will learn to work with historical sources, to formulate arguments, to read critically, and to write clearly. No prior knowledge of European history is required.</td>
</tr>
<tr>
<td>HI 1322. INTRODUCTION TO EUROPEAN CULTURAL HISTORY.</td>
<td>I</td>
<td>In this course students think through some of the major intellectual currents that have defined modern Western Civilization. Topics include the philosophical impact of science on modern thought, the development of liberalism and socialism, the crisis of culture in the twentieth century. Students read selections from major thinkers in the Western tradition and develop their skills at critical thinking, analysis, oral and written argument. No prior knowledge of European history is required.</td>
</tr>
<tr>
<td>HI 1323. INTRODUCTION TO RUSSIAN/SOVET HISTORY.</td>
<td>I</td>
<td>An introduction to historical analysis through consideration of selected topics in the History of Russia and the History of the Soviet Union, such as the Slavophile-Westernizer debate, serfdom, the famine of 1933-32, and the Sino-Soviet split. Suggested background: elementary knowledge of science. No prior knowledge of Russian/Soviet history is expected.</td>
</tr>
<tr>
<td>HI 1331. INTRODUCTION TO THE HISTORY OF SCIENCE.</td>
<td>I</td>
<td>An introduction to the methods and source material historians use to study science. Topics covered will range from early Greek science to Newton and the Scientific Revolution in the 17th-century. Suggested background: elementary knowledge of science.</td>
</tr>
<tr>
<td>HI 1332. INTRODUCTION TO THE HISTORY OF TECHNOLOGY.</td>
<td>I</td>
<td>An introduction to concepts of historical analysis — i.e., the nature and methodology of scholarly inquiry about the past — through the concentrated examination of selected case studies in the history of technology. Possible topics include: the influence of slavery on the development of technology in the ancient world and the middle ages; the power revolution of the middle ages; the causes of the Industrial Revolution in 18th-century Britain; and the emergence of science-based technology in 19th-century America.</td>
</tr>
<tr>
<td>HI 1341. INTRODUCTION TO GLOBAL HISTORY.</td>
<td>I</td>
<td>An introduction to the study of global history since 1500. Topics include global expansion, the Columbian exchange, and the slave trade; Renaissance, Reforma- tion, and revolution in Europe; global industrialization, imperialism, and nation building; the world wars and revolutionary movements; decolonization and the Cold War. The course will also discuss case studies of developing nations of interest to students. Especially appropriate as background for students interested in International Studies or any of WPI’s global Project Centers.</td>
</tr>
<tr>
<td>HI 2311. AMERICAN COLONIAL HISTORY.</td>
<td>I</td>
<td>This course surveys early American history up to the ratification of the Constitution. It considers the tragic interactions among Europeans, Indians, and Africans on the North American continent, the growth and development of English colonies, and the revolt against the Empire that culminated in the creation of the United States of America.</td>
</tr>
<tr>
<td>HI 2313. AMERICAN HISTORY, 1789-1877.</td>
<td>I</td>
<td>This course surveys American history from the Presidency of George Washington to the Civil War and its aftermath. Topics include the rise of American democracy, the emergence of middle-class culture, and the forces that pulled apart the Union and struggled to put it back together.</td>
</tr>
<tr>
<td>HI 2314. AMERICAN HISTORY, 1877-1920.</td>
<td>I</td>
<td>This course surveys the transformation of the United States into an urban and industrial nation. Topics will include changes in the organization of business and labor, immigration and the development of cities, the peripheral role of the South and West in the industrial economy, politics and government in the age of &quot;laissez-faire,&quot; and the diverse sources and nature of late 19th- and early 20th-century reform movements. (Formerly HI 1131.)</td>
</tr>
<tr>
<td>HI 2315. THE SHAPING OF POST-1920 AMERICA.</td>
<td>I</td>
<td>This course surveys the major political, social, and economic changes of American history from 1920 to the present. Emphasis will be placed on the Great Depression, the New Deal, suburbanization, McCarthyism, the persistence of poverty, the domestic effects of the Vietnam war, and recent demographic trends. (Formerly HI 2141.)</td>
</tr>
<tr>
<td>HI 2316. AMERICAN FOREIGN POLICY FROM WOODROW WILSON TO THE PRESENT.</td>
<td>I</td>
<td>This survey of American diplomatic history begins with the legacy of Woodrow Wilson, continues through our apparent isolation in the 1920’s, American neutrality in the 1930’s, World War II, the early and later Cold War periods, and concludes with an overview of the current global involvement of the United States. (Formerly HI 2101.)</td>
</tr>
<tr>
<td>HI 2317. LAW AND SOCIETY IN AMERICA, 1865-1910.</td>
<td>I</td>
<td>This survey course explores the dramatic expansion of government’s role in American life between the Civil War and World War I. It does so by examining the response of constitutional, common, and statutory law to the social, economic, and political change associated with this pivotal period in the nation’s history. (Formerly HI 2111.)</td>
</tr>
<tr>
<td>HI 2321. EUROPE FROM THE FRENCH REVOLUTION TO WORLD WAR I.</td>
<td>I</td>
<td>This survey of major socio-economic, political, and cultural developments in European history from the Old Regime to World War I. The course will focus upon those factors and events that led to the formation of modern European society: Nation-State building; The French Revolution, industrialization; liberal- ism, democracy, and socialism; national unification of Italy and Germany; the coming of World War I. No prior knowledge of European history is required. (Formerly HI 1202.)</td>
</tr>
<tr>
<td>HI 2322. EUROPE SINCE WORLD WAR I.</td>
<td>I</td>
<td>A survey of the major political, socio-economic, and cultural developments in European history since World War I. The course will focus upon those factors and events that have led to the current world situation: the World Wars, fascism and communism, the Holocaust, the Cold War, the welfare state, decolonization, post-industrial society, popular culture, the collapse of communism, contempor ary Europe. No prior knowledge of European history is required. (Formerly HI 2222.)</td>
</tr>
<tr>
<td>HI 2324. INDUSTRY AND EMPIRE IN BRITISH HISTORY.</td>
<td>I</td>
<td>A survey of modern Britain from the 18th century to the present. Topics include the British state and national identity, the industrial revolution, political and social reform, the status of women, sport and society, Ireland, the British Empire, the World Wars, the welfare state, economic decline. Especially appropriate as background for students planning IQP’s or Sufficiency Projects in London. No prior knowledge of British history is required.</td>
</tr>
<tr>
<td>HI 2325. MODERN FRANCE.</td>
<td>I</td>
<td>This course examines the historical origins of modern France and the distinguishing features of French society and culture. Some of the topics covered include: Bourbon absolutism; the cause and effects of the French Revolution; the struggle for democratic liberalism in the 19th century; class and ideological conflict in the Third Republic; Vichy fascism, and present-day politics in the Fifth Republic. No prior knowledge of French history is required. This course will be offered in 2002-03 and in alternating years thereafter.</td>
</tr>
</tbody>
</table>
HI 2326. RUSSIA FROM PETER THE GREAT TO STALIN.
Cat. II
A survey of the history of Tsarist and Soviet Russia from the Reign of Peter I (1689) through the first Five-Year Plan (1928-32). The theory of modernization is used as an analytic tool.
No prior knowledge of Russian/Soviet history is expected.
This course will be offered in 2003-04 and in alternate years thereafter.
(Formerly HI 3222.)

HI 2327. RUSSIA FROM THE SOVIET PERIOD TO THE PRESENT.
Cat. II
A survey of Russian history from Stalin to the present. The historical analysis will illuminate problems faced by the current post-Soviet leaders in such diverse areas as housing and foreign policy.
No prior knowledge of Soviet history is expected.
This course will be offered in 2002-03 and in alternate years thereafter.
(Formerly HI 3242.)

HI 2328. HISTORY OF REVOLUTIONS IN THE TWENTIETH CENTURY.
Cat. I
A survey of the history of revolutions in the present century including those in Russia, China, Cuba, and “?”. The theory of modernization will be used as an analytic tool.
No prior knowledge of the history of revolutions is expected. (Formerly HI 1242.)

HI 2331. AMERICAN SCIENCE AND TECHNOLOGY TO 1859.
Cat. I
A survey of the content and character of American science (and, to some degree, American technology) from the first European explorations until just before the publication of The Origin of Species. Topics include: medieval science in the new world; the Scientific Revolution and its influence in America; the American Industrial Revolution; the rise of science as a profession; the interplay of science and technology with the state and federal governments. (Formerly HI 3421.)

HI 2332. AMERICAN SCIENCE AND TECHNOLOGY FROM 1859.
Cat. I
A survey of the content and character of American science (and, to some degree, American technology and medicine) from the publication of The Origin of Species through the present. Topics include: Darwinism and Social Darwinism in America; scientific agriculture and the federal government; scientific technology and the rise of an industrial society; scientific education and the new universities; positivism and the growth of the physical sciences; the new biology and medicine; conservation, scientific management, the gospel of efficiency and progressivism; science, World War I and the 1920’s; the intellectual migration and its influence; science, technology and World War II; Big Science and the Military-Industrial-Scientific Complex; attacks on Big Science. (Formerly HI 3431.)

HI 2333. HISTORY OF SCIENCE FROM 1700.
Cat. I
A survey of major developments in science since Newton. Topics may include: 18th century physical science within the context of the Enlightenment; the revolution in biological thought in the 19th century; relativity and the quantum theory; key concepts such as the conservation of energy and the electromagnetic field; the changing structure of the scientific community.
A knowledge of advanced science is not required but would be advantageous. (Formerly HI 2423.)

HI 2334. EUROPEAN TECHNOLOGICAL DEVELOPMENT.
Cat. I
A survey of the development of technology in Europe from the late medieval period to World War I. Emphasis will be placed on understanding the evolution of technology within its cultural, social, and political contexts. Topics may include the military, mechanical, maritime, and building technologies of the medieval and Renaissance periods; the commonly misunderstood figures of Leonardo da Vinci; the causes and nature of the Industrial Revolution; the effects of the British Industrial Revolution in France and Germany in the 19th century; the transition from craft-based industries to those that are science based such as the dyestuffs and electrical power industries; World War I as a technological conflict. (Formerly HI 2113.)

HI 2341. CONTEMPORARY WORLD ISSUES IN HISTORICAL PERSPECTIVE.
Cat. II
This course examines the historical origins of contemporary global crises and political transformations. Students keep abreast of on-going current events through periodical literature and explore the underlying long-term causes of these events as analyzed by scholarly historical texts. Topics will vary each time the course is taught but may include such topics as: The European Union, The Israeli-Palestinian Crisis, Democratization in Africa, The Developing World and Debt Relief. No prior knowledge of world history is required.
This course will be offered in 2003-2004 and in alternate years thereafter.

HI 2342. CULTURES IN CONTACT: THE WORLD TO 1650.
Cat. II
This course surveys global history from the adoption of agriculture to the initial stage of global colonialism, focusing on major and informative instances of intercultural contact. The course is organized around case studies that may include the agricultural revolution; the diffusion of religious traditions; Rome as a multicultural empire; the Silk Road; exchanges around the Indian Ocean; the expansion of Islam; The Crusades; European encounters with the New World; and Japanese contact with the West.
This course will be offered in 2002-03 and in alternate years thereafter.

HI 3311. AMERICAN LABOR HISTORY.
Cat. I
This seminar course will deal with the history of organized labor in America as well as with the historic contributions of working people, whether unionized or not, to the growth and development of American ideas, politics, culture, and society.
Among the topics to be covered will be: the origins, growth, and expansion of trade and industrial unionism; the roots and development of working class consciousness; the underlying causes and eventual resolution of labor disturbances; the philosophical and ideological perspectives of the labor movement. Students will explore topics raised by common readings via written papers, seminar presentations, and work with primary source materials.
Suggested background: HI 2334, American History, 1877-1920; or HI 2315, The Shaping of Post-1920 America. (Formerly HI 2151.)

HI 3312. TOPICS IN AMERICAN SOCIAL HISTORY.
Cat. I
A seminar course on analysis of selected aspects of social organization in American history, with emphasis on the composition and changing societal character of various groups over time, and their relationship to larger social, economic, and political developments. Typical topics include: communities, families, minorities, and women.
Suggested background: Some college-level American history. (Formerly HI 3113.)

HI 3314. THE AMERICAN REVOLUTION.
Cat. I
This seminar course considers the social, political, and intellectual history of the years surrounding American independence, paying particular attention to the changes in society and ideas that shaped the revolt against Great Britain, the winning of independence, and the creation of new political structures that led to the Constitution.

HI 3321. TOPICS IN MODERN EUROPEAN HISTORY.
Cat. II
This seminar course examines topics in the cultural, socio-economic and political history of modern Europe, with a focus on Great Britain. Topics may vary each year among the following: nationalism, class and gender, political economy, environmental history, sport and society, film and history. Readings will include primary and secondary sources.
This course will be offered in 2003-04 and in alternating years thereafter.

HI 3322. TOPICS IN THE WESTERN INTELLECTUAL TRADITION.
Cat. II
This seminar course in the history of ideas focuses each year on a different theme within the intellectual-cultural traditions of Western Civilization. Some topics are the following: The Impact of the New Physics on 20th Century Philosophy; The Social History of Ideas; The Enlightenment and the French Revolution; Sexuality, Psychoanalysis, and Revolution. The course is structured around classroom discussion of major texts on the topic under study and a related research paper.
This course will be offered in 2003-04 and in alternating years thereafter.

HI 3324. TOPICS IN THE HISTORY OF THE RUSSIAN REVOLUTIONARY TRADITION.
Cat. I
This seminar course studies the Russian Revolutionary tradition and the historical and personal factors that shaped it. Emphases are on shared research, written and oral presentations of one’s ideas, and the value of constructive criticism.
Suggested background: study of Russian history or European history.

HI 3331. TOPICS IN SCIENCE, TECHNOLOGY, AND SOCIETY.
Cat. I
A seminar course on the relationships among science, technology, and society in Europe through a series of case studies. Topics from which the case studies might be drawn include the harnessing of science for industrial purposes; the role of the chemical industry in war; the function of the science advisor in government; the military-industrial complex in Nazi Germany; the political views and activities of major scientists such as Einstein. Students will use current theories and critiques of “autonomous technology” to analyze the case studies.
Suggested background: Courses in European history and the history of science and technology. (Formerly HI 3444.)
HI 3333. TOPICS IN AMERICAN TECHNOLOGICAL DEVELOPMENT. 
Cat. I
A seminar course examining selected examples of technological change in the United States. Topics from which these case studies might be chosen include: colonial technology; mechanization of ante-bellum industry; the impact of science on Gilded Age technology; 20th-century behavioral technologies; the evolution of the military-industrial complex; the Manhattan Project; the exploitation of space; computers and post-World-War-II technology; and the emergence of biotechnology. In addressing these cases, this seminar will employ and seek to evaluate one or more significant historical theses about the nature of technological change.
Suggested background: Some familiarity with the basic outlines and concerns of both American history and the history of American technology.

HI 3341. AFRICAN HISTORY AND CULTURE. 
Cat. II
This survey course uses an interdisciplinary approach to examine fundamental issues in African political, social, and cultural history. The course may include various topics, such as ancient African kingdoms, the influence of Islam, the Atlantic slave trade, imperialism and decolonization, contemporary democracy, or African literature and art.
Suggested background: HI 1341 Introduction to Global History.
This course will be offered in 2003-04 and in alternate years thereafter.

HI 3411. PRO-SEMINAR IN GLOBAL PERSPECTIVES. 
Cat. II
This course examines the fundamentals of intercultural communication to prepare students to live and work with people from other cultures. It explores how different patterns of thinking and behavior, assumptions and values, have arisen from different cultural traditions and divergent histories in the world. Racial, prejudice, and bigotry—often the result of cultural, social, and technological differences in human experience—are among the concerns of the class. This course cannot teach students how to behave and think in all parts of the world, but it raises questions about ethnocentric assumptions often taken for granted by those working or studying in another culture. It is excellent preparation for an international IQP or educational exchange.
Suggested background: Previous courses in Humanities.
This course will be offered in 2003-04 and in alternate years thereafter.

HI 3421. TOPICS IN MEDIEVAL AND RENAISSANCE STUDIES. 
Cat. II
This seminar course examines interdisciplinary topics in the study of the medieval and renaissance world. The course emphasizes various types of primary source material. Topics may include the Roman, Judeo-Christian, and Germanic heritage; warfare and social structure; the emergence of the modern town; folk and popular culture; encounters with the new world; and change and continuity in early modern society. It is appropriate for students with preparation in any of several areas of the humanities, including history, literature, history of science and technology, and art history.
This course will be offered in 2003-04 and in alternate years thereafter.

HUMANITIES AND ARTS COURSES 199

IS 1813. AMERICAN HISTORY FOR INTERNATIONAL STUDENTS. 
Cat. I
An introduction to American history designed to provide international students with a basic understanding of the history and culture of the United States. Written and oral assignments will also help these students gain a more effective command of the English language. (Formerly HI 1101.)

Music

MU 1611. FUNDAMENTALS OF MUSIC I. 
Cat. I
This course concentrates on basic music theory of the common practice period. If time permits, instruction includes ear training, sight singing, and work on scales and intervals.
Suggested background: basic knowledge of reading music. (Formerly MU 1737.)

MU 2611. FUNDAMENTALS OF MUSIC II. 
Cat. I
Fundamentals II is a course on music theory at the advanced level beginning with secondary dominants and modulations and working through 19th-century chromatic harmony. (Formerly MU 1747.)
MU 2612. MUSIC OF THE MEDIEVAL AND RENAISSANCE PERIODS.  
Cat. II  
Music of the medieval church and secular troubadours is studied with special attention given to composers such as Machaut, DesPres, Palestrina, Byrd and Gabrieli.  
This course will be offered in 2002-03 and in alternate years thereafter.  
(Formerly MU 2717.)

MU 2613. MUSIC OF THE BAROQUE PERIOD.  
Cat. II  
Music is examined from the operas of Monteverdi through the cantatas of Buxtehude, culminating in the works of Bach and Handel.  
This course will be offered in 2003-04 and in alternate years thereafter.  
(Formerly MU 2718.)

MU 2614. MUSIC OF THE CLASSIC PERIOD.  
Cat. II  
Music of the classic period concentrates on works by C.P.E. Bach, Haydn, Mozart, and Beethoven.  
This course will be offered in 2002-03 and in alternate years thereafter.  
(Formerly MU 2727.)

MU 2615. MUSIC OF THE ROMANTIC PERIOD.  
Cat. II  
Emphasis is on the grandeur and madness of the romantic composers of Europe: Beethoven, Schubert, Berlioz, von Weber, Liszt, Chopin, Brahms, Wagner and Tchaikovsky.  
This course will be offered in 2003-04 and in alternate years thereafter.  
(Formerly MU 2728.)

MU 3611. COMPUTER TECHNIQUES IN MUSIC.  
Cat. I  
This course concentrates on both the technical and artistic aspects of computer music. Topics covered include the MIDI protocol and specification, sequencer design, voice editing, synthesizer architecture, and literature.

MU 3612. COMPUTERS AND SYNTHESIZERS IN MUSIC.  
Cat. I  
This course focuses on technical and aesthetic problem solving in computer music. Using programming languages, students propose and design creative solutions to contemporary problems which currently have no commercial solutions. Students work with sequencers, signal processors, synthesizers, MIDI controllers, editors, and programming languages.

MU 3613. DIGITAL SOUND DESIGN.  
Cat. I  
This course introduces the student to the theory and practice of digital sound design. It focuses on creative problem-solving in applications where digital audio production is a key component. Topics include digital sound recording and editing, creation and synchronization of digital sound tracks for video, theatrical sound design, and multimedia production.

MU 4621. INDEPENDENT INSTRUCTION (LESSONS) IN MUSIC.  
IS/P  
Students electing to take their humanities and arts Sufficiency in music may, for one of their five courses, undertake 1/3 unit (normally at 1/12 unit per term) of private vocal or instrumental instruction. (Supplemental ensemble work is strongly recommended.) The student must receive prior approval by a member of the WPI music faculty, and the instruction must be beyond the elementary level. Lessons involve a separate fee. Note that the maximum of 1/3 unit credit for lessons may be earned in addition to 1/3 unit credit for performance (see condition A or B below). Additional work, either in performance or lessons, may be acknowledged on the WPI transcript but will carry no WPI credit. (Formerly MU 3787.) Private lessons: voice, piano, organ, winds, brass, strings, and percussion.

MU—. SEMINARS.  
IS/P  
Seminars (taken as #4 type IS/P only) are available in a variety of areas such as the following:

MU 4623 Introduction to Jazz History  
Cat. II. This seminar will be offered in 2000-01.

MU 4624 Introduction to Jazz Theory  
Cat. II. This seminar will be offered in 1999-2000.

MU 4625 Survey of American Popular Music (Formerly DGW 2444.)  

MU 4626 Counterpoint: An Introduction (Formerly DPM 3341.)  
Cat. II. This seminar will be offered in 2000-01.

MU 4629 Music of the Twentieth-Century  
Cat. II. This seminar will be offered in 1999-2000.

MU 4628. PERFORMANCE SUFFICIENCY.  
IS/P  
A final (sixth term) Sufficiency in music may be fulfilled by a recital performance in addition to a related paper, provided the music faculty determines that the student's capabilities be of a high order. During this term, the student usually is under private instruction, the cost of which is borne by the student.  
NOTE: Two 1/3 units credit remain the maximum allowed for all lessons and performance credit.

MU—. ENSEMBLES.  
IS/P  
One-sixth unit of credit will be awarded at the conclusion of two successive terms of participation. Ensembles currently receiving credit are:

Choral  
MU 4631 Men's Glee Club  
MU 4632 Women's Chorale

Instrumental  
MU 4633 Brass Ensemble  
MU 4634 Jazz Band  
MU 4635 Stage Band  
MU 4636 Concert Band  
MU 4637 String Ensemble

Credit would be given only under one of the two conditions below:

Condition A The performance or experience takes place in a course or ensemble at a college or other institution from which WPI would normally accept transfer credit. The determination of which institutions are acceptable will be made by the WPI Humanities and Arts Department Head in conjunction with the relevant faculty members.

Condition B The performance or experience takes place in a WPI ensemble taught by a part- or full-time WPI instructor.

Philosophy

PY/RE 1731. INTRODUCTION TO PHILOSOPHY AND RELIGION.  
Cat. I  
This course provides an overview of key concepts, methods and authors in both fields. These introduce the student to the types of reasoning required for the pursuit of in-depth analysis in each discipline. Emphasis on topics and authors varies with the particular instructor.  
(Formerly HU 1010.)

PY 2711. PHILOSOPHICAL THEORIES OF KNOWLEDGE AND REALITY.  
Cat. I  
This course introduces students to methods of philosophical analysis relating to the classification and conceptualization of entities and the nature of knowledge. The course will focus on a related set of problems or on the elaboration of a philosophical issue of knowledge or reality in the history of philosophy. Among themes and problems considered might be: How has the being of nature and knowledge of nature been represented in Western philosophy and science? What kind of a phenomenon is mind or thought and can entities in addition to human beings, such as computers, be said to have this attribute? What are reliable methods of arriving at and evaluating scientific knowledge, and are these methods identical for the natural and human sciences? Readings might include excerpts from the works of Plato, Aristotle, Bacon, Descartes, Kant, James, Dewey and Heidegger, as well as numerous contemporary philosophers.  
Suggested background: familiarity with basic philosophical concepts and terms (as in PY/RE 1731). (Formerly PY 2000.)

PY 2712. SOCIAL AND POLITICAL PHILOSOPHY.  
Cat. II  
This course examines metaphysical and moral questions that philosophers have raised about social and political life. Among questions treated might be: What are the grounds, if any, of the obligation of a citizen to obey a sovereign? Are there basic principles of justice by which societies, institutions and practices are rightly evaluated? What is democracy, and how can we tell if an institution or practice is democratic? To what degree do economic institutions put limits on the realization of freedom, democracy and self-determination? Readings might include excerpts from the works of Plato, Aristotle, Locke, Rousseau and Marx, as well as numerous contemporary philosophers.  
Suggested background: familiarity with basic concepts in philosophy (as in PY/RE 1731). (Formerly PY 2500.)

PY 2713. BIOETHICS.  
Cat. II  
The purpose of this course is to evaluate the social impact of technology in the areas of biology/biotechnology, biomedical engineering and chemistry. The focus of the course will be on the human values in these areas and how they are affected by new technological developments. The course will deal with problems such as human experimentation, behavior control, death, genetic engineering and counseling, abortion, and the allocation of scarce medical resources. These problems will be examined through lectures, discussions and papers.
PY 2714. ETHICS AND THE PROFESSIONS: PERSONAL, PROFESSIONAL, AND SOCIAL DILEmmas.
Cat. II
This course will present a framework by which various ethical dilemmas that arise in the professions, especially the science-related professions, can be identified, examined, and evaluated on the level of personal morality, professional codes of ethics, and social values. The goal is to study the solutions of these dilemmas in each of the three levels to determine what relations there may be between them, and whether or not resolutions of a dilemma on one level are appropriate for another level. Ethical concepts, professional codes of ethics, and policy positions will be used to analyze and evaluate these issues in a case study format. Representatives of appropriate professions will be invited to address specific issues pertaining to ethical dilemmas in their field.
This course will be offered in 2002-03 and in alternate years thereafter. (Formerly PY 3100.)

PY 2715. PHILOSOPHICAL THEORIES OF THE SELF.
Cat. II
This course will focus on philosophical questions concerning the nature of human identity. It will examine arguments from various philosophical traditions on topics such as the nature of personhood, self-deception, the importance or unimportance of everyday concerns, the comparative role of individual decisions and social norms, and the differences between secular and religious, Western and Eastern, political and apolitical approaches to all these issues. Authors may include some of the following: Thoreau, Kierkegaard, Hegel, Camus, Buddha, Plato, Marx, Freud and de Beauvoir.
Suggested background: familiarity with basic ethical concepts and terms (as in PY/RE 1731) and PY/RE 2731 or PY 2712.
This course will be offered in 2002-03 and in alternate years thereafter. (Formerly PY 3400.)

PY 2716. PHILOSOPHY OF DIFFERENCE.
Cat. II
This course examines philosophical presuppositions and questions of value underlying and expressed in the construction of masculinity and femininity in modern society. The course may also examine social identities rooted in race, ethnicity, sexual preference, and ability/disability. Possible topics include: changing conceptions of love, sex, marriage, and parenting; how our conceptions of masculinity and femininity are influenced by and influence (for example) religion, science, politics, work, and art; and the relations between feminist theory and other critical social theories. (Formerly HU 2411, Women’s Studies: Analysis of Gender in Modern Society; students may not receive credit for both this course and PY 2716.)
This course will be offered in 2002-03 and in alternating years thereafter.

PY 2717. PHILOSOPHY AND THE ENVIRONMENT.
Cat. I
This course will focus on the following questions:
What is the scope of the current environmental crisis? What does this crisis reveal about the philosophical presuppositions and dominant values of our intellectual worldviews and social institutions? How can existing social theories help explain the environmental crisis? What implications does the crisis have for our sense of personal identity? What moral and spiritual resources can help us respond to it?
Readings will be taken from contemporary and historical philosophers and naturalists.
Suggested background: familiarity with basic concepts in philosophy (as in PY/RE 1731).

PY/RE 2731. INTRODUCTORY ETHICS.
Cat. I
This course will review at an introductory level theories of ethics, individual figures in the history of ethics, and selected problems in ethics. The emphasis will be on philosophical or religious ethics depending on the instructor. (Formerly PY/RE 2122.)

PY 3711. TOPICS IN PHILOSOPHY.
Cat. I
The purpose of this course is to expose students to somewhat more advanced and specialized study in philosophy. Its focus will vary, but will typically be one of the following types: a particular philosopher (e.g., Plato, Kant, Mill); a particular philosophical tradition (e.g., Pragmatism, Ordinary Language philosophy, Empiricism); a particular philosophical problem (free will, knowledge of other minds, historical explanation); or a particular philosophical classic (Hegel’s Phenomenology of Mind, Aristotle’s Ethics).
Suggested background: three other philosophy courses. (Formerly PY 3800.)

PY 3712. PHILOSOPHY OF RELIGION.
Cat. II
This course will focus on philosophical questions concerning the following topics: the existence and nature of God; the compatibility of God and evil; the nature of religious faith and the relationship between religion, science, and ethics; interpretations of the nature of religious language; the philosophically interesting differences between Western and Eastern religions; philosophical critiques of the role of religion in social life. Authors may include: Hume, Kant, Kierkegaard, Buber, Tillich, Daly, Nietzsche and Buddha.
Suggested background: familiarity with basic religious concepts and terms (as in PY/RE 1731).
This course will be offered in 2002-03 and in alternate years thereafter. (Formerly PY 3200.)

PY/RE 3731. PROBLEMS IN ETHICS AND SOCIAL PHILOSOPHY.
Cat. I
This course will examine in depth selected problems in ethical theory and social philosophy. The specific content or emphasis will be determined by the instructor.
Suggested background: knowledge of either PY/RE 2731 or PY 2712. (Formerly RE 2323.)
Spanish

SP 1523. ELEMENTARY SPANISH I.
Cat. I
A very intensive course that will introduce the student to the basic grammar of Spanish, emphasizing the four language skills: listening, speaking, reading and writing. It will also introduce the student to different aspects of Hispanic cultures in the U.S. and in Spanish-speaking countries. Students who have taken Spanish in high school are urged to take a placement exam before enrolling in either level of Elementary Spanish. See the instructor.

SP 1524. ELEMENTARY SPANISH II.
Cat. I
A continuation of Elementary Spanish I. Recommended background: SP 1523.

SP 2521. INTERMEDIATE SPANISH I.
Cat. I
A course designed to allow students to improve their written and oral skills, expand their vocabulary and review some important grammatical structures. Students will also read short stories and poems by some of the most representative Spanish American and Spanish authors, such as Horacio Quiroga, Jorge Luis Borges, Gabriela Mistral and Ana María Matute. Recommended background: Elementary Spanish II.

SP 2522. INTERMEDIATE SPANISH II.
Cat. I
A continuation of Intermediate Spanish I. Recommended background: SP 2521.

SP 3521. ADVANCED SPANISH I.
Cat. I
A course that continues to improve student’s language skills while deepening their understanding of Hispanic cultures. Some of the topics studied are: the origins of Hispanic cultures in Spain and Spanish America; family; men and women in Hispanic societies; education; religion. Recommended background: Intermediate Spanish II.

SP 3522. ADVANCED SPANISH II.
Cat. I
A continuation of Advanced Spanish I. Recommended background: SP 3521.

SP 3523. TOPICS IN LATIN AMERICAN CULTURE.
Cat. I
An introduction to various aspects of life in Latin American countries from early times to the present. Focusing on the social and political development of Latin America, the course will reveal the unity and diversity that characterize contemporary Latin American culture. Typical topics for study include: the precolumbian civilizations and their cultural legacy; the conquistadores and the colonial period; the independence movements; the search for and the definition of an American identity; the twentieth-century dictatorships; and the move toward democracy. Recommended background: SP 3521 (Advanced Spanish I) and SP 3522 (Advanced Spanish II) or equivalent.

SP 3524. SPANISH-AMERICAN LITERATURE IN THE TWENTIETH CENTURY.
Cat. I
This course, taught in the Spanish language, focuses on the major literary movements in Spanish America, from the “Modernista” movement at the turn of the century to the Latin American “Boom” of the 1960s to the political literature of the ’70s and ’80s. The work of representative authors, such as Rubén Darío, Julio César, Rosario Castellanos, Elena Poniatowska, will be discussed. Recommended background: SP 3521 (Advanced Spanish I) and SP 3522 (Advanced Spanish II) or equivalent.

SP 3525. SPANISH AMERICAN FILM/MEDIA: CULTURAL ISSUES.
Cat. I
Through Latin American and Caribbean films, and other media sources, this course studies images, topics, and cultural and historical issues related to modern Latin American and the Caribbean. Within the context and influence of the New Latin American Cinema and/or within the context of the World Wide Web, radio, newspapers, and television the course teaches students to recognize cinematographic or media strategies of persuasion, and to understand the images and symbols utilized in the development of a national/regional identity. Among the topics to be studied are: immigration, gender issues, national identity, political issues, and cultural hegemonies.
Taught in advanced level Spanish. May be used toward foreign language Sufficiency, Minor, or Major.
Recommended Background: SP 2521 and SP 2522, and SP 3523.

WR/EN 2211. ELEMENTS OF WRITING.
Cat. I
This course is designed for students who wish to work intensively on their writing. The course will emphasize the processes of composing and revising, the rhetorical strategies of expository prose, and the interaction between writer and audience. In a workshop setting, students will write a sequence of short papers and complete one longer writing project, learn to read critically and respond helpful to each other’s writing, and make oral presentations from written texts.

WR/EN 3011. PEER TUTORING IN WRITING.
Cat. I
Peer Tutoring in Writing introduced students to the theory and practice of composition. In this course, students research, read, and write about their own and others’ literacy practices. Through reading and writing assignments, peer reviews, interviews, presentations, and a tutoring internship in the CCAC, students hone their communication skills while increasing their ability to examine critically the role of communication in the production of knowledge.

WR/EN 3214. WRITING ABOUT DISEASE AND PUBLIC HEALTH.
Cat. I
This writing workshop focuses on the purposes and genres of writing about disease and public health. We will consider how biomedical writers communicate technical information about disease and public health to general audiences; how writers capture the human experience of disease and health care; how writers treat the public policy implications of disease; and how writers design publicity to promote public health. We will examine such genres as the experimental article, news reports, medical advice, profiles, commentary, and public health messages. Recommended background: EN 2211 or equivalent writing courses. Students who have taken EN 3215 may not receive credit also for EN/WR 3214.
INTERDISCIPLINARY

ID 1050. INTRODUCTION TO ENTREPRENEURSHIP.
Cat. I
This course is to provide students with the fundamentals of entrepreneurship. It is designed for students interested in starting their own business, or for those interested in leading an entrepreneurial group within an existing business. Topics include: product development; sources of venture capital; patents and copyrights; market research for new ventures; organization and control for new ventures; management stages in an entrepreneurial business.

ID/SS 2050. SOCIAL SCIENCE RESEARCH FOR THE IQP.
Cat. I
This course is open to students conducting off-campus IQPs in the Project Centers, and may count towards their Social Science distribution requirement. The course introduces students to the basic tools for social science research and for economic analysis such as cost-benefit analysis. It also provides practice in specific research skills. The project topics students have selected in conjunction with the sponsoring agencies. Students learn to develop social science hypotheses based upon literature reviews in their topic areas, construct and administer questionnaires, conduct interviews, analyze data using computerized statistical packages, and make recommendations based upon their findings. Students make presentations, write an organized project proposal as well as develop a written model for reporting their project findings. Examinations will cover the social science text and lecture material, while the project proposal will serve as the term paper.

ID/AR 3150. LIGHT, VISION AND UNDERSTANDING.
Cat. II
By using material from the sciences and the humanities this course examines the ways in which ideas of knowledge and of human nature have been fashioned. The specific topics include physical theories about light, biological and psychological theories of visual perception, and artistic theories and practices concerned with representation. The mixing of material from different academic disciplines is deliberate, and meant to counter the notion that human pursuits are “naturally” arranged in the neat packages found in the modern university. The course draws upon the physical and social sciences, and the humanities, to examine how those fields relate to one another, and how they produce knowledge and self-knowledge. Cultural as well as disciplinary factors are assessed in this process.

Light, Vision and Understanding is conducted as a seminar. The diverse collection of reading materials includes a number of primary texts in different fields. In addition, the students keep a journal in which they record the results of numerous individual observations and experiments concerning light and visual perception. The course can fit into several Sufficiency areas as well as serve as a starting point for an IQP. There are no specific requirements for this course, although some knowledge of college-level physics, as well as an acquaintance with the visual arts, is helpful.

This course will be offered in 2002-03 and in alternating years thereafter.

ID/SP 3525. SPANISH AMERICAN FILM/MEDIA: CULTURAL ISSUES.
Cat. I
Through Latin American and Caribbean films, and other media sources, this course studies images, topics, and cultural and historical issues related to modern Latin American and the Caribbean. Within the context and influence of the New Latin American Cinema and/or within the context of the World Wide Web, radio, newspapers, and television the course teaches students to recognize cinematographic or media strategies of persuasion, and to understand images and symbols utilized in the development of a national/ regional identity. Among the topics to be studied are: immigration, gender issues, national identity, political issues, and cultural hegemonies. Taught in advanced level Spanish. May be used toward foreign language Sufficiency, Minor, or Major. Recommended Background: SP 2521 and SP 2522.

ID/SP 3526. COMPARATIVE BUSINESS ENVIRONMENTS.
Cat. I
The basis of this course is a comparative study and analysis of specific Latin American and Caribbean business practices and environments, and the customs informing those practices. ID/SP 3526 focuses on countries such as Mexico, Argentina, Chile, Puerto Rico, and Costa Rica. The course’s main objective is to study communication strategies, business protocol, and negotiation practices in the countries mentioned above. Through oral presentations and written essays, students will have the opportunity to explore other countries in Latin America and the Caribbean.

Taught in advanced level Spanish. May be used toward foreign language Sufficiency, Minor, or Major. Recommended Background: SP 2521 and SP 2522.
attention is given to the use of financial data both in controlling day-to-day activities and planning future operations. Principal topics include: master budgets, cost analysis and classification systems, cost-volume-profit analysis, standard cost accounting and an introduction to capital budgeting.

Recommended background: MG 1100.

MG 2200. FINANCIAL MANAGEMENT.
Cat. I
The financial and competitive status of a company at any given point in time can usually be attributed to prior management decisions. In this course, the student will learn how to use several financial models that together, serve as a sound theoretical framework for analyzing the three types of financial decisions faced by the financial manager. These are: 1. investing decisions, 2. financing decisions, and 3. working capital management decisions. The impact of managerial decisions on the financial statements is emphasized. In addition, ethical conduct and global issues relating to the core concepts in the course are explored.

Recommended background: MG 1100 and MA 2611.

Students may not receive credit for both MG/IE 2200 and MG 2200.

MG 2250. FINANCIAL SYSTEM OF THE UNITED STATES.
Cat. II
An analysis of how the financial system of the United States has developed and contributes to the achievement of broad national economic goals as high national income, satisfactory economic growth, stable prices, and equilibrium in balance of payments with other countries. Emphasis is placed on the theory of the supply and demand for short-term money and long-term capital, and the resultant effect on interest rates.

Primary concentration on the sources and uses of funds of the major non-bank financial institutions, such as insurance companies, pension funds, mutual funds, finance companies, savings and loan banks and mutual savings banks. A discussion of the reforms of financial institutions, and of money and capital markets to more efficiently allocate the scarce resources of the country.

This course is intended to serve the business major and other students interested in understanding the role of financial intermediaries in the United States economy.

Suggested background: some knowledge of accounting and economics will be helpful in taking this course.

This course will be offered in 2002-03 and in alternate years thereafter.

MG 2260. INVESTMENT AND SECURITY ANALYSIS.
Cat. I
This course is designed to provide an introduction to the language and methodology of security analysis. It is intended to serve two different groups of students: those interested in the subject from the viewpoint of intelligent management of their own portfolios, and those students who have a possible career interest in some facet of the securities industry. Principal topics include: institutional structure and language of the securities market; investment research; alternative investment opportunities; financial statement analysis; fundamental evaluation of common stocks, preferred stocks and bonds; technical analysis; and business cycle analysis.

Recommended background: MG 1100 and SS 1120.

MG/IE 2300. ORGANIZATIONAL SCIENCE—FOUNDATION.
Cat. I
This first course in organizational science provides the foundation for an understanding of organization and management. It is a survey of the social science of work, describing the knowledge and processes required for organizational success including: motivation, communication, supervision, leadership, the group processes of decision making, conflict, work and organizational design, and reconciliation of the goals of individuals and organizations. Lecture, video presentation, group discussion and group mini-projects will be employed to introduce and illustrate the basic elements of management.

MG/IE 2500. MANAGEMENT SCIENCE I: DETERMINISTIC DECISION MODELS.
Cat. I
This course is designed to provide an introduction to a variety of tools and techniques found useful by modern industrial engineers, operations researchers and managers. These tools are oriented toward the creation and use of mathematical models to assist in managerial decision making in business and other organizations.

The models discussed in this course deal with deterministic decision-making problems where there are constraints on available actions. Discussion centers on “classical” methods of optimization and basic methods of linear programming. It is expected that the student will develop an ability to recognize situations in which a given technique is appropriate.

Recommended background: knowledge of calculus.

MG 2710. BUSINESS APPLICATION PLATFORMS.
Cat. I
This course provides an introduction to business computer hardware architectures and their operating systems. It enables students to assess the capabilities of different computer architectures for effective use in a business environment and to allow coherent development of an efficient business computing infrastructure. The course covers the basic components of different microcomputer platforms for use as personal workstations and information servers in a connected environment of networks: CPUs, memory, busses, peripheral devices: disks, displays, device controllers; basic network components: network adapters, switches, and media; and operating systems. The course includes a laboratory for hands-on design and application such as configuring and installing workstations, servers, and small local area networks.

Recommended background: CS 1005 or CS 1006, or ability to program in a higher level programming language.

MG 2720. BUSINESS APPLICATION DEVELOPMENT TOOLS.
Cat. I
This course introduces students to the concepts and principles of visual, object-oriented techniques for the development of business applications. Students will use commercial, computer-based development tools and rapid development and prototyping techniques for the design of small business applications for such areas as customer tracking, order processing, and financial analysis.

Recommended background: CS 1005 or CS 1006, or ability to program in a higher level programming language.

MG/IE 2850. ENGINEERING ECONOMICS.
Cat. I
To aid all engineering students in understanding economics and business constraints on engineering decision making.

Topics include evaluation of alternative; the six time-value-of-money factors; present worth; annual cash flow and rate-of-return analysis; incremental analysis; depreciation and income taxes; replacement analysis; inflation; handling probabilistic events; public economy; break-even and minimum cost points; and foreign exchange.

MG 2950. BUSINESS LAW AND ETHICS.
Cat. I
Imparts an understanding of how law, ethics, and public policy affect modern business. Approximately two-thirds of the term is devoted to coverage of fundamental substantive areas of business law (torts, contracts, property, business organizations), public policies (regulatory and promotional), and approaches to ethical analysis for decision-making. Particular attention is paid to technology-based enterprises (e.g. intellectual property, environmental regulation). The concluding portion of the course involves all students in examination of recent cases in which law, ethics and human, societal and global concerns intersect with business decision-making today.

MG/IE 3351. ORGANIZATIONAL SCIENCE—MANAGEMENT OF CHANGE.
Cat. I
This second course in organizational science provides experience in applying theories of organization and management to the analysis and implementation of organizational change. The course utilizes readings, experiential activities, and case studies of change management in technology-based organizations to provide a conceptual understanding as well as practical knowledge of the change management process. The course is designed as a seminar and workshop.

Recommended background: MG/IE 2300 or consent of the professor.

MG/IE 3400. PRODUCTION SYSTEM DESIGN.
Cat. I
This course is an introduction to the planning, analysis and design of production systems. It is designed for students in engineering or management who may wish to assume responsibilities in the production of goods or services. Topics to be covered will include: operations strategy, project management, quality management, process analysis, capacity management, and just-in-time and lean systems.

Recommended background: Differential and integral calculus.

MG/IE 3401. PRODUCTION PLANNING AND CONTROL.
Cat. I
This course is an introduction to the planning and control of production systems. Topics include: forecasting, scheduling, material management, and statistical process control.

Recommended background: MG/IE 3400, MA 2611, and differential and integral calculus.

MG/IE 3405. WORK SYSTEMS AND FACILITIES PLANNING.
Cat. I
This course covers the fundamentals of developing efficient layouts for production and service facilities. Methods analysis, work measurement, material handling and material flow analysis are also covered. Mathematical models and computer tools are used to assist decision-making.

Recommended background: MG/IE 2500 and MG/IE 3400.

MG/IE 3420. QUALITY PLANNING, DESIGN AND CONTROL.
Cat. I
This course focuses on the quality aspects of product design and manufacturing. Topics include: the quality/cost relationship, statistical process control, process capability studies, and design of experiments.

Recommended background: MG/IE 3400 and MA 2612 or consent of the instructor.
MG/IE 3450. HUMAN FACTORS ENGINEERING.  
Cat. I  
This course examines the human-machine interface in the workplace, concentrating on how workplace design can influence effectiveness and enhance health, safety, and satisfaction. Human sensory, motor, and decision systems are studied, as well as principles for designing visual and auditory displays, control devices and tools, and work spaces. Problems with repetitive and high physical effort tasks, illumination, noise, and atmospheric conditions, along with relevant governmental regulations, are also considered.

MG/IE 3460. SIMULATION MODELING AND ANALYSIS.  
Cat. I  
This course covers the application of simulation to a variety of managerial problems with examples from operations management, industrial engineering and manufacturing engineering. It introduces the student to the concepts of computer simulation, with an emphasis on the design of a simulation experiment and statistical interpretation of its results. It will discuss simulation of queueing models, inventory and industrial dynamics, and gaming situations. The role and use of computers for the execution of simulations will also be highlighted.

A commercial simulation language such as SIMAN will be used to solve problems from the manufacturing and service industries. Recommended background: CS 1005, or CS 1006, and MA 2612.

MG/IE 3501. MANAGEMENT SCIENCE II: RISK ANALYSIS.  
Cat. I  
This course provides coverage in decision analysis. Decision analysis is a technology that assists decision makers in quantifying consideration of complexity and uncertainty in problems of choice. The course applies decision analysis to problems in risk assessment and risk evaluation. Decision making in risk analysis is examined across a wide set of management engineering problems including case studies in environmental risk, product liability, facilities design, and R and D management. The course is intended to be highly integrative with respect to risk analysis including issues such as business ethics and risk communication.

Suggested background: knowledge of calculus and introductory probability and statistics.

MG 3600. MARKETING MANAGEMENT.  
Cat. I  
This class is designed to give students a broad overview of diverse topics in marketing management. After this class, students should have a solid understanding of the main concepts and principles of marketing, and be able to apply them to actual business situations. The course demonstrates the application of various social science concepts and methodologies in the marketing context. Topics include: The Marketing Environment, International Marketing, Market Research, Consumer Behavior, Business-to-Business Marketing, Services Marketing, Market Segmentation, New Product Development, Channels, Marketing Communications, Personal Selling, and Pricing.

MG 3640. MANAGEMENT OF PROCESS AND PRODUCT INNOVATION.  
Cat. II  
This course is based on the hypothesis that high performance firms depend on a sustainable pattern of new and innovative processes and products. Successful companies are examined in regard to their strategies for innovation and technology transfer. Technology alliances among industry, universities, and government are considered in order to increase the leverage of the individual firm. Benchmarking and commercialization from research to actualization is discussed through cases and examples. Recommended background: MG/IE 2200 or MG/IE 2850. Students may not receive credit for both MG/IE 3440 and MG 3640.

MG 3651. INDUSTRIAL MARKETING.  
Cat. II  
Provides an understanding of the industrial marketing process and practices. It presents the latest concepts, tools and techniques for marketing complex products and services to industrial and institutional users. Topics include: product innovation strategies; purchasing management and buyer behavior; major intelligence; pricing strategies and tactics; developing markets for new industrial products; bid proposals; industrial distribution; managing the industrial sales force; marketing controls.

This course will be offered in 2002-03 and in alternate years thereafter.

MG 3700. INFORMATION SYSTEMS MANAGEMENT.  
Cat. I  
This course introduces students to the management of information technology within complex organizations. It covers the range of information technologies employed by business organizations and the manner in which they are deployed. The course places special emphasis on the management of information resources from a user and manager point of view and will help students understand how particular technological arrangements can facilitate achievement of organizational goals. The impact of information technology on management control, organizational structure, individual workers, relationships between organizations, and business transformation will be discussed. Students may not receive credit for both MG 2700 and MG 3700.

Recommended background: MG 2101 and MG 2300 or equivalent business background.

MG 3720. BUSINESS DATA MANAGEMENT.  
Cat. I  
This course introduces students to the theory and practice of database management and the application of database software to implement business information systems that support managerial and operational decision making. Special topics covered include relational data models, query languages, normalization, locking, concurrency control and recovery. The course covers data administration and the design of data tables for computerized databases. Students will use a commercial database package to design and implement a small business database application. Students may not receive credit for both MG 4700 and MG 3720.

Recommended background: MG 2720 or equivalent knowledge.

MG 3740. ORGANIZATIONAL APPLICATIONS OF TELECOMMUNICATIONS.  
Cat. II  
Students taking this course will develop an understanding of how organizations can effectively use telecommunications technology to enhance business functionality. Students will analyze the development of organizational communications infrastructures and their use for the development of "virtual" organizational structures and to support globally-distributed organizations. The course will begin with a survey of the concepts and technologies which form the basis of a business telecommunications system and which allow the merging of voice, data and video in an integrated multimedia communications structure. Students may not receive credit for both MG 4701 and MG 3740.

Recommended background: MG 2710 and MG 3700.

MG 3910. RECOGNIZING AND EVALUATING NEW VENTURE OPPORTUNITIES.  
Cat. I  
This course focuses on identifying ideas for new businesses and learning how to evaluate those ideas to determine if they are feasible. Using various opportunity recognition models, students will be expected to come up with a business idea and conduct an analysis of the feasibility of the venture and its fit with the founder.

Recommended background for this course consists of MG/IE 2850 and two of the following: MG 1100, MG 2950, MG 3400, MG 3600, or MG 3700.

Students who completed MG 3910 in 1999-2000 may not receive credit for this course.

MG 3920. PLANNING AND LAUNCHING NEW VENTURES.  
Cat. I  
This course focuses on business plan development, especially the financial aspects of the plan. The intent is that students will use a feasibility analysis, such as the one completed in MG 3910, and turn that into a complete business plan. Additionally, students will learn about seed capital, venture, and other means of financing new ventures.

Recommended background for this course consists of MG 3910, MG/IE 2850 and two of the following: MG 1100, MG 2950, MG 3400, MG 3600, or MG 3700.

Students may not receive credit for both ID 1050 and MG 3920.

MG 4151. COST ACCOUNTING.  
Cat. I  
This course is designed to give basic understanding and skill in the area of cost accumulation to anyone concerned with recording the expenses associated with a given activity or project.

Cost accounting provides data for three major purposes: 1) planning and controlling routine operations, 2) making non-routine decisions, and 3) inventory valuation and income determination. All three are important, but the course stresses the first two as they relate to project activity.

The goal of the course is to put cost accounting in focus as a highly useful technique in any decision-making situation where expense levels are important. While some attention is directed toward accounting systems and procedures for data accumulation, stress is given to the theme that cost accounting is a vital and dynamic tool for problem-solving.

Recommended background: MG 1100.

This course will be offered in 2003-04 and in alternate years thereafter.

MG 4364. HUMAN RESOURCE MANAGEMENT.  
Cat. II  
This course in applied organizational sciences introduces concepts and techniques of human resource management. It provides experience in the solution of a variety of human resource problems through classroom exercises and organizational cases, introducing and building upon the basic concepts and techniques of industrial and organizational psychology. The course focuses on changing labor markets, employee recruitment and selection, performance appraisal and compensation, job evaluation, training and development, job design, labor relations, diversity and gender issues in the workplace, government involvement in human resource issues, job satisfaction, and motivation to work.

Recommended background: MG/IE 2300 or agreement of the professor.

This course will be offered in 2002-03 and in alternating years thereafter.
MG 4365. LEADERSHIP IN GROUPS AND ORGANIZATIONS.
Cat. II
This course considers the essence of leadership in groups and organizations. Specifically, it examines the personal, interpersonal, group, and contextual factors which affect formal and emergent leadership in groups and organizations. It also examines the effectiveness of various leadership approaches and styles under various conditions. Using case studies, simulations, group projects, and selected readings on leadership in groups and organizations, this course will give students an opportunity to assess and develop their own leadership talents.
Recommended background: MG/IE 2300 or consent of the professor.

MG/IE 4410. CASE STUDIES IN INDUSTRIAL ENGINEERING.
Cat. I
A number of in-depth case studies in operations and industrial engineering are analyzed. The cases will cover both manufacturing and service systems ranging from production system design to operations planning and control.
Recommended background: MG/IE 3400, MG/IE 3401, MG/IE 2500 and MG/IE 3501.
Students may not receive credit for both MG/IE 3410 and MG/IE 4410.

MG/IE 4460. GLOBAL PLANNING AND LOGISTICS.
Cat. II
This case-based course will examine methods and strategies for managing and controlling material movement, with particular emphasis on international operations, from the purchase of production materials to the control of work in process to the distribution of the finished product. Strategies that will be discussed include the design of international distribution networks, the use of third-party logistics providers, and the creation of links between logistic systems and marketing to create competitive advantage. The course will also explore tactical issues that must be managed to pursue a logistics strategy successfully, including choices regarding means of transportation, packaging, and inventory policies.
Underlying themes of the course will be the use of information technologies (such as electronic data interchange and bar coding) and mathematical models to support logistics decision-making.
Recommended background: MG/IE 3400 and MG/IE 2200 or MG/IE 3400 and MG/IE 2500 or consent of professor.

MG/IE 4720. SYSTEMS ANALYSIS AND DESIGN.
Cat. I
This course integrates students' background in MIS in a one-term project focusing on development of creative solutions to open-ended business and manufacturing problems. The project will utilize systems analysis and design tools such as systems development life cycle, feasibility study, cost-benefit analysis, structured analysis and design. Students will acquire the skills necessary to analyze, develop, implement, and document real-life information systems. Students must be able to organize themselves and the project to complete their work within a seven week term. It is recommended that MIS majors take this course in preparation for their MQP. Students may not receive credit for both MG 3750 and MG 4720.
Recommended background: MG 3720.

MG 4750. MANAGEMENT OF THE IS FUNCTION.
Cat. II
This course integrates students' background in management policy and business analysis and addresses the practical problems of developing and running an IS organization. It focuses on the planning and management required to assure systems development life cycle, feasibility study, cost-benefit analysis, structured analysis and design. Students will acquire the skills necessary to analyze, develop, implement, and document real-life information systems. Students must be able to organize themselves and the project to complete their work within a seven week term. It is recommended that MIS majors take this course in preparation for their MQP. Students may not receive credit for both MG 3750 and MG 4720.
Recommended background: MG 3720.

MG 4930. GROWING AND MANAGING NEW VENTURES.
Cat. I
One of the most troublesome aspects of entrepreneurship is running the business once it is started. This course focuses on techniques to grow the new venture and how to manage both the growth and operations. Considerable emphasis will be placed on expanding existing markets, finding new markets, anticipating the next generation of products, and managing cash flow. This course is the capstone course for both the Entrepreneurship Minor and the Management Minor.
Recommended background for this course consists of five of the following: MG 1100, MG 1900, MG 2101, MG/IE 2300, MG/IE 2500, MG 2500, MG 3400, MG 3600, MG 3700, MG 3910, MG 3920.
Students may not receive credit for both MG 3960 and MG 4930.

IS4-MG SEMINAR*:
Current developments in management seminars will be organized periodically and announced in the Undergraduate Catalog. No more than 1/3 credit will be available for this type #4 IS/P.
*Initials of instructors in charge will appear in Undergraduate Catalog in addition to a description of seminar to be offered.

MATHEMATICAL SCIENCES

The second digit in mathematical sciences course numbers is coded as follows:
0 — Basic
2 — Applied mathematics (general)
4 — Applied mathematics (differential equations)
6 — Statistics and probability
8 — Mathematics (general)

MA 1020. CALCULUS I WITH PRELIMINARY TOPICS.
Cat. I (14-week course)
This course includes the topics of MA 1021 and also presents selected topics from algebra, trigonometry, and analytic geometry.
This course, which extends for 14 weeks and offers 1 1/3 unit of credit, is designed for students whose precalculus mathematics is not adequate for MA 1021. Although the course will make use of computers, no programming experience is assumed.

MA 1021. CALCULUS I.
Cat. I
This course provides an introduction to differentiation and its applications. Topics covered include: functions and their graphs, limits, continuity, differentiation, linear approximation, chain rule, min/max problems, and applications of derivatives.
Recommended background: Algebra, trigonometry and analytic geometry.
Although the course will make use of computers, no programming experience is assumed.

MA 1022. CALCULUS II.
Cat. I
This course provides an introduction to integration and its applications. Topics covered include: inverse trigonometric functions, Riemann sums, fundamental theorem of calculus, basic techniques of integration, volumes of revolution, arc length, exponential and logarithmic functions, and applications.
Recommended background: MA 1021.
Although the course will make use of computers, no programming experience is assumed.

MA 1023. CALCULUS III.
Cat. I
This course provides an introduction to series, parametric curves and vector algebra.
Topics covered include: numerical methods, indeterminate forms, improper integrals, sequences, Taylor's theorem with remainder, convergence of series and power series, polar coordinates, parametric curves and vector algebra.
Recommended background: MA 1022.
Although the course will make use of computers, no programming experience is assumed.

MA 1024. CALCULUS IV.
Cat. I
This course provides an introduction to multivariable calculus.
Topics covered include: vector functions, partial derivatives and gradient, multivariable optimization, double and triple integrals, polar coordinates, other coordinate systems and applications.
Recommended background: MA 1023.
Although the course will make use of computers, no programming experience is assumed.

MA 2051. ORDINARY DIFFERENTIAL EQUATIONS.
Cat. I
This course develops techniques for solving ordinary differential equations. Topics covered include: introduction to modeling using first-order differential equations, solution methods for linear higher-order equations, qualitative behavior of nonlinear first-order equations, oscillatory phenomena including spring-mass system and RLC-circuits and Laplace transform. Additional topics may be chosen from power series method, methods for solving systems of equations and numerical methods for solving ordinary differential equations.
Recommended background: MA 1024.

MA 2071. MATRICES AND LINEAR ALGEBRA I.
Cat. I
This course provides a study of computational techniques of matrix algebra and an introduction to vector spaces.
Topics covered include: matrix algebra, systems of linear equations, eigenvalues and eigenvectors, least squares, vector spaces, inner products, and introduction to numerical techniques, and applications of linear algebra.
Recommended background: None.

MA 2073. MATRICES AND LINEAR ALGEBRA II.
Cat. I
This course provides a deeper understanding of topics introduced in MA 2071 and also continues the development of those topics. Topics covered include: abstract vector spaces, linear transformations, matrix representations of a linear transformation, characteristics and minimal polynomials, diagonalization, eigenvalues and eigenvectors, inner product spaces.
MA 2210. MATHEMATICAL METHODS IN DECISION MAKING.

This course is designed primarily for Mathematical Science majors and those interested in the deeper mathematical issues underlying linear algebra. Undergraduate credit may not be earned both for this course and for MA 3071. Recommended background: MA 2071.

MA 2211. APPLIED STATISTICS I.

Cat. I

This course is designed to introduce the student to data analytic and applied statistical methods commonly used in industrial and scientific applications as well as in course and project work at WPI. Emphasis will be on the practical aspects of statistics with students analyzing real data sets on an interactive computer package.

Topics covered include analytic and graphical representation of data, exploratory data analysis, basic issues in the design and conduct of experimental and observational studies, discrete and continuous probability models, the central limit theorem, and one and two sample point and interval estimation.

Recommended background: MA 2071.

MA 2212. APPLIED STATISTICS II.

Cat. I

This course is a continuation of MA 2211. Topics covered include tests of hypotheses, simple and multiple regression, one and two-way tables for categorical data, and design and analysis of one factor experiments.

Recommended background: MA 2211.

MA 2221. COMBINATORICS.

Cat. I

This course introduces students to the principles of decision theory as applied to the planning, design and management of complex projects. It will be useful to students in all areas of engineering, actuarial mathematics as well as those in such interdisciplinary areas as environmental studies. It emphasizes quantitative, analytic approaches to decision making using the tools of applied mathematics—operations research, probability and computations. Topics covered include: the systems approach, mathematical modeling, optimization and decision analyses. Case studies from various areas of engineering or actuarial mathematics are used to illustrate applications of the materials covered in this course.

Recommended background: MA 1024. Suggested background: Familiarity with vectors and matrices. Although the course makes use of computers, no programming experience is assumed. Students who have received credit for CE 2010 may not receive credit for MA 2210.

MA 2222. VECTOR AND TENSOR CALCULUS.

Cat. I

This course provides an introduction to tensor and vector calculus, an essential tool for applied mathematicians, scientists, and engineers.

Topics covered include: scalar and vector functions and fields, tensors, basic differential operations for vectors and tensors, line and surface integrals, change of variable theorem in integration, integral theorems of vector and tensor calculus. The theory will be illustrated by applications to areas such as electrostatics, theory of heat, electromagnetics, elasticity and fluid mechanics.

Recommended background: MA 1024.

MA 2271. GRAPH THEORY.

Cat. II

This course introduces the concepts and techniques of graph theory—a part of mathematics finding increasing application to diverse areas such as management, computer science and electrical engineering. Topics covered include: graphs and digraphs, paths and circuits, graph and digraph algorithms, trees, cliques, planarity, duality and colorability.

This course is designed primarily for Mathematical Science majors and those interested in the deeper mathematical issues underlying graph theory. Undergraduate credit may not be earned both for this course and for MA 3271. Recommended background: MA 2071. This course will be offered in 2002-03 and in alternate years thereafter.

MA 2273. COMBINATORICS.

Cat. II

This course introduces the concepts and techniques of combinatorics—a part of mathematics with applications in computer science and in the social, biological, and physical sciences. Emphasis will be given to problem solving. Topics will be selected from: basic counting methods, inclusion-exclusion principle, generating functions, recurrence relations, systems of distinct representatives, combinatorial designs, combinatorial algorithms and applications of combinatorics.

This course is designed primarily for Mathematical Sciences majors and those interested in the deeper mathematical issues underlying combinatorics. Undergraduate credit may not be earned both for this course and for MA 2273. Recommended background: MA 2071. This course will be offered in 2003-04 and in alternate years thereafter.

MA 2431. MATHEMATICAL MODELING WITH ORDINARY DIFFERENTIAL EQUATIONS.

Cat. I

This course focuses on the theoretical foundations of ordinary equations while building models for physical and biological systems. Mathematical topics may include methods for solving systems of ordinary differential equations, existence and uniqueness theory, stability theory, phase-plane analysis and limit cycles. Examples will be chosen from electrical and mechanical oscillations, control theory, ecological models and reaction kinetics. Students will learn how to turn a real-life physical or biological problem into a mathematical one and to interpret the mathematical results.

This course is designed primarily for Mathematical Sciences majors and those interested in the deeper mathematical issues underlying mathematical modeling. Undergraduate credit may not be earned both for this course and for MA 3431. Recommended background: MA 2071, MA 2051 and MA 2071.

MA 2631. PROBABILITY.

Cat. I

The purpose of this course is twofold:

- To introduce the student to probability. Topics to be covered will be chosen from: axiomatic development of probability; independence; Bayes theorem; discrete and continuous random variables; expectation; special distributions including the binomial and normal; moment generating functions; multivariate distributions; conditional and marginal distributions; independence of random variables; transformations of random variables; limit theorems.
- To introduce fundamental ideas and methods of mathematics using the study of probability as the vehicle. These ideas and methods may include systematic theorem-proof development starting with basic axioms; mathematical induction; set theory; applications of univariate and multivariate calculus.

This course is designed primarily for Mathematical Sciences majors and those interested in the deeper mathematical issues underlying probability theory. Undergraduate credit may not be earned both for this course and for MA 3613.

MA 2632. LIFE CONTINGENCIES.

Cat. I

A continuation of a study of actuarial mathematics with emphasis on the theory and application of contingency mathematics in the areas of life insurance and annuities.

Topics usually included are: measurement of interest, including accumulated and present value factors; annuities certain; amortization schedules and sinking funds; and bonds.

Recommended background: MA 1024 and the ability to write computer programs.

MA 2633. DISCRETE OPTIMIZATION.

Cat. II

Discrete optimization is a lively field of applied mathematics in which techniques from combinatorics, linear programming, and the theory of algorithms are used to solve optimization problems over discrete structures, such as networks or graphs.
The course will emphasize algorithmic solutions to general problems, their complexity, and their application to real-world problems drawn from such areas as VLSI design, telecommunications, airline crew scheduling, and product distribution.

Topics will be selected from: Network flow, optimal matching, integrality of polyhedra, matroids, and NP-completeness.

Undergraduate credit may not be earned both for this course and for MA 4233. Recommended background: At least one of MA 2271, MA 2273 or MA 3231. This course will be offered in 2002-03 and in alternate years thereafter.

MA 3257/CS 4032. NUMERICAL METHODS FOR LINEAR AND NONLINEAR SYSTEMS. Cat. I
This course provides an introduction to modern computational methods for linear and nonlinear equations and systems and their applications.

Topics covered include: solution of nonlinear scalar equations, direct and iterative algorithms for the solution of systems of linear equations, solution of nonlinear systems, the eigenvalue problem for matrices. Error analysis will be emphasized throughout.

Recommended background: MA 2071. An ability to write computer programs in a scientific language is assumed.

MA 3457/CS 4033. NUMERICAL METHODS FOR CALCULUS AND DIFFERENTIAL EQUATIONS. Cat. I
This course provides an introduction to modern computational methods for differential and integral calculus and differential equations.

Topics covered include: interpolation and polynomial approximation, approximation theory, numerical differentiation and integration, numerical solutions of ordinary differential equations. Error analysis will be emphasized throughout.

Recommended background: MA 2051. An ability to write computer programs in a scientific language is assumed. Undergraduate credit may not be earned for both this course and for MA 3255/CS 4031.

MA 3471. ADVANCED ORDINARY DIFFERENTIAL EQUATIONS. Cat. II
The first part of the course will cover existence and uniqueness of solutions, continuous dependence of solutions on parameters and initial conditions, maximal interval of existence of solutions, Gronwall’s inequality, linear systems and the variation of constants formula, Floquet theory, stability of linear and perturbed linear systems. The second part of the course will cover material selected by the instructor. Possible topics include: Introduction to dynamical systems, stability by Lyapunov’s direct method, study of periodic solutions, singular perturbation theory and nonlinear oscillation theory.

Undergraduate credit may not be earned both for this course and for MA 4471. Recommended background: MA 2431 and MA 3832. This course will be offered in 2003-04 and in alternate years thereafter.

MA 3475. CALCULUS OF VARIATIONS. Cat.II
This course covers the calculus of variations and select topics from optimal control theory. The purpose of the course is to expose students to mathematical concepts and techniques needed to handle various problems of design encountered in many fields, e.g., electrical engineering, structural mechanics and manufacturing.

Topics covered will include: derivation of the necessary conditions of a minimum for simple variational problems and problems with constraints, variational principles of mechanics and physics, direct methods of minimization of functions, Pontryagin’s maximum principle in the theory of optimal control and elements of dynamic programming.

Undergraduate credit may not be earned both for this course and for MA 4475. Recommended background: MA 2051. This course will be offered in 2002-03 and alternate years thereafter.

MA 3613. PROBABILITY FOR APPLICATIONS. Cat. I
This course is designed to introduce the student to probability.

Topics to be covered are: basic probability theory including Bayes theorem; discrete and continuous random variables; special distributions including the Bernoulli, Binomial, Geometric, Poisson, Uniform, Normal, Exponential, Chi-square, Gamma, Weibull, and Beta distributions; multivariate distributions; conditional and marginal distributions; independence; expectation; transformations of univariate random variables.

Recommended background: MA 1024.

MA 3627. APPLIED STATISTICS III. Cat. II
This course continues the exploration of statistics for scientific and industrial applications, begun in MA 2611 and MA 2612. Topics will be chosen from distribution-free methods, the design and analysis of general factorial experiments, two-level factorial and fractional factorial experiments, Taguchi methods, response surface analysis, and statistical quality control.

Recommended background: MA 2612. This course will be offered in 2003-04, and in alternating years thereafter.

MA 3631. MATHEMATICAL STATISTICS. Cat. I
This course introduces students to the mathematical principles of statistics. Topics will be chosen from: Sampling distributions, limit theorems, point and interval estimation, sufficiency, completeness, efficiency, consistency; the Rao-Blackwell theorem and the Cramer-Rao bound; minimum variance unbiased estimators and maximum likelihood estimators; tests of hypotheses including the Neyman-Pearson lemma, uniformly most powerful and likelihood ratio tests.

Recommended background: MA 2631.

MA 3823. GROUP THEORY. Cat. II
This course provides an introduction to one of the major areas of modern algebra. Topics covered include: groups, subgroups, permutation groups, normal subgroups, factor groups, homomorphisms, isomorphisms and the fundamental homomorphism theorem. Recommended background: MA 2073. This course will be offered in 2002-03 and in alternate years thereafter.

Undergraduate credit may not be earned both for this course and for MA 3821.

MA 3825. RINGS AND FIELDS. Cat. II
This course provides an introduction to one of the major areas of modern algebra. Topics covered include: rings, integral domains, ideals, quotient rings, ring homomorphisms, polynomial rings, polynomial factorization, extensions, fields and properties of finite fields. Recommended background: MA 2073. This course will be offered in 2003-04 and in alternate years thereafter.

Undergraduate credit may not be earned both for this course and for MA 3821.

MA 3831. ADVANCED CALCULUS I. Cat. I
Advanced Calculus is a two-part course giving a rigorous presentation of the important concepts of classical real analysis. Topics covered in the two-course sequence include: basic set theory, elementary topology of Euclidean spaces, limits and continuity, differentiation Reimann-Stieltjes integration, infinite series, sequences of functions, and topics in multivariate calculus. Recommended background: MA 2051 and MA 2071.

MA 3832. ADVANCED CALCULUS II. Cat. I
MA 3832 is a continuation of MA 3831. For the contents of this course, see the description given for MA 3831. Recommended background: MA 3831.

MA 4213. RISK THEORY. Cat. II
This course covers topics in risk theory as it is applied, under specified assumptions, to insurance.

Topics covered include: economics of insurance, short term individual risk models, single period and extended period collective risk models, and applications. Recommended background: MA 2631. This course will be offered in 2003-04 and in alternate years thereafter.

MA 4214. SURVIVAL MODELS. Cat. II
Survival models are statistical models of times to occurrence of some event. They are widely used in areas such as the life sciences and actuarial science (where they model such events as time to death, or to the development or recurrence of a disease), and engineering (where they model the reliability or useful life of products or processes). This course introduces the nature and properties of survival models, and considers techniques for estimation and testing of such models using realistic data.

Topics covered will be chosen from: parametric and nonparametric survival models, censoring and truncation, nonparametric estimation (including confidence intervals and hypothesis testing) using right-, left-, and otherwise censored or truncated data.

Recommended background: MA 3631. This course will be offered in 2002-03, and in alternating years thereafter.

MA 4235. MATHEMATICAL OPTIMIZATION. Cat. II
This course explores theoretical conditions for the existence of solutions and effective computational procedures to find these solutions for optimization problems involving nonlinear functions.

Topics covered include: classical optimization techniques, Lagrange multipliers and Kuhn-Tucker theory, duality in nonlinear programming, and algorithms for constrained and unconstrained problems.

Recommended background: Vector calculus at the level of MA 2251.

MA 4237. PROBABILISTIC METHODS IN OPERATIONS RESEARCH. Cat. II
This course develops probabilistic methods useful to planners and decision makers in such areas as strategic planning, service facilities design, and failure of complex systems.
Topics covered include: decisions theory, inventory theory, queuing theory, reliability theory, and simulation. Recommended background: Probability theory at the level of MA 3613 or MA 2631.

This course will be offered in 2003-04 and in alternate years thereafter.

MA 4291. APPLICABLE COMPLEX VARIABLES. 
Cat. I
This course provides an introduction to the ideas and techniques of complex analysis that are frequently used by scientists and engineers. The presentation will follow a middle ground between rigor and intuition.

Topics covered include: complex numbers, analytic functions, Taylor and Laurent expansions, Cauchy integral theorem, residue theory, and conformal mappings. Recommended background: MA 1024 and MA 2051.

MA 4411. NUMERICAL ANALYSIS OF DIFFERENTIAL EQUATIONS. 
Cat. II
This course is concerned with the development and analysis of numerical methods for differential equations.

Topics covered include: well-posedness of initial value problems, analysis of Euler’s method, local and global truncation error, Runge-Kutta methods, higher order equations and systems of equations, convergence and stability analysis of one-step methods, multistep methods, methods for stiff differential equations and absolute stability, introduction to methods for partial differential equations. Recommended background: MA 2071 and MA 3457/CS 4037. An ability to write computer programs in a scientific language is assumed.

This course will be offered in 2002-03, and in alternating years thereafter.

MA 4451. BOUNDARY VALUE PROBLEMS. 
Cat. I
Science and engineering majors often encounter partial differential equations in the study of heat flow, vibrations, electric circuits and similar areas. Solution techniques for these types of problems will be emphasized in this course.

Topics covered include: derivation of partial differential equations as models of prototype problems in the areas mentioned above, Fourier Series, solution of linear partial differential equations by separation of variables, Fourier integrals and a study of Bessel functions.

Recommended background: MA 1024 or and MA 2051.

MA 4473. PARTIAL DIFFERENTIAL EQUATIONS. 
Cat. II
The first part of the course will cover the following topics: classification of partial differential equations, solving simple first order equations by the method of characteristics, solutions of Laplace’s and Poisson’s equations including the construction of Green’s function, solutions of the heat equation including the construction of the fundamental solution, maximum principles for elliptic and parabolic equations. For the second part of the course, the instructor may choose to expand on any one of the above topics.

Recommended background: MA 2521 and MA 3832.

This course will be offered in 2002-03 and in alternate years thereafter.

MA 4631. PROBABILITY AND MATHEMATICAL STATISTICS I. 
Cat. I (14 week course)
Intended for advanced undergraduates and beginning graduate students in the mathematical sciences and for others intending to pursue the mathematical study of probability and statistics, this course begins by covering the material of MA 3613 at a more advanced level. Additional topics covered are: one-to-one and many-to-one transformations of random variables; sampling distributions; order statistics, limit theorems.

Recommended background: MA 2631 or MA 3613, MA 3831 - MA 3832.

MA 4632. PROBABILITY AND MATHEMATICAL STATISTICS II. 
Cat. I (14 week course)
This course is designed to complement MA 4631 and provide background in principles of statistics.

Topics covered include: point and interval estimation; sufficiency, completeness, efficiency, consistency; the Rao-Blackwell theorem and the Cramer-Rao bound; minimum variance unbiased estimators, maximum likelihood estimators and Bayes estimators; tests of hypothesis including uniformly most powerful, likelihood ratio, minimax and bayesian tests.

Recommended background: MA 3631 or MA 4631.

MA 4658. STATISTICAL CONSULTING. 
Cat. I (14 week course)
After suitable preparation through readings and discussion, undergraduate students will learn about statistical practice as part of a statistical consulting team consisting of undergraduate and graduate students. The team will provide statistical expertise to clients from the WPI community under faculty supervision. There are no formal prerequisites, but knowledge of a range of statistical methodology, such as that supplied by MA 2611-12 and MA 3627, is strongly recommended.

MA 4891. TOPICS IN MATHEMATICS. 
Cat. I

ME 1520. THE TECHNOLOGY OF ALPINE SKIING. 
Cat. I
This course explores science and engineering issues associated with equipment and technique for alpine skiing, particularly racing. A diverse group of technical subjects related to engineering mechanics are discussed: tribology, beams, rigid body motion, material science, machining, and biomechanics. Specifically we will examine: ski-snow interactions, technique for gliding, turning and stopping, selection of line in racing; equipment design, testing and performance; and ski injuries. We will also address issues in the epidemiology of skiing injuries, the calculation of the cost of ski injuries to society, the impact of ski equipment technology on litigation and the impact of litigation on equipment and trul design.

This course will be offered in 2003-04, and in alternating years thereafter.

ME 1800. MATERIALS SELECTION AND MANUFACTURING PROCESSES. 
Cat. I
This course is designed to introduce the student to the engineering fundamentals of the most commonly encountered manufacturing processes. A thorough treatment of manufacturing processes including forging, casting, machining and assembly is assumed. The course will be offered in 2002-03 and in alternating years thereafter.

ME 2300. INTRODUCTION TO ENGINEERING DESIGN. 
Cat. I
Real world engineering design problems usually have more than one correct solution. This course utilizes a realistic design process to introduce students to the methods and techniques for solving engineering problems. Lectures will support the design projects and may cover engineering economics, fluid dynamics, heat transfer, mechanics, statistics, and design circuits. No prior knowledge of fluids, heat transfer, economics, statistics or electrical circuits is required. Laboratory sessions will be used to build, test and demonstrate various designs.

This course is designed for sophomores and juniors to provide a broad overview of engineering design.

The course includes a significant writing component and makes extensive use of PCs for word processing, spread sheet calculations and programming.

Recommended background: Calculus, MA 2051, PH 1110, ES 2501, and any programming language (BASIC, Fortran, Pascal, C).

Recommended background: Ordinary Differential Equations (MA 2051), mechanics (PH 1110), statics (ES 2501), any programming language.

ME 2713. ASTRONAUTICS. 
Cat. I
Topics studied: Orbital mechanics including spacecraft maneuvering and station keeping, transfer orbits, and interplanetary transfers; space environment including characteristics of low earth highly elliptical and geosynchronous orbits; ascent and reentry trajectories.

Recommended background: Dynamics (ES 2503).

ME 2820. MATERIALS PROCESSING. 
Cat. I
An introduction to material processing in manufacturing. This course provides important background for anyone interested in manufacturing, design engineering design, sales, or management.

Processing of polymers, ceramics, metals and composites is discussed. Processes covered include: rolling, injection molding, forging, powder metallurgy, joining and machining. The relationships between materials, processes, processing parameters and the properties of manufactured parts are developed. During the course the students should develop the ability to choose materials, processes, and processing parameters for designing manufacturing procedures to take a prototype part to production.
ME 3023. MECHANICAL BEHAVIOR AND MODELING PROPERTIES OF ENGINEERING MATERIALS.
Cat. I
This course is concerned with different types of material response to mechanical loads. The course studies the constitutive equations that are used to model the properties of engineering materials. The behavior of elastic, plastic, composite, and visco-elastic materials is considered. Experiments describing materials behaviors will be conducted and the behavior will be modeled.

Topics include: descriptions of material behavior, methods of determining the material parameters from experimental tests, behavior of different types of materials under simple states of loading and deformation such as tensile stress-strain response (elastic and plastic), and time-dependent behavior at room and elevated temperature (viscoelasticity and creep) are studied. Theories of failure and fracture modes under monotonic and cyclic loading, fracture and fracture mechanics, and methods of modifying material behavior are discussed. These topics will be integrated in several material selection projects.
Recommended background: statics (ES 2501), stress analysis (ES 2502), continuum mechanics (ES 3501), materials (ES 2001).

ME 3310. KINEMATICS OF MECHANISMS.
Cat. I
An introduction to the synthesis and analysis of linkages, cams and gear trains is presented. The design process is introduced and used to solve unstructured design problems in linkage and cam design. Algebraic and graphical techniques to analyze the displacement, velocity and acceleration of linkages and mechanisms are developed. Computer programs for the design and analysis of linkages are used by students. Results of student design projects are presented in professional engineering reports.
Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), dynamics (ES 2503).

ME 3311. DYNAMICS OF MECHANISMS AND MACHINES.
Cat. I
This course provides an in-depth study of forces in dynamic systems. Dynamic force analysis is developed using matrix methods. Computer programs are used to solve the sets of simultaneous equations derived by students for realistic, unstructured design problems. Inertial and shaking forces, elementary mechanical vibrations, torque-time functions, rotational and reciprocating balance and cam dynamics are covered using the internal combustion engine as a design example. Students execute unstructured design projects and prepare professional engineering reports on the results. Computers are used extensively to solve the dynamic equations.
Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), dynamics (ES 2503), kinematics (ME 3310), linear algebra.

ME 3320. DESIGN OF MACHINE ELEMENTS.
Cat. I
This is an introductory course in mechanical design analysis, and it examines stress and fatigue in many machine elements. Common machine elements are studied and methods of selection and design are related to the associated hardware.
Topics covered include: combined stresses, fatigue analysis, design of shafts, springs, gears, bearings and miscellaneous machine elements.
Recommended background: mechanics (ES 2501, ES 2502, ES 2503), materials (ME 1800, ME 2820), computer programming (CS 1001).

ME 3321. DYNAMIC MODELING.
Cat. I
This course introduces students to the modeling and analysis of dynamic systems. A unified treatment of mechanical, electrical, fluid and thermal systems is presented using the bond graph modeling language. The creation of dynamic models and the analysis of model response is emphasized.
Lecture topics include energy storage and dissipation elements, transducers, transformers, formulation of equations for a dynamic system and time response of linear systems. Computers are used extensively for both system modeling and analysis.
Recommended background: mathematics (MA 2051, MA 2071), fluids (ES 3004), mechanics (ES 2501, ES 2503).

ME 3410. COMPRESSIBLE FLOW.
Cat. I
The application of basic thermodynamics and fluid mechanics to model the flow phenomena of compressible fluids. The assumptions leading to various flow models and the limits of these models are emphasized. The approach is, in the main, a one-dimensional control volume analysis, and the course is designed for engineering students.
Topics covered include: one-dimensional unsteady flow, flow with heat transfer, flow with friction, normal and oblique shock waves, flow with chemical reaction, and flow with applied electric and magnetic fields.
Recommended background: thermodynamics (ES 3001), fluids (ES 3004).

ME 3501. ELEMENTARY CONTINUUM MECHANICS.
Cat. I
This course is designed to teach the basic techniques of solving problems in mechanics, and to provide the student with the ability to apply these techniques to real-life problems. The course covers a wide range of topics, including statics, dynamics, kinematics, and materials behavior. Emphasis is placed on the development of problem-solving skills and on the application of these skills to real-world problems.
Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), dynamics (ES 2503).

ME 3502. ADVANCED MECHANICS OF MATERIALS.
Cat. I
This course is designed to provide students with a deeper understanding of the behavior of materials under various types of loading. The course covers topics such as stress analysis, fatigue, fracture mechanics, and composite materials. Emphasis is placed on the development of problem-solving skills and on the application of these skills to real-world problems.
Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), stress analysis (ES 2502).

ME 3505. MECHANICAL VIBRATIONS.
Cat. I
This course is designed to introduce students to the fundamental concepts of mechanical vibrations, which are important in the design and analysis of mechanical and structural systems subjected to time varying loads. The objective of the course is to expose students to the conceptual and mathematical modeling of mechanical systems under the action of dynamic loads.
Topics covered include: formulation of the equations of motions for flexible and deformable bodies using Newton's Laws, D'Lambert's Principle, and energy methods; prediction of natural frequency for single-degree-of-freedom systems, modeling the stiffness characteristics, damping, and other vibrational properties of a mechanical systems, some basics of frequency response analysis and Duhamel integral methods. The course is mainly focused on the analysis of single-degree-of-freedom systems, however, a basic introduction to multi-degree-of-freedom systems may also be considered.
Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), dynamics (ES 2503).

ME 3506. REHABILITATION ENGINEERING.
Cat. I
This course is designed for students who want to learn the principles and techniques of rehabilitation engineering, which is the process of designing and building structures, devices, and systems to improve the quality of life for people with disabilities. The course covers topics such as ergonomics, physical and cognitive parameters that effect the user interface, safety, economics, reliability and esthetics. Design and analysis of devices used for mobility and in daily activities in residential, educational and vocational settings. Laboratory sessions will be used to develop conceptual designs that solve real problems.
Recommended background: mechanics (ES 2501, ES 2502, ES 2503), kinematics (ME 3310), design (ME 2300), materials (ME 1800, ME 2820), electrical engineering (EE 3601).

ME 3512. INTRODUCTION TO THE FINITE ELEMENT METHOD.
Cat. I
This course introduces students to the basic concepts and techniques of the finite element method, which is a powerful tool for solving problems in engineering. The course covers topics such as the formulation of the finite element method, the assembly of the finite element equations, and the solution of these equations using numerical methods. Emphasis is placed on the development of problem-solving skills and on the application of these skills to real-world problems.
Recommended background: mathematics (MA 2051, MA 2071), mechanics (ME 3310), fluids (ES 3004), materials (ME 2001, ME 2820), computer programming (CS 1001).

ME 3601. PRINCIPLES OF MECHANICAL ENGINEERING
Cat. I
Intended for students other than mechanical or manufacturing engineering students, this course is oriented towards developing competence in mechanical engineering concepts on the level that the technology interfaces directly with their own discipline. The course is designed specifically to help students meet the challenge that students will face in the development of a broad systems perspective and in understanding of the principal elements of mechanical engineering technology. The expectation is that students completing this course will be able to handle adequately the mechanical aspects of a broad range of application topics. In addition, and most important, they will be prepared to work effectively with mechanical engineers on the joint solution of complex problems.
Topics covered during the course include, but are not limited to, the fundamentals of: statics, dynamics, kinematics, materials, materials behavior, fluid.
dynamics, thermodynamics, stress analysis, vibrations, error and uncertainty analysis, as well as current trends and future directions in solution methodologies, and will be illustrated with representative applications, such as, electrothermo-mechanical and viscoelastic systems, electronic packaging, and MEMS. Selected projects are included to emphasize the direct application of the information presented in lectures.

Intended for non-Mechanical Engineering or non-Manufacturing Engineering majors.

Recommended background: MA 1021-1024, MA 2051, CH 1010, PH 1110/1111-PH1120/1121, or equivalent. Intended audience, non-mechanical and manufacturing majors.

**ME 3602. INTERMEDIATE FLUID DYNAMICS.**

*Cat. I*

A second course in fluid mechanics concerned with the application of basic principles. Applications include velocity potentials and stream functions, fluid machinery, pipe network and unsteady flow. The equations of viscous flow are developed with applications including exact solutions, energy, dissipation and introductory boundary layer theory.

Recommended background: fluids (ES 3004).

**ME 3711. AERODYNAMICS I.**

*Cat. I*

A first course in the science and engineering of heavier-than-air flight vehicles. Topics covered include: application of fluid mechanics and thermodynamic principles to study lift and drag, the effects of viscosity and compressibility, methods of estimating performance, and the elements of stability. The theory of airfoil circulation is developed and used to examine induced drag, downwash, ground effect and vortex wake turbulence.

Methods of characterizing and presenting airflow performance data are developed and utilized to examine the performance of wings. Propulsion systems, including propellers and their effects on flight performance are discussed. Longitudinal, lateral and turning stability of aircraft are considered for both static and dynamic conditions.

Recommended background: thermodynamics (ES 3001), fluids (ES 3004).

**ME 3715. ROCKET AND SPACECRAFT PROPULSION.**

*Cat. II*

This course provides an introductory study of propulsion systems for launch vehicles and spacecraft. Rocket propulsion systems discussed include solid, liquid-biopropellant and hybrid. Spacecraft propulsion systems discussed include cold gas, solid, liquid and electric. Advanced propulsion and micropropulsion concepts are introduced. Issues associated with combustor, nozzle, and propellant storage and feed systems are discussed.

Recommended background: thermodynamics (ES 3001), fluid mechanics (ES 3004), heat transfer (ES 3003), spacecraft (ME 3602), intermediate fluid mechanics (ME 3602), compressible flow (ME 3410) or supersonic aerodynamics (ME 4712).

This course will be offered in 2003-04 and in alternating years thereafter.

**ME 3716. AIR BREATHING PROPULSION.**

*Cat. II*

This course provides a study of air breathing engines for aircraft and ground-based applications. Topics covered include: Thermodynamic cycles and fluid dynamics of air engines, including gas turbines (turbojets, turbosfans, turboprops), ramjets, and scramjets. Performance of specific engine components such as inlet, combustors, nozzles, as well as axial compressors and turbines will be addressed.

Recommended background: thermodynamics (ES 3001), fluid mechanics (ES 3004), aerodynamics I (ME 3711), and compressible flow (ME 3410).

This course will be offered in 2002-03 and in alternating years thereafter.

**ME 3811. MICROSTRUCTURE ANALYSIS AND CONTROL.**

*Cat. I*

An in-depth study of the microstructure and properties of alloy systems in current use.

Topics covered include: interpretation of microstructure and its relationship to engineering properties, and the design of microstructures. Among the alloy systems studied are low alloy steels, alloyed steels, cast iron, copper base alloys, aluminum alloys, titanium alloys, nickel base superalloys and composites.

Recommended background: materials science (ES 2001).

**ME 3820. COMPUTER-AIDED MANUFACTURING.**

*Cat. I*

This introductory course in modern control systems will give students an understanding of the basic techniques, and the range of equipment used in most computer controlled manufacturing operations. The class work is reinforced by hands-on laboratories in the Robotics/CAM lab. Modeling and analysis of machining processes, and applications of PLC (programmable logic control) are included.

Class topics include: Manufacturing Automation, Microcomputers for Process Monitoring and Control, Computer Numerical Control, Switching Theory and Ladder Logic, Transducers and Signal Conditioning, and Closed Loop Digital Control. The laboratories allow students to program and implement several types of the controllers, and will provide an introduction to the topic of industrial robotics.

Recommended background: manufacturing (ME 1800), elementary computer/logic device programming.

**ME 3901. ENGINEERING EXPERIMENTATION.**

*Cat. I*

A course designed to develop analytical and experimental skills in modern engineering measurement methods, based on electronic instrumentation and computer-based data acquisition systems. The lectures are concerned with the engineering analysis and design as well as the principles of instrumentation, whereas the laboratories afford the student an opportunity to use modern devices in actual experiments.

Lecture topics include: review of engineering fundamentals and, among others, discussions of standards, measurement and sensor devices, measurement planning, data acquisition, analysis of experimental data, and report writing.

Laboratory experiments address both mechanical and thermal systems and instrumentation in either traditional mechanical engineering (heat transfer, flow measurement/visualization, forced/stratified measurement, motion/vibration measurement) or materials engineering (temperature and pressure measurements in materials processing, measurement of strain and position in mechanical testing of materials). Each year students will be notified which type of experiments will be used in each term offered. Students may also consult with their academic advisor or the Mechanical Engineering department office.


**ME 4010. MECHANICAL ENGINEERING SENIOR SEMINAR.**

*Cat. I*

For students who will soon be entering the engineering profession.

Current thought on mechanical engineering and related engineering problems presented by staff members and visiting lecturers from the engineering profession. Emphasis is placed on the transition from engineering student to professional engineer.

Registration as a junior or senior is assumed; not for credit.

**ME 4320. ADVANCED ENGINEERING DESIGN.**

*Cat. I*

This course integrates students’ background in ME in a one-term design project that is usually taken from a local company. Students must organize themselves and the project to successfully realize a product that meets customer needs. Activities include problem definition, design analysis, mathematical modeling, CAD modeling, manufacturing, testing, liaison to vendors, customer relations, marketing, technical management, purchasing, report writing, and oral presentations.

Recommended background: mechanisms (ME 3310, ME 3311), stress analysis (ES 3502), design (ME 3320), thermo-fluids (ES 3001, ES 3003, ES 3004), materials (ES 2001), manufacturing (ME 1800).

**ME 4412. INTRODUCTION TO COMBUSTION.**

*Cat. II*

This course will be an introduction to chemical and physical aspects of combustion.

Topics covered include thermodynamics of combustion, chemical kinetics, premixed flames, diffusion flames, ignition, detonation, pollutant formation, advanced and conventional combustion systems and combustion measurement techniques.

Course emphasis will be on developing basic understanding of combustion phenomena relevant to engineering applications of combustion. Computer programming and available software may be employed to solve combustion problems.

This course may be used toward a graduate degree by submission of an additional report based on a review of research literature as arranged with the instructor.

Recommended background: thermodynamics (ES 3001), fluids (ES 3004).

Offered in 2003-04 and in alternating years thereafter.

**ME 4429. THERMOFLUID APPLICATION AND DESIGN.**

*Cat. I*

This course integrates thermodynamics, fluid mechanics and heat transfer through the use of design projects involving modern technologies, such as electronic cooling, vapor compression power cycles, and turbines. Activities include problem definition, design creation and analysis, mathematical modeling, cost analysis and optimization.

Recommended background: thermofluids (ES 3001, ES 3003, ES 3004) and an introduction to design.

**ME 4430. INTEGRATED THERMOELECTRICAL DESIGN AND ANALYSIS.**

*Cat. II*

Current state-of-the-art computer based methodologies used in the design and analysis of thermoelectrical systems will be presented and illustrated by selected laboratory demonstrations, and used in projects. Projects will include thermal, mechanical, electronic, and photonic loads of steady state and dynamic nature and will integrate design, analysis, and testing. Students will prepare a technical report and present their results. Topics will include, but not be limited to, thermoelectrics of fiber optic telecommunication cables, high-energy beam interactions with materials, shape memory alloys, microelectronics, MEMS and mechatronics.

Recommended background: MA 2051, ES 2501, ES 2502, ES 3003, EE 3601, ME 3901, and an introduction to design.

This course will be offered in 2003-04 and in alternating years thereafter.
ME 4504. BIOMECHANICS.
Cat. II
This course emphasizes the applications of mechanics to describe the material properties of living tissues. It is concerned with the description and measurement of these properties as related to their physiological functions. Emphasis on the interrelationships between biomechanics and physiology in medicine, surgery, body injury and protheses.
Topics covered include: review of basic mechanics, stress, strain, constitutive equations and the field equations, viscoelastic behavior, and models of material behavior. The measurement and characterization of properties of tendons, skin, muscles and bone. Biomechanics as related to body injury and the design of prosthetic devices.
Recommended background: mechanics (ES 2501, ES 2502, ES 2503, ME 3501), mathematics (MA 2051).
Offered in 2003-04 and in alternating years thereafter.

ME 4505. ADVANCED DYNAMICS.
Cat. II
This course completes a sequence of sophomore, junior and senior courses in Dynamic Systems, i.e., ES 2503, ME 3505, and ME 4505, which are essential in an undergraduate Mechanical Engineering curriculum. An advanced course intended to emphasize the development and applications of dynamics in three-dimensional space. Problem solutions emphasize the use of vector algebra, matrix methods and differential equations with a goal of developing the student’s ability to translate physical problems into mathematical models.
Topics covered include: three-dimensional kinematics using rotating and stationary frames of reference, development of force, energy and momentum equations governing general particle and rigid body systems. Applications of equations to rigid, elastic, and fluid problems.
Recommended background: dynamics (ES 2503).

ME 4530. COMPUTATIONAL METHODS IN MECHANICAL ENGINEERING.
Cat. II
This course teaches the students how to analyze and solve complicated mechanical engineering problems utilizing state-of-the-art numerical analysis methods and digital computer. Some fundamental numerical schemes such as roots of algebraic and transcendental equations; solution of simultaneous algebraic equations; matrix analysis; curve fitting and data interpolation; numerical integration and differentiation; numerical solution of differential equations; symbolic manipulation and numerical solution of linear and nonlinear differential equations; Fourier and frequency response analysis; eigenvalue problems; and other numerical analysis problems are considered. Emphasis will be on modeling, numerical formulation and numerical and symbolic solution of practical problems in mechanical engineering. Fundamentals of FORTRAN programming are also included.
Recommended background: mechanics (ES 2501, ES 2502, ES 2503), mathematics (MA 2051, MA 2071).

ME 4605. COMPUTATIONAL FLUID MECHANICS.
Cat. I
This course serves as an introduction to the use of finite-difference methods to solve fluid flow problems.
Topics covered include: difference approximations; truncation error and consistency; the development of finite-difference equations from partial differential equations using Taylor series, polynomial fitting, integral methods, and control volumes; algebraic mapping and irregular grid generation; stability; explicit and implicit differences; iterative solutions using Gaussian elimination, Thomas’ algorithm, Gauss-Seidel, and Successive Over-Relaxation; boundary layer solutions using Dufort-Frankel and Crank-Nicolson; Navier-Stokes solutions using the vorticity transport-stream-function and primitive variable approaches.
Recommended background: fluids (ES 3602).

ME/BE 4606. BIOFLUIDS.
Cat. II
This course emphasizes the applications of fluid mechanics to biological problems. The course concentrates primarily on the human circulatory and respiratory systems. Topics covered include: blood flow in the heart, arteries, veins and microcirculation and air flow in the lungs and airways. Mass transfer across the walls of these systems is also presented.
Recommended background: continuum mechanics (ME 3501), fluids (ES 3004).
Offered in 2002-03 and in alternating years thereafter.

ME 4712. SUPERSONIC AERODYNAMICS.
Cat. I
This course introduces the study of performance and dynamic behavior of vehicles moving through fluids.
Topics covered include: subsonic and supersonic performance of aircraft and rockets, external flow fields, aerodynamic heating, shock and expansion patterns, control surface interaction, and real gas effects, aerodynamic stability including interaction with structural dynamics. Applications to flutter, dynamic stability, and control system performance.
Recommended background: aerodynamics (ME 3711).
Offered in 2002-03 and in alternating years thereafter.

ME 4715. AEROSPACE STRUCTURES.
Cat. I
Aircraft and space vehicle structural design including finite element analysis, modal analysis, and thermal loading along with traditional and composite material characteristics and selection for atmospheric and space environment are studied. Flutter, transient response, and large structure dynamics are typical examples used.
Recommended background: mechanics (ES 2501, ES 2502, ES 2503), aerodynamics (ME 3711).

ME 4724. HIGH SPEED FLOW.
Cat. II
This course will introduce the students to the physical phenomena associated with flows at supersonic/hypersonic speeds. Emphasis will be placed on the hypersonic limit and various models developed to treat the continuum flow at this limit.
Topics covered include: characterization of hypersonic flow, normal shock relations, the piston analogy and shock tube equations, oblique shocks, expansion fans at the hypersonic limit, similarity methods, the Newtonian model, Mach number independence of the inviscid equations, small disturbance theory for planar and axially symmetric bodies, lift and drag coefficients, dynamics of the viscous portion of the flow, and real gas effects.
Recommended background: thermodynamics (ES 3001), compressible flow (ME 3410), fluid dynamics (ES 3004, ME 3602), aerodynamics (ME 3711).
Offered in 2003-04 and in alternating years thereafter.

ME 4770. AIRCRAFT DESIGN.
Cat. II
This course introduces students to design of aircraft systems. Students complete a conceptual design of an aircraft in a term-long project. Students must establish design specifications, develop and analyze alternate designs, and justify their design in a written report. The design project incorporates fundamentals of aerodynamics, structures, aircraft performance, aircraft stability, and propulsion into a capstone design experience. The design project culminates in a Conceptual Design Review with oral presentations and a written final report. Design teams, software tools, and technical communication are emphasized.
Recommended background: intermediate fluid mechanics (ME 3602), aerodynamics I (ME 3711), air breathing propulsion (ME 3716), aerospace structures (ME 4715).
This course will be offered in 2003-04 and in alternating years thereafter.

ME 4771. SPACECRAFT AND MISSION DESIGN.
Cat. II
This course introduces students to design of spacecraft, spacecraft subsystem and space missions. Topics covered in lectures address mission classification and the space environment, the design of subsystems that include spacecraft power and propulsion, attitude dynamics and control, structural, thermal, and communication. Lectures are in parallel with a term-long conceptual design of a spacecraft, spacecraft subsystem or space mission. The design project culminates in a Conceptual Design Review with oral presentations and a written final report. Design teams, software tools, and technical communication are emphasized.
Recommended background: fluid mechanics (ES 3604), heat transfer (ES 3003), control engineering (ES 3611), astrodynamics (ME 2713), rocket and spacecraft propulsion (ME 3715), aerospace structures (ME 4715).
This course will be offered in 2002-03 and in alternating years thereafter.

ME 4813. CERAMICS.
Cat. II
A course which develops an understanding of the structure-property relations in ceramic materials. Content of interest to individuals interested in selecting and using ceramics as engineering materials. Limited material included on theory and practice of producing the initial shape.
Topics covered include: bonding and configuration of atoms in crystalline and noncrystalline materials, phase diagrams, microstructures, and macrostructures. Mechanical, optical and thermal properties as related to structure.
Recommended background: materials (ES 2001).

ME/BE 4814. BIOMATERIALS.
Cat. I
A course specializing in material selection and special problems associated with biomedical engineering.
Topics covered include: fundamentals of metals, plastics, and ceramics and how they can be applied to biomedical applications. Case histories of successful and unsuccessful material selections. Current literature is the primary source of material.
Recommended background: materials (ES 2001).

ME 4815. INDUSTRIAL ROBOTICS.
Cat. I
This course introduces students to robotics within manufacturing systems. Topics include: classification of robots, robot kinematics, motion generation and transmission, end effectors, motion accuracy, sensors, robot control and automation. This course is a combination of lecture, laboratory and project work, and utilizes industrial robots. Through the laboratory work, students will become familiar with robotic programming (using a robotic programming language VAL II) and the robotic teaching mode. The experimental component of the laboratory exercise measures the motion and positioning capabilities of robots as
ME 4816. MATERIALS OPTIMIZATION FOR ENGINEERS.
Cat. II
A course designed to synthesize the students’ background in materials science and engineering for selecting materials and processing methods in realistic applications. Case studies will cover a wide range of applied problems encountered in materials engineering. Current literature for newer materials and processes will be used.
Recommended background: materials (ME 2820, ME 3811, ME 3823).
Offered in 2002-03 and in alternating years thereafter.

ME 4821. CHEMISTRY, PROPERTIES, AND PROCESSING OF PLASTICS.
Cat. II
Topics covered include: polymer chemistry, physical and chemical properties, processing methods, selection of materials, comparisons of plastics with metals, design considerations, and new materials. Laboratory studies are included. Use of current literature is stressed.
Recommended background: materials (ES 2001, ME 2820).

ME 4822. SOLIDIFICATION PROCESSES.
Cat. II
A course designed for in-depth study of industrial processes based on liquid-solid transformation. Fundamentals are developed and applied to commercial processes.
Topics covered include: quantitative treatment of casting and processes, semi-solid forming, laser welding, rapid solidification, spray forming, compocasting and other emerging technologies, which utilize liquid-solid transformations. Library and laboratory work are included.
Suggested background: General understanding of heat flow, fluid flow, diffusion, and metallurgy.
Offered in 2002-03 and in alternating years thereafter.

ME 4832. CORROSION AND CORROSION CONTROL.
Cat. II
An introductory course designed to acquaint the student with the different forms of corrosion and the fundamentals of oxidation and electro-chemical corrosion.
Topics covered include: corrosion principles, environmental effects, metallurgical aspects, galvanic corrosion, crevice corrosion, pitting, intergranular corrosion, erosion corrosion, stress corrosion, cracking and hydrogen embrittlement, corrosion testing, corrosion prevention, oxidation and other high-temperature metal-gas reactions.
Recommended background: materials (ES 2001).
Offered in 2002-03 and in alternating years thereafter.

ME 4840. PHYSICAL METALLURGY.
Cat. I
Fundamental relationships between the structure and properties of engineering materials are studied. Principles of diffusion and phase transformation are applied to the strengthening of commercial alloy systems. Role of crystal lattice defects on material properties and fracture are presented.
Strongly recommended as a senior-graduate level course for students interested in pursuing a graduate program in materials or materials engineering at WPI, or other schools.
Recommended background: materials (ES 2001, ME 2820, ME 3811).

ME 4850. SOLID STATE THERMODYNAMICS.
Cat. I
Classical and atomistic thermodynamics are developed and applied to the behavior of solids, liquids and gases. Phase equilibria and phase diagrams are discussed. Emphasis is placed on the gas phase reactions and reactions between solids and gases as well as the behavior or solutions. Applications to Materials Engineering processes and phenomena are discussed.
Recommended background: materials (ES 2001, chemistry (CH 1020).

ME 4922. THEORY AND PRACTICE OF LASER INSTRUMENTATION.
Cat. II
This course introduces and analyses the fundamentals of optical and image processing techniques applicable to engineering measurements. Optical instrumentation is widely used in high precision position, vibration, and inspection applications in the industrial environment. The goal of this course is to provide a rigorous background in the basic principles preparing the student for the more advanced courses on laser instrumentation. The course will include both in-class lectures and laboratories. Topics to be covered include: accelerated recipes of light, waves, and polarization; basic building blocks including lenses, detectors, optical components, and fiber optics; interferometry and coherence; basic holography and speckle; infrared temperature measurement; stress birefrinence; basic video, imaging, and digital image processing.
Recommended background: mathematics (MA 2051), experimentation (ME 3901).
Suggested background: physics (PH 1140).
Offered in 2002-03 and in alternating years thereafter.

IS/P. SPECIAL TOPICS.
Cat. I
For students who wish to pursue in depth various mechanical engineering topics. Topics covered include: theoretical or experimental studies in subjects of interest to mechanical engineers.
Registration as a junior or senior is assumed.

MILITARY SCIENCE

The intent of the Military Science program of courses is that they be taken in sequential order. Any student who wishes to depart from this recommendation must consult with the Military Science department head.

MS 1031 and MS 1071 will appear on the WPI transcript as a zero credit course with a grade. Successful completion of MS 1051 and MS 1061 earns 1/9 unit in MS 1061. Successful completion of MS 1071 and MS 1081 earns 1/9 unit in MS 1081.

MS 1051. INTRODUCTION TO ROTC I.
This course introduces students to the ROTC program, the US Army and Armed Services. Students are introduced to a leadership atmosphere, challenges (e.g., rappelling) and rewards inherent in a career as a commissioned Army Officer. Students are introduced to the roles, organization and branches of the Army. Students are introduced to the elements of leadership and their measurements. The course requires one hour of class work and one hour of physical fitness training per week. Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also recommended.

MS 1061. INTRODUCTION TO ROTC I.
This course continues the studies begun in MS 1051. Students make oral presentations on the elements of leadership, enhancing effective communication. Students begin to develop leadership potential by instilling self-confidence and fostering teamwork through basic survival techniques (e.g., water survival).
The course requires one hour of class work and one hour of physical fitness training per week.
Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also recommended.

MS 1071. INTRODUCTION TO LEADERSHIP I.
This course introduces leadership development methodologies based upon the study of the elements of leadership. The course also includes customs, courtesies and traditions of the Armed Services, and requires each student to write an autobiography.
The course requires one hour of class work and one hour of physical fitness training per week.
Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also recommended.

MS 1081. INTRODUCTION TO LEADERSHIP II.
This course stresses fundamental competencies from leadership methodologies. Students are introduced to basic land navigation, values and obligations of an officer, and duties of the non-commissioned officer. Requires a submission of a written after-action report on field training and a memorandum for record.
The course requires one hour of class work and one hour of physical fitness training per week.
Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also recommended.

MS 2051. SELF AND TEAM DEVELOPMENT I.
This course introduces students to team building techniques. Students build upon the basic leader principals and leadership development methodologies to refine their understanding of leadership. Students are required to write and present a military operations order.
The course requires two hours of class work and two hours of physical fitness training per week. Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.
Recommended background: MS 1081

MS 2061. SELF AND TEAM DEVELOPMENT II.
Students train in complex first aid situations and use that as a springboard to assess and mitigate medical, accident and combat risk to a unit under their control. Students will learn in-depth map reading techniques and conduct practical exercises in land navigation. Students will also give an oral presentation on military history.
The course requires two hours of class work and two hours of physical fitness training per week. Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.
Recommended background: MS2051

MS 2071. INDIVIDUAL AND TEAM MILITARY TACTICS I.
Students continue the study of leader principals and are introduced to formal policies such as equal opportunity, ethics, and values. Military communication skills are trained along with the principles of camouflage. Complex cases of risk management are studied. Students will submit a written information paper.
The course requires two hours of class work and two hours of physical fitness training per week. Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.

Recommended background: MS 2061

MS 2081. INDIVIDUAL AND TEAM MILITARY TACTICS II.

This course covers small unit movement and military tactics. It combines previous study in weapon, movement and communications to teach the combination of firepower and maneuver to the student. This course also teaches the student the elements of how the military trains its personnel. A written decision paper and practical exercise in conducting training is included in this course.

The course requires two hours of class work and two hours of physical fitness training per week. Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.

Recommended background: MS 2071

MS 3051. LEADING SMALL ORGANIZATIONS IA.

Cat. 1 (1/6 unit)

This course focuses on development of individual leadership abilities. This course reviews leadership styles, management strategies and training techniques for leaders of small units. Building and developing communication skills and teamwork are addressed. Examines leadership of small units conducting conventional combat operations and practical employment of weapon systems. Development of oral communication skills through military briefings and issuance of operations orders. Special attention is placed on evaluations through practical exercises.

This course requires two hours of class work and three hours of physical fitness training per week. Participation in leadership labs and participation in an off-campus training session (field training exercise) is also required.

Prerequisite: Students must have completed the basic course or ROTC Basic Camp and have signed a personal contract with the US Army. Department Head approval is required.

MS 3061. LEADING SMALL ORGANIZATIONS IB.

Cat. 1 (1/6 unit)

Student learns how to conduct crisis planning and management. Introduction to military organizational structure and related MTOE equipment in tactical combined-arms and joint operations. Discussion of roles and functions of combat arms, combat support, and combat service support branches. Case studies of small-unit operations. Introduction to Army special operations, operations other than war, and trends in the military. Students write self-evaluations throughout this course. Students are graded on their performance during leadership practical exercises.

This course requires two hours of class work and three hours of physical fitness training per week. Attendance at monthly labs and formal social functions is required. Students write self-evaluations throughout this course. Students are graded on their performance during leadership practical exercises.

Prerequisite: MS 3051

MS 3071. LEADING SMALL ORGANIZATIONS IIA.

Cat. 1 (1/6 unit)

Continues development of skills taught in MS 3061. Focus on military doctrine, tactics, techniques, and procedures of squad and platoon offensive, defensive, and patrolling operations. Instructions and practical exercise in the application of leadership and organizational behavior skills required for the successful execution of small dismounted infantry unit missions. Intensive preparation for the U.S. Army ROTC Advanced Camp during summer semester. Provides multiple venues for cadet evaluations under the Leadership Development Program. Opportunities exist for voluntary winter training. Students are graded on their performance during leadership practical exercises.

This course requires three hours of class work and three hours of physical fitness training per week. Attendance at monthly leadership is required.

Prerequisite: MS 3061

MS 3081. LEADING SMALL ORGANIZATIONS IIB.

Cat. 1 (1/6 unit) Formal social functions

Doctrinal, tactics, techniques and procedures of squad and platoon offensive, defensive, and patrolling operations. Instruction and practical exercise in the application of the leadership and organizational behavior skills required for the successful execution of small dismounted infantry unit missions. Intensive preparation for the U.S. Army ROTC Advanced Camp during summer semester. All previous study culminates in a weekend Field Training Exercise (FTX) during which time students exercise platoon tactics, land navigation, command and control, and patrolling. This exercise measures each student’s leadership potential. Throughout the course leadership skills are deeply inculcated and measured.

This course requires three hours of class work and three hours of physical fitness training per week. Attendance at monthly labs, attendance at formal social functions and an off-campus weekend leadership exercise is required.

Prerequisite: MS 3071

MS 3091. ADVANCED CAMP.

Cat. 1 (no units)

This summer camp is mandatory and must be passed to complete ROTC training. This is a five-week summer camp conducted at Fort Lewis, WA in a rigorous environment. All costs are born by the Army and students are paid by the Army during the camp.

This course is a full-time commitment for the duration of the five weeks. Recommended background: MS 3081.

MS 4051. LEADERSHIP CHALLENGES AND GOAL SETTING I.

Cat. 1 (1/6 unit)

Cadets organize and lead all the junior cadets. Written submission of a report on summer camp is required and the students perform leadership evaluations under cadre supervision on the junior level students. Cadets learn about the Army officer personnel system and attend seminars on various professional development topics. Cadets develop and submit career requests to the Army Accessions Board and complete a field trip to the Association of the United States Army national convention.

This course requires three hours of class work and three hours of physical fitness per week. Three lab exercises and a field training exercise are required. Participation in the field trip is strongly encouraged.

Recommended background: MS 3091.

MS 4061. LEADERSHIP CHALLENGES AND GOAL SETTING II.

Cat. 1 (1/6 unit)

Cadets organize and lead all the junior cadets. Cadets conduct a field trip to a site of military history significance. Cadets conduct two briefings and submit an integrating essay for grade. Other topics covered include Army families, maintenance management for military equipment, and logistic systems management.

This course requires three hours of class work and three hours of physical fitness per week. Three lab exercises and a formal dining is required. Participation in the military history field trip is strongly encouraged.

Recommended background: MS 4051.

MS 4071. TRANSITION TO LIEUTENANT I.

Cat. 1 (1/6 unit)

Cadets organize and lead all the junior cadets. This course covers joint operations (Army combined with Air Force and Navy), the Army Reserve, and National Guard. The course focuses on the morality of warfare, principles and law of war, and professional ethics. Cadets submit a written essay of ethics and written counseling reports on subordinates.

This course requires three hours of class work and three hours of physical fitness per week. Three lab exercises and a formal military ball are required.

Recommended background: MS 4061.

MS 4081. TRANSITION TO LIEUTENANT II.

Cat. 1 (1/6 unit)

Cadets organize and lead all the junior cadets. This course covers the military legal system, personnel actions and personal finances. It certifies fundamental competencies in land navigation, tactics, counseling, and interpersonal communications.

This course requires three hours of class work and three hours of physical fitness per week. Three lab exercises and a formal military ball are required.

Recommended background: MS 4061.

PHYSICAL EDUCATION

PE 1001, 1002, 1003, 1004. PHYSICAL EDUCATION—GENERAL.

Cat. 1 (1/12 unit)

Out-of-doors in the fall and spring. Indoors during the winter months. Skills in a number of lifetime sports are taught.

Cat. 1 (1/12 unit)

PE 1001. INTRODUCTION TO LIFETIME SPORTS: GOLF, TENNIS, RECREATIONAL.

Cat. 1 (1/12 unit)

PE 1002. INTRODUCTION TO LIFETIME SPORTS: VOLLEYBALL, SQUASH, RECREATIONAL.

Cat. 1 (1/12 unit)

PE 1003. INTRODUCTION TO LIFETIME SPORTS: SWIMMING, BADMINTON, RECREATIONAL.

Cat. 1 (1/12 unit)

PE 1004. INTRODUCTION TO LIFETIME SPORTS: TABLE TENNIS, GOLF, TENNIS.

Cat. 1 (1/12 unit)

PE 1005. INTRODUCTION TO LIFETIME SPORTS: SWIMMING, RECREATIONAL, TABLE TENNIS, RACQUETBALL.

Cat. 1 (1/12 unit)
PE 1006. WELLNESS.
Cat. I (1/12 unit)
Introductory course designed to acquaint students with knowledge and skills necessary to make choices that foster health and well-being.

PE 1007. BASIC WATER SAFETY.
Cat. I (1/12 unit)
Prerequisite for PE 1057.

PE 1011. TOUCH FOOTBALL.
Cat. I (1/12 unit)
Basic rules, individual and team skills, practical application through game competition.

PE 1012. BASKETBALL.
Cat. I (1/12 unit)
Basic rules, individual and team skills, practical application through game competition.

PE 1013. SOFTBALL.
Cat. I (1/12 unit)
Basic rules, individual and team skills, practical application through game competition.

PE 1014. RACQUETS—TENNIS.
Cat. I (1/12 unit)
Basic strokes and techniques for beginning tennis.

PE 1015. RACQUETS—BADMINTON, TABLE TENNIS.
Cat. I (1/12 unit)
Techniques and tactics offered for all levels of ability.

PE 1016. RACQUETS—SQUASH, RACQUETBALL.
Cat. I (1/12 unit)
Basic strokes and techniques for beginning squash and racquetball.

PE 1017. BEGINNERS SWIMMING.
Cat. I (1/12 unit)
This program follows the Red Cross Manual.

PE 1018. CO-ED VOLLEYBALL.
Cat. I (1/12 unit)
Basic rules, individual and team skills, practical application through game competition.

PE 1021. BOWLING.
Cat. I (1/12 unit)
Introductory course designed to acquaint students with the basic skills, knowledge and practical experience.

PE 1024. RACQUETS—INTERMEDIATE TENNIS.
Cat. I (1/12 unit)
Introductory course designed to acquaint students with the basic skills, knowledge and practical experience.

PE 1027. INTERMEDIATE SWIMMING.
Cat. I (1/12 unit)
The program follows the Red Cross Manual for certification; fee is required.

PE 1055. PHYSICAL CONDITIONING.
Cat. I (1/2 unit)
This course provides an opportunity for students to work on an individual conditioning program.

PE 1057. LIFEGUARDING.
Cat. I (1/12 unit)
The program follows the Red Cross Manual for lifeguarding. Red Cross fee and books are required.

PE 1059. WEIGHT TRAINING PROGRAM FOR WOMEN.
Cat. I (1/2 unit)
This introductory course is designed to acquaint students to circuit training and free weight programs.

PE 1070. LEISURE EDUCATION: REDEFINING SOCIAL NORMS.
Cat. I (1/12 unit)
Introductory course designed to explore various leisure education alternatives.

PE 1077. SWIM AND STAY FIT.
Cat. I (1/12 unit)
This is a program designed for persons who want to improve their physical fitness through swimming.

PE 1100. PHYSICAL EDUCATION EQUIVALENCY.
Cat. I (1/12 unit)
Credit by equivalent activity in one of four categories: 1) WPI athletic team participation, 2) club sports, 3) approved courses not offered at WPI, 4) individualized program at WPI, 5) Proficiency testing. Advance approval by the Physical Education Department Head is necessary.
PH 1130. INTRODUCTION TO 20TH CENTURY PHYSICS.
Cat. I
This course is designed to help the student acquire an understanding of the pivotal ideas and developments of twentieth-century physics.

Recommended background: familiarity with material covered in PH 1110 and PH 1120 (or PH 1111 and PH 1121) and completion of MA 1021 and MA 1022. This course will be offered in 2002-03 and in alternate years thereafter.

PH 1140. OSCILLATIONS, AND WAVES.
Cat. I
An introduction to oscillating systems and waves.

Topics include: free, clamped forced, and coupled oscillations of physical systems, traveling waves and wave packets, reflection, and interference phenomena.

Recommended background: working knowledge of the material covered in PH 1110 and PH 1120 (or PH 1111 and PH 1121) and completion of MA 1021, MA 1022 and MA 1023. This course will be offered in 2002-03 and in alternate years thereafter.

PH 2201. INTERMEDIATE MECHANICS I.
Cat. I
This course emphasizes a systematic approach to the mathematical formulation of mechanics problems and to the physical interpretation of the mathematical solutions.

Topics covered include: Newton's laws of motion, kinematics and dynamics of a single particle, vector analysis, motion of particles, rigid body rotation about an axis.

Recommended background: PH 1110, PH 1120, PH 1130, PH 1140, MA 1021, MA 1022, MA 1023, MA 1024 and concurrent registration in or completion of MA 2051. This course will be offered in 2002-03 and in alternate years thereafter.

PH 2202. INTERMEDIATE MECHANICS II.
Cat. I
This course is a continuation of the treatment of mechanics started in PH 2201.

Topics covered include: rigid-body dynamics, rotating coordinate systems, Newton's law of gravitation, central-force problem, driven harmonic oscillator, an introduction to generalized coordinates, and the Lagrangian and Hamiltonian formulation of mechanics.

PH 2301. ELECTROMAGNETIC FIELDS.
Cat. I
Introduction to the theory and application of electromagnetic fields, appropriate as a basis for further study in electromagnetism, optics, and solid-state physics.

Topics include: electric field produced by charge distributions, electrostatic potential, dielectric properties of matter, quasi-static time-dependent phenomena, and the Lorentz force law. Recommended background is PH 1110, PH 1120, PH 1130, PH 1140, MA 1021, MA 1022, MA 1023, MA 1024 and concurrent registration in or completion of MA 2051. This course will be offered in 2002-03 and in alternate years thereafter.

PH 2501. PHOTONICS.
Cat. I
An introduction to the use of optics for transmission and processing of information. The emphasis is on understanding principles underlying practical photonic devices. Topics include lasers, light emitting diodes, optical fiber communications, fiber lasers and fiber amplifiers, planar optical waveguides, light modulators and photodetectors. Recommended background is PH 1110, PH 1120, PH 1130 and PH 1140 (or their equivalents). This course will be offered in 2002-03 and in alternate years thereafter.

PH 2502. LASERS.
Cat. II
An introduction to the physical principles underlying lasers and their applications. Topics will include the coherent nature of laser light, optical cavities, beam optics, atomic radiation, conditions for laser oscillation, optical amplifiers (including fiber amplifiers), pulsed lasers (Q switching and mode locking), laser excitation (optical and electrical), and selected laser applications. Recommended background is PH 1110, PH 1120, PH 1130 and PH 1140 (or their equivalents). This course will be offered in 2003-04 and in alternate years thereafter.

PH 2601. PHOTONICS LABORATORY.
Cat. II
This course provides an experimental approach to concepts covered in Photonics (PH 2501), Lasers (PH 2502), and Optics (PH 3504). Through a series of individually tailored experiments, students will reinforce their knowledge in one or more of these areas, while at the same time gaining exposure to modern photonics laboratory equipment. Experiments available include properties of optical fibers, optical fiber diagnostics, optical communications systems, properties of photodetectors, mode structure and threshold behavior of lasers, coherence properties of laser light, characterization of fiber amplifiers, diffraction of light, polarization of light, interferometry.

Recommended background: PH 1110/1111, PH 1120/1121, PH 1130, PH 1140, and one or more of the courses PH 2501, PH 2502, or PH 3504. No prior laboratory background is expected. This course will be offered in 2002-03 and in alternate years thereafter.

PH 2651. INTERMEDIATE PHYSICS LABORATORY.
Cat. I
This course offers experience in experimentation and observation for students of the sciences and others. In a series of subject units, students learn or review the principal techniques underlying the phenomena to be observed and the basis for the measurement techniques employed. Principles and uses of laboratory instruments including the cathode-ray oscilloscope, meters for frequency, time, electrical and other quantities are stressed. In addition to systematic measurement procedures and data recording, strong emphasis is placed on processing of the data, preparation and interpretation of graphical presentations, and analysis of precision and accuracy, including determination and interpretation of best value, measures of error and uncertainty, linear best fit to data, and identification of systematic and random errors. Preparation of high-quality experiment reports is also emphasized. Representative experiment subjects are: mechanical motions and vibrations; free and driven electrical oscillations; electric fields and potential; magnetic materials and fields; electron beam dynamics; optics; diffraction-grating spectroscopy; radioactive decay and nuclear energy measurements.

Recommended background: the Introductory Physics course sequence or equivalent. No prior laboratory background beyond that experience is required. Students who have received credit for PH 2650 or PH 3600 may not receive credit for PH 2651.

PH 3117. PROBLEM SOLVING SEMINAR.
Cat. I
This course is intended to give students some experience in solving the kinds of problems that form the daily diet of a working physicist. Small groups of students will be presented with a series of problems, which they will solve under the guidance of one or more faculty members.

Topics will be selected from a wide variety of physical disciplines. This course is intended for third- and fourth-year physics majors, after completion of intermediate-level classical mechanics, electromagnetism, and quantum mechanics.

PH 3301. ELECTROMAGNETIC THEORY.
Cat. I
A continuation of PH 2301, this course deals with more advanced subjects in electromagnetism, as well as study of basic subjects with a more advanced level of mathematical analysis. Fundamentals of electric and magnetic fields, dielectric and magnetic properties of matter, quasi-static time-dependent phenomena, and generation and propagation of electromagnetic waves are investigated from the point of view of the classical Maxwell’s equations.

PH 3401. QUANTUM MECHANICS I.
Cat. I
This course includes a study of the basic postulates of quantum mechanics, its mathematical language and applications to one-dimensional problems. The course is recommended for physics majors and other students whose future work will involve the application of quantum mechanics.

Topics include wave packets, the uncertainty principle, introduction to operator algebra, application of the Schrödinger equation to the simple harmonic oscillator, barrier penetration and potential wells.

Recommended background: Junior standing, MA 4451, and completion of the introductory physics sequence, including the introduction to the 20th century physics. Suggested background: knowledge (or concurrent study) of linear algebra, Fourier series, and Fourier transformers.

PH 3402. QUANTUM MECHANICS II.
Cat. I
This course represents a continuation of PH 3401 and includes a study of three-dimensional systems and the application of quantum mechanics in selected fields.

Topics include: the hydrogen atom, angular momentum, spin, perturbation theory and examples of the application of quantum mechanics in fields such as atomic and molecular physics, solid state physics, optics, and nuclear physics.

Recommended background: PH 3401.

PH 3401. RELATIVITY.
Cat. II
This course is designed to help the student acquire an understanding of the formalism and concepts of relativity as well as its application to physical problems.

Topics include: the Lorentz transformation, 4-vectors and tensors, covariance of the equations of physics, transformation of electromagnetic fields, particle kinematics and dynamics.

Recommended background: knowledge of mechanics and electromagnetics at the intermediate level.

This course will be offered in 2002-03 and in alternate years thereafter.
PH 3502. SOLID STATE PHYSICS.
Cat. II
An introduction to solid state physics.
Topics include: crystallography, lattice vibrations, electron band structure, metals, semiconductors, dielectric and magnetic properties.
Recommended background: prior knowledge of quantum mechanics at an intermediate level.
Suggested background: knowledge of statistical physics is helpful.
This course will be offered in 2002-03 and in alternate years thereafter.

PH 3503. NUCLEAR PHYSICS.
Cat. II
This course is intended to acquaint the student with the measurable properties of nuclei and the principles necessary to perform these measurements. The major part of the course will be an introduction to the theory of nuclei.
The principal topics will include binding energy, nuclear models and nuclear reactions. The deuteron will be discussed in detail and the nuclear shell model will be treated as well as the nuclear optical model.
Recommended background: some knowledge of the phenomena of modern physics at the level of an introductory physics course and knowledge of intermediate level quantum mechanics.
This course will be offered in 2003-04 and in alternate years thereafter.

PH 3504. OPTICS.
Cat. II
This course provides an introduction to classical physical optics, in particular interference, diffraction and polarization, and to the elementary theory of lenses. The theory covered will be applied in the analysis of one or more modern optical instruments.
Recommended background: knowledge of introductory electricity and magnetism and of differential equations.
Suggested background: PH 2301.
This course will be offered in 2003-04 and in alternate years thereafter.

PH 4201. ADVANCED CLASSICAL MECHANICS.
Cat. I
A review of the basic principles and introduction to advanced methods of mechanics, emphasizing the relationship between dynamical symmetries and conserved quantities, as well as classical mechanics as a background to quantum mechanics.
Topics include: Lagrangian mechanics and the variational principle, central force motion, theory of small oscillations, Hamiltonian mechanics, canonical transformations, Hamilton-Jacobi Theory, rigid body motion, and continuous systems.
Recommended background: PH 2201 and PH 2202.
This is a 14-week course.

PH 4206. STATISTICAL PHYSICS.
Cat. I
An introduction to the basic principles of thermodynamics and statistical physics. Topics covered include: basic ideas of probability theory, statistical description of systems of particles, thermodynamic laws, entropy, microcanonical and canonical ensembles, ideal and real gases, ensembles of weakly interacting spin 1/2 systems.
Recommended background: knowledge of quantum mechanics at the level of PH 3401-3402 and of thermodynamics at the level of ES 3001.

Graduate Physics Courses of Interest to Undergraduates

PH 511/PH 4201. CLASSICAL MECHANICS.

PH 514. QUANTUM MECHANICS I.
Schroedinger wave equation. Harmonic oscillator, hydrogen atom, potential wells, approximation methods.

PH 515. QUANTUM MECHANICS II.

PH 522. THERMODYNAMICS AND STATISTICAL MECHANICS.
Quantum concepts applied to thermodynamics. Bose-Einstein and Fermi-Dirac statistics.

PH 533. ADVANCED ELECTROMAGNETIC THEORY.
Classical electrodynamics and radiation theory.
The course requirements generally include an individual or group (your choice) project and an oral presentation. The topics are selected by the student with the approval of the instructor. This course will be offered in 2003-04 and in alternate years thereafter.

**SS 1301. U.S. GOVERNMENT.**

Cat. I This course is an introduction to the fundamental principles, institutions, and processes of the constitutional democracy of the United States. It examines the formal structure of the Federal system of government, including Congress, the presidency, the judiciary, and the various departments, agencies, and commissions which comprise the executive branch. Emphasis is placed on the relationships among federal, state, and local governments in the formulation and administration of domestic policies, and on the interactions among interest groups, elected officials and the public at large with administrators in the policy process. The various topics covered in the survey are linked by consideration of fiscal and budgetary issues, executive management, legislative oversight, administrative discretion, policy analysis and evaluation and democratic accountability.

May be included in certain Humanities and Arts Sufficiency programs. See page 59.

**SS 1303. AMERICAN PUBLIC POLICY.**

Cat. I American Public Policy focuses on the outcomes or products of political institutions and political controversy. The course first addresses the dynamics of policy formations and stalemate, the identification of policy goals, success and failure in implementation, and techniques of policy analysis. Students are then encouraged to apply these concepts in the study of a specific policy area of their choosing, such as foreign, social, urban, energy or environmental policy. This course is an important first step for students wishing to complete IQPs in public policy research. Students are encouraged to complete SS 1303 prior to enrolling in upper level policy courses such as SS 2303, SS 2304 or SS 2311. There is no specific preparation for this course, but a basic understanding of American political institutions is assumed.

**SS 1310. LAW, COURTS, AND POLITICS.**

Cat. I This course is an introduction to law and the role courts play in society. The course examines the structure of judicial systems, the nature of civil and criminal law, police practice in the enforcement of criminal law, and the responsibilities of judges, attorneys and prosecutors. Additional topics for discussion include the interpretation of precedent and statute in a common law system and how judicial discretion enables interest groups to use courts for social change. The student is expected to complete the course with an understanding of how courts exercise and thereby control the power of the state. As such, courts function as political actors in a complex system of governance. It is recommended that students complete this course before enrolling in SS 2310, Constitutional Law.

**SS 1320. TOPICS IN INTERNATIONAL POLITICS.**

Cat. II SS 1320 is a survey course designed to introduce students to the basic concepts of international relations: power and influence, nations and states, sovereignty and law. These concepts will be explored through the study of issues such as diplomacy and its uses, theories of collective security and conflict, and international law and development. The study of international organizations such as the UN, the European Union or the Organization of American States will also supplement the students’ understanding of the basic concepts. The course may also include comparative political analysis of states or regions. It is designed to provide the basic background materials for students who wish to complete IQPs on topics that involve international relations or comparative political systems.

This course will be offered in 2002-03, and in alternating years thereafter.

**SS 1401. INTRODUCTION TO COGNITIVE PSYCHOLOGY.**

Cat. I This course is concerned with understanding and explaining the mental processes and strategies underlying human behavior. The ways in which sensory input is transformed, reduced, elaborated, stored, and recovered will be examined in order to develop a picture of the human mind as an active processor of information. Topics will include perception, memory, problem-solving, judgement and decision making, human-computer interaction, and artificial intelligence. Special attention will be paid to defining the limitations of the human cognitive system. Students will undertake a project which employs one of the experimental techniques of cognitive psychology to collect and analyze data on a topic of their own choosing.

**SS 1402. INTRODUCTION TO SOCIAL PSYCHOLOGY.**

Cat. I Social psychology is concerned with how people think about, feel for, and act toward other people. Social psychologists study how people interact by focusing on the individual (not society as a whole) as the unit of analysis, by emphasizing the effect on the individual of the situation or circumstances in which behavior occurs, and by acquiring knowledge through empirical scientific investigation. This course will examine the causes of human behavior in a variety of domains of social life. Topics will include, but not be limited to, person perception, attitude formation and change, interpersonal attraction, stereotyping and prejudice, and small group behavior. Special attention will be given to applied topics: How can research methods of social psychology be used to help solve social problems? Students will work together in small groups to explore in depth topics in social psychology of their own choosing.

May be included in certain Humanities and Arts Sufficiency programs. See page 59.

**SS 1503. THE PSYCHOLOGY OF DECISION MAKING AND PROBLEM SOLVING.**

Cat II This course provides the psychological background and practical skills needed to improve both professional and personal decision making and problem solving. Topics will include memory improvement, creativity, methods of problem solving, group problem solving and decision making, multiattribute utility models, social judgment theory, expert-novice differences, risky decision making, dynamic decision making, and human ability to manage complex systems. Special attention will be paid to the rationale for and appropriate use of decision support tools, including system dynamics software.

This course will be offered in 2003-04 and in alternate years thereafter.

**SS 1510. INTRODUCTION TO SYSTEM DYNAMICS MODELING.**

Cat. I The goal of this course is to provide students with an introduction to the field of system dynamics computer simulation modeling.

The course begins with the history of system dynamics and the study of why policy makers can benefit from its use. Next, students systematically examine the various types of dynamic behavior that socioeconomic systems exhibit and learn to identify and model the underlying nonlinear stock-flow-feedback loop structures that cause them. The course concludes with an examination of a set of well-known system dynamics models that have been created to address a variety of socioeconomic problems. Emphasis is placed on how the system dynamics modeling process is used to test proposed policy changes and how the implementation of model-based results can improve the behavior of socioeconomic systems.

**SS 1520. SYSTEM DYNAMICS MODELING.**

Cat. I The purpose of this course is to prepare students to produce original system dynamics models of economic and social systems. Models of this type can be used to examine the possible impacts of policy changes and technological innovations on socioeconomic systems.

The curriculum in this course is divided into three distinct parts. First, a detailed examination of the steps of the system dynamics modeling process: problem identification (including data collection), feedback structure conceptualization, model formulation, model testing and analysis, model documentation and presentation, and policy implementation. Second, a survey of the "nuts and bolts" of continuous simulation modeling: information and material delays, time constants, the use of noise and numerical integration techniques, control theory heuristics, and software details (both simulation and model presentation and documentation software). Third, a step-by-step-in-class production of a model, involving the construction, testing, and assembly of subsectors. Students will be required to complete modeling assignments working in groups and take in-class quizzes on modeling issues.

Recommended background: SS/ID 2050, or permission of instructor.

**SS/ID 2050. SOCIAL SCIENCE RESEARCH FOR THE IQP.**

Cat. I This course is open to students conducting IQPs in the Washington, London, and Puerto Rico off-campus Project Centers, and may count towards their Social Science distribution requirement. The course introduces students to the basic tools for social science research and for economic analysis such as cost-benefit analysis. It also provides practice in specific research skills using the project topics. Students have selected in conjunction with the sponsoring agencies. Students learn to develop social science hypotheses based upon literature reviews in their topic areas, construct and administer questionnaires, conduct interviews, analyze data using computerized statistical packages, and make presentations based upon their findings. Students make presentations, write an organized project proposal as well as develop a written model for reporting their project findings. Examinations will cover the social science text and lecture material, while the project proposal will serve as the term paper.

**SS 2110. INTERMEDIATE MICROECONOMICS.**

Cat. II The topics addressed in this course are similar to those covered in SS 1110 (Introductory Microeconomics) but the treatment proceeds in a more rigorous and theoretical fashion to provide a firm platform for students majoring in Economics or Management, or those having a strong interest in economics. Mathematics at a level comparable to that taught in MA 1021-MA 1024 is frequently applied to lend precision to the analysis. The course rigorously develops the microeconomic foundations of the theory of the firm, the theory of the consumer, the theory of markets, and the conditions required for efficiency in economic systems.

Recommended background: SS 1110. This course will be offered in 2003-04 and in alternate years thereafter.
SS 2117. ENVIRONMENTAL ECONOMICS. Cat. II
This course investigates the effect of human activity upon the environment as well as the effect of the environment on human well being-being. It pays special attention to the impact of production and consumption of material goods upon the longevity and well being of the human community. The analysis focuses on some of the challenges presented by changes in market economics, where markets are combined with government intervention to manage pollution and scarcity. The course reviews efforts to measure the costs and benefits of improving environmental conditions and evaluates current and potential policies in terms of the costs of the environmental improvements they may yield. Attention is also paid to the special difficulties which arise when the impacts of pollution spill across traditional political boundaries.
Recommended background: SS 1110.
This course will be offered in 2002-03 and in alternate years thereafter.

SS 2210. INTERMEDIATE MACROECONOMICS. Cat. II
This course is an advanced treatment of macroeconomic theory well suited for students majoring in Economics or Management, or others with a strong interest in economics. The topics addressed in SS 2210 are similar to those covered in SS 1120; however, the presentation of the material will proceed in a more rigorous and theoretical fashion.
Recommended background: SS 1110.
This course will be offered in 2002-03 and in alternate years thereafter.

SS 2211. GOVERNMENT BUDGETS AND FISCAL POLICY. IS/F only
A study of the functions and impact of government expenditures and revenues on the economic system. An analysis of the rationale of governmental budgets in allocating scarce resources between private and public goods and services using cost-benefit techniques. More specifically, the effect of various types of government spending, taxation, and user charges on factor supplies and distribution of national income. An analysis of intergovernmental fiscal relations, and the relationship between fiscal and monetary policies to achieve full employment, reasonable price stability and economic growth. This course is designed for the economics major who has opted for the specialty area of economic growth and stability and for students interested in understanding the role of government spending and taxation in the economy.
Recommended background: SS 1120 and SS 1301.

SS 2215. DEVELOPMENT ECONOMICS. Cat. II
This course is a general introduction to the field of development economics. The focus is on ways in which a developing country can increase its productive capacity, both agricultural and industrial, in order to achieve sustained economic growth. The course proceeds by first examining how economic growth and economic development are measured and how the various nations of the world compare according to well-known social and economic indicators. Theories of economic growth and theories of economic development are then examined, as are the various social and cultural structures that are thought to influence economic progress. The inputs to economic growth and development (land, labor, capital, entrepreneurial ability, education, technical change), and the possible distributions of income and levels of employment that result from their use, is considered next. Domestic economic problems and policies such as development planning, the choice of sectoral policies, the choice of monetary and fiscal policies, rapid capital growth, and urbanization and rural economic development are then examined. The course concludes with a consideration of international problems and policies such as import substitution and export promotion, foreign debt, foreign investment, and the role of international firms. In conjunction with a traditional presentation of the above topics, the course curriculum will include the use of computer simulation models and games. These materials have been formulated with a simulation technique, system dynamics, that has its origins in control engineering and the theory of servomechanisms. As a result, students will find them complementary to their work in engineering and science. In addition, the various development theories and simulation and gaming results will be related, where possible, to specific developing nations where WPI has on-going project activities (e.g., Ecuador and Thailand). This course is recommended for those students wishing to do an IQP or MQP in a developing nation.
Recommended background: SS 1120.
This course will be offered in 2003-04 and in alternate years thereafter.

SS 2207. CREATIVITY AND THE SCIENTIFIC COMMUNITY. Cat. II
An interdisciplinary course that examines the continuing tension between individual, organizational and institutional research communities and some of their most interesting strands in the psychological literature on creativity and materials from the sociology and philosophy of science focusing on the process of discovery and its relationship to scientific advance. Research findings on innovation and the nature of science are introduced. Examples are drawn from studies of industrial research and development, academic science, the history of technology and history of science. A focal concern is to explore the effect that the growing interdependence of science with political and economic systems has had on the fragile balance between the individual researcher and the scientific community.
Recommended background: SS 1402 or permission of the instructor.
This course will be offered in 2002-03 and in alternate years thereafter. May be included in certain Humanities and Arts Sufficiency programs. See page 59.

SS 2208. THE SOCIETY - TECHNOLOGY DEBATE. Cat. II
A course which considers what one means when they that we live in a technological society, focusing on the characteristics of technology that humanistic critics find problematic or objectionable. In the course of the analysis, the nature of technology, its connection to scientific advance, as well as its relationship to the state, and the social role of scientists and technologists will be considered. Special attention is given to the behavior of experts in scientific and technological controversies, and to the debate about the "technological mentality" said to pervade western societies. Utopian, Dystopian and Marxist interpretations of where technological development is taking us will be examined in an effort to understand the major themes in the larger debate about the social impact of technology.
Computer science majors can take this course in place of CS 3043 if they write a term paper on a computer-related topic.
Recommended background: SS 1202.
This course will be offered in 2003-04 and in alternate years thereafter. May be included in certain Humanities and Arts Sufficiency programs. See page 59.

SS 2302. SCIENCE-TECHNOLOGY POLICY. Cat. II
This course is an examination of the relationship between science-technology and government. It reviews the history of public policy for science and technology, theories and opinions about the proper role of government and several current issues on the national political agenda. Examples of these issues include genetic engineering, the environment and engineering education. It also examines the formation of science policy, the politics of science and technology, the science bureaucracy, enduring controversies such as public participation in scientific debates, the most effective means for supporting research, and the regulation of technology. Throughout the course we will pay particular attention to the fundamental tension between government demands for accountability and the scientific community’s commitment to autonomy and self-regulation.
Recommended background: SS 1301 or SS 1303.
This course will be offered in 2002-03 and in alternate years thereafter.

SS 2304. GOVERNMENT DECISION MAKING AND ADMINISTRATIVE LAW. Cat. II
The course addresses the role of technical expertise in political decision making. Policymakers and public administrators rely on the expert knowledge of scientists and engineers to “bring reason” to otherwise political decisions. The course specifically addresses decision making in the administrative context including the value of expert knowledge, circumstances of inadequate information and the need to accommodate the political agenda. The context for the discussion will be the problems of regulated industries (for example, energy or those industries subject to environmental regulation). Legal review of administrative decision making will also be addressed.
Recommended background: SS 1301 or SS 1303 or SS 2310.
This course will be offered in 2003-04 and in alternate years thereafter.

SS 2310. CONSTITUTIONAL LAW. Cat. II
Constitutional Law is a study of those Supreme Court decisions which interpret the foundation of American governance, the U.S. Constitution. These decisions address a wide variety of questions of historic and contemporary significance. For example: What are the limits on the powers of the President? How are the powers of the Congress restricted? How are legislative powers to be shared with the state and local governments? Other questions focus on the rights of individuals. What is the right to privacy and where is it found in law? Does the Constitution protect women who desire abortions, prevent discrimination against homosexuals, provide support for affirmative action programs? These and many other questions of social and political importance are answered by the Supreme Court as it interprets the words of the founders. It is only through the decisions of the Court that we can come to have a complete understanding of the “living Constitution.”
Recommended background: SS 1310. (Formerly Dynamics and Limits of Law.)
This course will be offered in 2002-03 and in alternate years thereafter.

SS 2311. LEGAL REGULATION OF THE ENVIRONMENT. Cat. I
This course deals with environmental law as it relates to people, pollution and land use in our society. A case method approach will be used to illustrate how the courts and legislators have dealt with these social-legal problems. The course is designed to introduce the student consider: 1) the legal framework within which environmental law operates; 2) the governmental institutions involved in the formulation, interpretation and application of environmental law; 3) the nature of the legal procedures and substantive principles currently being invoked to resolve environmental problems; 4) the types of hazards to the environment presently subject to legal constraints; 5) the impact that the mandates of
environmental law have had, and will have, on personal liberties and property rights; 6) the role individuals and groups can play within the context of our legal system to protect and improve man’s terrestrial habitat and the earth’s atmosphere; and 7) some methods and sources for legal research that they may use on their own.

Recommended background: SS 1303 or SS 1310.

SS 2312. INTERNATIONAL ENVIRONMENTAL POLICY. Cat. II

Environmental issues present some of the major international problems and opportunities facing the world today. Worst-case scenarios envision irrevocable degradation of the earth’s natural systems, but virtually every analysis sees the need for major change worldwide to cope with problems such as global warming, deforestation, ozone depletion, biodiversity, and population growth, not to mention exponential increases in “conventional” pollutants in newly industrialized countries. The global environment issues represent a “second generation” of environmental policies in which innovation has moved from national regulations to international law and institutions. In addition, the environment has emerged as a major aspect of international trade, conditioning corporate investment and accounting for some $200 billion in sales of pollution control equipment in 1991. Exploration of the genesis and implications of these phenomena is the essence of the course. Topically, the material begins with the nature of global environmental problems, drawing on literature from large-scale global modeling as well as particular analyses of the problems mentioned above. Approximately half the course focuses on international laws and institutions, including multilateral treaties (e.g., the Montreal Protocol limiting CFC use, ocean dumping, biodiversity), international institutions (UNEP, the Rio Convention, the OECD) and private initiatives (international standards organizations, ICCP, Industry Committee for Ozone Layer Protection, etc.) In addition, US policy toward global environmental issues will be compared with that in Japan, Europe and developing countries, from which it differs significantly. Students will design and undertake term projects that address particular issues in detail in an interdisciplinary manner.

Recommended background: SS 1303.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 2313. INTELLECTUAL PROPERTY LAW. Cat. II

Intellectual property includes ideas, and the works of inventors, authors, composers and other creative people. Patents, copyrights and trademarks establish legal rights in intellectual property. Alternative control over the use of an idea might be maintained by treating it as a trade secret. In these ways, the ideas of inventors and creators are protected and others are prohibited from appropriating the ideas and creative works of others. This course addresses the concept of intellectual property and the public policies that support the law of patent, copyright and trademark. Subjects include the process of obtaining patents, trademarks and copyrights; requirements of originality and, for patents, utility; infringement issues; and the problems posed by international trade and efforts to address them through the World Intellectual Property Organization.

Recommended background: SS 1310 or SS 2310.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 2401. THE PSYCHOLOGY OF EDUCATION. Cat. II

This course is concerned with the learning of persons in educational settings from pre-school through college. Material in the course will be organized into five units covering a wide range of topics: Unit 1: Understanding Student Characteristics — Cognitive, Personality, Social, and Moral Development; Unit 2: Understanding the Learning Process — Behavioral, Humanistic, and Cognitive Theories of Learning; Unit 3: Understanding Motivation to Learn; Unit 4: Understanding Student Diversity — Cultural, Economic, and Gender Effects upon Learning; Unit 5: Evaluating Student Learning — Standardized Tests, Intelligence, Grades, and other Assessment Issues. Students planning IQP’s in educational settings will find this course particularly useful. Instructional methods include lecture, discussion, demonstration, and project work. Course will also focus on current issues in technological education and international higher education.

Recommended background: SS 1401.

This course will be offered in 2003-04, and in alternate years thereafter.

SS 2405. THE PSYCHOLOGICAL STUDY OF ENVIRONMENTAL ISSUES. Cat. II

Environmental policymakers are increasingly coming to the realization that, in order to be effective, their policies must be based on an understanding of how people think. In this course the fields of social and cognitive psychology will provide the background and methodology for an examination of the thought processes of individuals and groups when they are faced with environmental problems in the course of their daily lives. This evaluating alternative public policies in such areas as global warming, hazardous waste disposal, cancer prevention, and species extinction. Topics will include: (1) Environmental values (How do people decide what a cleaner environment is worth to them?); (2) Environmental perception and judgment (How do people decide that an environmental problem is severe enough to warrant remedial action?); (3) Environmental attitudes and behavior (What is the relationship between what people say they should do about the environment and what they actually end up doing?); Students considering or planning IQP projects on environmental topics will find this course to be particularly valuable.

Recommended background: SS 1401 or SS 1402.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 2406. CROSS-CULTURAL PSYCHOLOGY: HUMAN BEHAVIOR IN GLOBAL PERSPECTIVE. Cat. II

This course is an introduction to the study of the ways in which social and cultural forces shape human behavior. Cross-cultural Psychology takes a global perspective of human behavior that acknowledges the uniqueness and interdependence of people of the world. Traditional topics of psychology (learning, cognition, personality development) as well as topics central to social psychology, such as intergroup relations and the impact of changing cultural settings will be explored. Cultural influence on technology development and transfer, as they relate to and impact upon individual behavior, will also be investigated. Students preparing to work at international project centers, International Scholars, and students interested in the global aspects of science and technology will find the material presented in this course especially useful.

Recommended background: SS 1402.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 2530. ADVANCED TOPICS IN SYSTEM DYNAMICS MODELING. Cat. II

This course will focus on advanced issues and topics in system dynamics computer simulation modeling. A variety of options for dealing with complexity through the development of large scale systems and the partitioning of complex problems will be discussed. Topics will include an extended discussion of model analysis, the use of summary statistics and sensitivity measures, the model validation process, and policy design. The application of system Dynamics to theory building and social policy are also reviewed. Complex nonlinear dynamics and the chaotic behavior of systems will be discussed. Students will be assigned group exercises centering on model analysis and policy design.

Recommended background: SS 2520.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 2540. GROUP MODEL BUILDING. Cat. II

This course will review the system dynamics practice of group model building, in which a system dynamics model is created through close interaction with a team of policy makers or managers. Topics will include theories of mental models, alternate techniques for eliciting, mapping, and sharing mental models for use in model building, procedures for group facilitation, individual and team learning, group communication and decision making processes, and factors that promote or impede group performance. Special attention will be paid to the rigorous assessment of learning and group performance.

Recommended background: SS 2520.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 3278. TECHNOLOGY ASSESSMENT AND IMPACT ANALYSIS SEMINAR. Cat. II

The Indicators, Impact and Assessment Seminar is a specialized concepts and methods course designed primarily for Society-Technology Majors and students preparing to carry out such analyses. It is run in “seminar” style with one third of the sessions being reserved for student presentations. The course includes a laboratory experience and will stress the assessment of the research designs of existing and proposed social impact and reception of innovation studies. One focus of attention will be the national effort to devise “science indicators” by the National Science Foundation to monitor the vitality of the research enterprise in the United States. Prospective and retrospective technology assessments will also be compared. Typical of the case studies to be considered would be an examination of the predicted impact of nuclear power 30 years ago and assessments of its promise today. Assessment of the promise and problems of computers, robotics and space technology being made today are possible topics of discussion, depending on class interest. The “Complexity and Scientific Community” or “The Technology-Society Interface” courses would be a good preparation for this seminar. Students with background in social science research methods and at least one social concepts course would be fully prepared for participation.

Recommended background: SS 2208.

This course will be offered in 2003-04 and in alternate years thereafter.

SS 3550. SYSTEM DYNAMICS SEMINAR. Cat. II

This special topics course is designed primarily for system dynamics majors and students presently engaged in planning system dynamics projects. The course will be conducted as a research seminar, with many sessions being reserved for students presenting their projects. Course topics will include: (1) Environmental education (How accurate are people’s mental conceptions of environmental problems and how can accuracy be improved by educational programs?); (4) Environmental attitudes and behavior (What is the relationship between what people say they should do about the environment and what they actually end up doing?); Students considering or planning IQP projects on environmental topics will find this course to be particularly valuable.

Recommended background: SS 1520 and SS 2530.

This course will be offered in 2003-04 and in alternate years thereafter.