

COURSE DESCRIPTIONS

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COURSE CATEGORIES

For purposes of planning programs of study, courses at WPI are divided into two categories.

Category I (Cat. I)

These courses cover core material of interest to large numbers of students. Category I courses are offered at least once a year.

Category II (Cat. II)

Category II courses are usually offered every other year.

BACKGROUND*Recommended*

The course will build on material in the recommended course. Instructors can assume that the student is knowledgeable of the material from the recommended course or from other experiences.

Suggested

The material from this course would be helpful to the student, but it is not assumed background.

CATALOG AND SCHEDULE ON THE WWW

The catalog and course schedule can be found on the world wide web at www.wpi.edu/+ugradcat and www.wpi.edu/+schedules.

COURSE NUMBERING

Each course at WPI is designated by a two-letter prefix identifying the subject area followed by a four digit number. The first digit is coded as follows:

- 1 — Courses for which first-year students will receive priority in registration. Upper class students may register on a space-available basis.
- 2 — Basic level courses.
- 3 — Advanced level undergraduate courses for which no graduate credit is given. (This restriction may be waived at the discretion of the degree department.)
- 4 — Advanced level undergraduate courses for which graduate credit may also be given.
- 5 — Graduate courses.

The last three digits may be used by the departments to indicate subject areas. Many graduate courses are also available to undergraduates.

COURSE CREDIT

Unless otherwise indicated, WPI courses usually carry credit of 1/3 unit. This level of activity suggests at least 17 hours of work per week, including class and laboratory time. The usual workload per term is 1 unit.

AEROSPACE STUDIES**AS 1001. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE I.**

Cat. I (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, officership and professionalism, Air Force officer opportunities, military customs and courtesies, and an introduction to communication skills.

The first course focuses on the foundation of officership and customs and courtesies.

The course includes one hour of class work and two hours of mandatory leadership laboratory per week. The AS 1001 Leadership Laboratory includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands.

AS 1002. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE II.

Cat. I (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 1002 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. I (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 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. 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 1003 Leadership Laboratory includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands.

AS 1004. THE FOUNDATIONS OF THE UNITED STATES AIR FORCE IV.

Cat. I (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 1004 Leadership Laboratory includes a study of Air Force customs and courtesies, drill and ceremonies, and military commands.

AS 2001. THE EVOLUTION OF USAF AIR AND SPACE POWER I.

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. 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 2001 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. 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 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 2002 Leadership Laboratory continues a study of Air Force customs and courtesies, drill and ceremonies, military commands, and preparation for field training.

AS 2003. 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 2003 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 2004 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.

AS 4101. NATIONAL SECURITY AFFAIRS I.*Cat. I (1/6 unit)*

The AS 4000 sequence of courses examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. Special topics of interest focus the military as a profession, officership, military justice, civilian control of the military, preparation for active duty and current issues affecting military professionalism. Throughout the AS 4000 sequence of courses, briefing and writing exercises will be accomplished with emphasis on refining communication skills.

The first course examines in depth the national security process, principles of war and the Air Force major commands.

The course includes three hours of class work and three hours of mandatory leadership laboratory each week. The AS 4101 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-like activities and giving the students the opportunity to apply leadership and management principles.

AS 4102. NATIONAL SECURITY AFFAIRS II.*Cat. I (1/6 unit)*

The AS 4000 sequence of courses examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. The second course provides a detailed examination of Air Force doctrine including a study of the joint doctrine and the roles of the other military services.

The course includes three hours of class work and three hours of mandatory leadership laboratory each week. The AS 4102 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-like activities and giving the students the opportunity to apply leadership and management principles.

AS 4103. NATIONAL SECURITY AFFAIRS III.*Cat. I (1/6 unit)*

The AS 4000 sequence of courses examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. The third course provides an extensive study of alliances and regional security issues, including international peacekeeping and terrorism. Continued attention is given to developing the research and communications skills required by junior officers.

The course includes three hours of class work and three hours of mandatory leadership laboratory each week. The AS 4103 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-like activities and giving the students the opportunity to apply leadership and management principles.

AS 4104. PREPARATION FOR ACTIVE DUTY.*Cat. I (1/6 unit)*

The AS 4000 sequence of courses examines the national security process, regional studies, advanced leadership ethics, and Air Force doctrine. The final course in the series examines officership, the military justice system, social responsibilities, current issues affecting the military profession, and various factors that will facilitate a smooth transition from civilian to military life.

The course includes three hours of class work and three hours of mandatory leadership laboratory each week. The AS 4104 Leadership Laboratory complements the classroom work by providing advanced leadership experiences in officer-like activities and giving the students the opportunity to apply leadership and management principles.

BIOLOGY AND BIOTECHNOLOGY

BB 1001. INTRODUCTION TO BIOLOGY.*Cat. I*

This course consists of an overview of the major concepts of Biology, including: cell theory, bioenergetics, molecular biology, reproduction, nutrition, growth, development, homeostatic controls, and ecological issues. This course is intended for students seeking a broad overview of contemporary Biology with emphasis on human issues and current topics.

Recommended background: high school or introductory college level chemistry.

BB 1002. ENVIRONMENTAL BIOLOGY.*Cat. I*

This course provides an introduction to natural ecosystems, population growth, and the interaction between human populations and our environment. Major areas of discussion include Ecosystems, Populations, Biodiversity, Pollution, and Environmental Economics. This course is designed for students seeking a broad overview of ecological systems and the effect of humans on the ecosystems.

Recommended background: High School biology.

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 2020 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.

Recommended background: BB 1040, BB 1050, BB 2002, and MA 1021-1022.

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 2004-05 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 3101.

Students may not receive credit for both BB 4080 and BB 3080.

BB 3101. HUMAN ANATOMY & PHYSIOLOGY: MOVEMENT AND COMMUNICATION.*Cat. I*

The form and function of the systems that are responsible for the support, movement, internal communication, and interaction of the human body with its environment will be presented and discussed: Integumentary, Skeletal, Muscular, Nervous (including the senses), and Endocrine.

Recommended background: BB 2550 Cell Biology or BB 1001, Introduction to Biology. Suggested background: Concurrent Laboratory Module: BB 3511 (Nerve and Muscle Physiology). Students who have received credit for BB2130 (Human Anatomy) may not take BB3101 for credit.

BB 3102. HUMAN ANATOMY & PHYSIOLOGY: TRANSPORT AND MAINTENANCE.*Cat. I*

The form and function of the systems of the human body that provide for the intake, distribution, and processing of nutrients, water, and oxygen, and the systems that safeguard health by elimination of wastes, regulation of metabolism, and surveillance against disease will be presented and discussed. Digestive, Respiratory, Circulatory, Lymphatic, Endocrine, Urinary, and Reproductive.

Recommended Background: BB 2550 (Cell Biology); either BB 1001 (Introduction to Biology) or BB 1030 (Introduction to Biological Macromolecules); CH 1010 and CH 1020 (General Chemistry). Suggested background: Concurrent Laboratory Module: BB 3514 (Circulatory and Respiratory Physiology). Students who have received credit for BB3110 (Animal Physiology) may not take BB 3102 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 2004-05 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 3101 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 3102 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 2004-05 and in alternating years thereafter.

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.

BB 4065. VIROLOGY.*Cat. I*

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.

Recommended background: BB 2550.

BB 4070. SEPARATION OF BIOLOGICAL MOLECULES.*Cat. I*

This course provides 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 4140. 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 2004-05 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.

Suggested background: MA 2071 and CS 2005.

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 an 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, Alzheimers 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 and 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.

IS4 BB. SPECIAL TOPICS.*Cat. I*

Experimental courses, special conferences and seminars are offered by advance arrangement only.

Graduate Biology and Biotechnology Courses of Interest to Undergraduates

The following courses are open to advanced undergraduates with special written permission of the course instructor and department head.

BB 501. SEMINAR.**BB 502. TECHNIQUES IN ELECTRON MICROSCOPY.**

This course presents the theory of operation, applications, and use of scanning and transmission electron microscopy in biology. Recent original articles from the biological literature illustrate the applications of these techniques to research. Students prepare specimens for both kinds of electron microscopes and employ the standard preparative techniques including fixation, dehydration, staining, critical point drying, vacuum evaporation, embedding and sectioning. Associated photographic methods are also introduced.

BB 505. FERMENTATION BIOLOGY.

Focuses on biological (especially microbiological) systems by which materials and energy can be interconverted (e.g., waste products into useful chemicals or fuels). The processes are dealt with at the physiological and the system level, with emphasis on the means by which useful conversions can be harnessed in a biologically intelligent way. The laboratory focuses on measurements of microbial physiology and on bench-scale process design.

BB 507. CELL CULTURE.

Techniques in animal cell and tissue culture from the excision of the original explant to hybridoma studies. The following topics are discussed: 1) initiation of primary cultures, their maintenance and subculture; 2) the initiation of suspension cultures, their maintenance and subculture; 3) organogenesis; 4) formation of protoplasts, their culture and fusion; and 5) cryopreservation and karyotyping.

BB 509. SCALE-UP OF BIOPROCESSING.

Strategies for optimization of bioprocesses for scale-up applications. In addition to the theory of scaling up unit operations in bioprocessing, students will scale-up a bench scale bioprocess (5 liters) including fermentation and downstream processing to 55 liters. Specific topics include the effects of scaling-up on: mass transfer and bioreactor design, harvesting techniques including tangential flow filtration and centrifugation, and chromatography (open column and HPLC).

Recommended courses include BB 3055 Microbial Physiology and BB 4070/560 Separations of Biological Molecules, as a working knowledge of the bench scale processes will be assumed. Otherwise, instructor permission is required.

BB 510. ADVANCED MICROBIAL GENETICS.

A study of modern molecular genetics as revealed by studies of microbial systems. This course covers detailed structure/function relationships in nucleic acids and proteins; molecular mechanisms of DNA replication and expression; mutagenesis, recombination, transposition, transformation, conjugation and repair; and molecular biology of plasmids and phages.

BB 542. ECOLOGICAL SIMULATION MODELING.

This course will cover computer simulation modeling 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.

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, Alzheimers 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 biology, 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
- 5 — Biomechanics, Biological Systems
- 6 — Biofluids
- 8 — Biomaterials

BE 1001. INTRODUCTION TO BIOMEDICAL ENGINEERING.

Cat. I

Lectures, demonstrations, hands-on experimentation, and scientific literature readings in the major branches of biomedical engineering. A series of laboratory demonstration/experiments are utilized to complement key concepts covered in various lectures.

BE 2204. BIOELECTRIC FOUNDATIONS.

Cat. I

An introduction to the origins and characteristics of the electric and electromagnetic signals that arise in biological tissues. Topics include the behavior of excitable cells and tissues, the intrinsic electrical and magnetic properties of biological tissues, and the response of excitable cells to electric and magnetic field stimulation. Laboratory projects include the measurement of bioelectric signals (EMG, EKG, EEG, EOG, and evoked response) and the fundamentals of data acquisition, analysis, and statistics. The principles of writing and maintaining a laboratory notebook are also developed and used.

Recommended background: BB 2550 or equivalent, PH 1120 or PH 1121.

Students who have received credit for BE 4101 may not receive credit for BE 2204.

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 and deformation in beams are presented and used to characterize the

material properties of tissues such as skin, 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. BIOINSTRUMENTATION 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 acid-base physiology. The principles of writing and maintaining a laboratory notebook are also developed and used.

Recommended background: BE 2204 and BB 2550 or equivalent.

BE 3300. 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.

Students who have previously received credit for BE 2300 may not receive credit for BE 3300.

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 2004-05, and in alternating years thereafter.

BE4023. 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 biological events. Design laboratories will include biopotential amplifiers and biosensor/bioinstrumentation systems for the measurement of physiological parameters.

Recommended background: BE 2204, and BE 3011.

This course will be offered in the 2004-05 academic year and in alternating years thereafter.

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: BE2204, and BE3011.

This course will be offered in the 2003-2004 academic year and in alternating years thereafter.

BE 4201. BIOMEDICAL IMAGING.*Cat. I*

This course is a practical introduction to biomedical image 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 2004-05, and in alternating years thereafter.

BE/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 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 2501, ES 2502, ME 3501), Mathematics (MA 2051).

This 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 3501 and fluid mechanics equivalent to ES 3004.

This course will be offered in 2004-05, and in alternating years thereafter.

BE/ME 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 cellular processes 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, bioresorbable and bioerodible biomaterials. Additionally, this course will examine criteria for restoring physiological function of tissue and organs and investigate strategies to design implants and prostheses based on control of biomaterial-tissue interactions.

Recommended background: BE 2604, 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/ME 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.

NOTE: This course can be used to satisfy a life science requirement in the biomedical engineering program. It cannot be used to satisfy a biomedical engineering course requirement.

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.

NOTE: This course can be used to satisfy a life science requirement in the biomedical engineering program. It cannot be used to satisfy a biomedical engineering course requirement.

BE 570. ENGINEERING IN THE CLINICAL ENVIRONMENT.

Examines the responsibilities and functions of the biomedical engineer in the health care complex in the solution of the technical and engineering problems associated with patient care. Topics include equipment management, monitoring systems, electrical safety, prosthetics, technical education for medical personnel, hospital systems engineering, and administrative functions.

BE 581. MEDICAL IMAGING SYSTEMS.

Overview of the physics of medical image analysis. Topics covered include X-Ray tubes, fluoroscopic screens, image intensifiers; nuclear medicine; ultrasound; computer tomography; nuclear magnetic resonance imaging. Image quality of each modality is described mathematically, using linear systems theory (Fourier transforms, convolutions). (Prerequisite: Signal analysis course EE 3303 or equivalent.)

BE 582. PRINCIPLES OF IN VIVO NUCLEAR MAGNETIC RESONANCE IMAGING.

This course emphasizes the applications of Fourier transform nuclear magnetic resonance (FTNMR) imaging and spectroscopy in medicine and biology. Course topics include: review of the basic physical concepts of NMR (including the Bloch equations), theoretical and experimental aspects of FTNMR, theory of relaxation and relaxation mechanisms in FTNMR, instrumentation for FTNMR, NMR imaging techniques (point, line, plane, and volume methods), and in vivo NMR spectroscopy (including volume localization techniques). (Prerequisites: Differential and integral calculus, ordinary differential equations; organic chemistry recommended.)

BE 585. PRINCIPLES OF IN VIVO NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY.

This course emphasizes the applications of Fourier transform nuclear magnetic resonance (FTNMR) spectroscopy in medicine and biology. Course topics include: Review of the basic physical concepts of NMR, review of covalent chemical binding and its relationship to the NMR chemical shift, factors in biological systems that influence the NMR chemical shift, data acquisition and processing techniques in vivo NMR spectroscopy, and the application of NMR spectroscopy to clinical studies. (Prerequisites: BE 582, organic chemistry and biochemistry are strongly recommended.)

BE 595. SPECIAL TOPICS IN BIOMEDICAL ENGINEERING.

Topics in Biomedical Engineering. Presentations and discussions of the current literature in one or more of the following areas: medical imaging, neurosensory systems, bio-statics.

BE 595B. BIOMATERIALS IN THE DESIGN OF MEDICAL DEVICES.

Biomaterials are an integral part of medical devices, implants, controlled drug delivery systems, and tissue engineered constructs. Extensive research efforts have been expended on understanding how biologic systems interact with biomaterials. Meanwhile, controversy has revolved around biomaterials and their availability as a result of the backlash to the huge liability resulting from controversies related to material and processing shortcomings of medical devices. This course specifically addresses the unique role of biomaterials in medical device design and the use of emerging biomaterials technology in medical devices. The need to understand design requirements of medical devices based on safety and efficacy will be addressed. Unexpected device failure can occur if testing fails to account for synergistic interactions from chronic loading, aqueous environments, and biologic interactions. Testing methodologies are readily available to assess accelerated effects of loading in physiologic-like environments. This combined with subchronic effects of animal implants is a potential tool in assessing durability. It is difficult to predict the chronic effects of the total biologic environment. The ultimate determination of safety comes not only from following the details of regulations, but with an understanding of potential failure modes and designs that lowers the risk of these failures. This course will evaluate biomaterials and their properties as related to the design and reliability of medical devices.

BE 595M. MEDICAL DEVICE REGULATION.

This course provides an overview of regulations that guide the Medical Devices industry. Primary focus is on the Food, Drug and Cosmetic Act and its associated regulations. The course covers the FD&C Act, including definitions, prohibited acts, penalties and general authority. The course also covers regulations, including establishment registration, premarket approval (PMA), and current good manufacturing practices. Requirements of other federal agencies (NRC, FCC, EPA) will also be discussed.

CHEMICAL ENGINEERING

CM 2011. CHEMICAL ENGINEERING FUNDAMENTALS.

Cat. I

This first course in chemical engineering is designed to give students the ability to use techniques and solve problems of interest to chemical engineers. Students will learn fundamental material by completing analysis, design, and/or laboratory projects. Topics covered include: material balances and stoichiometry, pressure, volume, and temperature behavior of pure fluids, 1st law of thermodynamics, vapor-liquid equilibria with ideal thermodynamics, and staged separation processes.

Recommended background: Elementary college chemistry and calculus.

Students may not receive credit towards CM distribution requirements for both CM 2011 and CM 2001.

CM 2012. ELEMENTARY CHEMICAL PROCESSES.

Cat. I

This course aims to build a strong foundation in analysis of chemical processes via a project-based approach. Topics covered include analysis and design of stagewise separation processes such as distillation, 1st and 2nd law (of thermodynamics) analysis of power and refrigeration cycles, and application of material and energy balances in industrial chemical processes, including those with recycle and non-ideal systems.

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

Students may not receive credit towards CM distribution requirements for both CM 2012 and ES 3000.

CM 2013. APPLIED CHEMICAL ENGINEERING THERMODYNAMICS.

Cat. I

This course uses a project-based approach to build confidence and competence in the use of chemical engineering thermodynamics for the analysis and design of chemical processes. Topics covered include extractive separation systems, solution thermodynamics and nonreacting multicomponent mixtures, phase equilibria and property changes on mixing.

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

Students may not receive credit towards CM distribution requirements for both CM 2013 and CM 2102.

CM 2014. ADVANCED CHEMICAL PROCESSES.

Cat. I

This course builds on prior work in material and energy balances, chemical engineering thermodynamics, and stagewise 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.

This course will be offered in 2004-05, and in alternating years thereafter.

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 air shed modelling, global atmospheric change and design and efficiencies of air pollution control devices.

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

This course will be offered in 2004-05, and in alternating years thereafter.

CM 4401. UNIT OPERATIONS OF CHEMICAL ENGINEERING I.

Cat. I

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. I

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. I

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. I

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. I

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, Fourier 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 zeolites, 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, AUGER, 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 adsorbants 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 multi-component 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 chemicals, 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 COURSES

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 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 2640. EXPERIMENTAL CHEMISTRY I: INSTRUMENTAL ANALYSIS.

Cat. I
This laboratory course focuses on the application of modern instrumental methods of analysis to chemical, biochemical and environmental problems. Practical experience is gained in quantitative ultraviolet-visible spectrophotometry, bioluminescence, high performance liquid chromatography, and capillary electrophoresis. Generally, after a set exercise to illustrate the capabilities and use of a particular instrument, student teams select a chemical, biochemical or environmental problem of interest to them, formulate an approach, conduct the analysis, and present their findings to the class.

Recommended background: CH 1010-CH 1040.

CH 2650. EXPERIMENTAL CHEMISTRY II.

Cat. I
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 2640 and CH 3510.

CH 2660. EXPERIMENTAL CHEMISTRY III.

Cat. I
The emphasis in CH 2660 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 spectroscopy. Micro-synthetic procedures are introduced. Mastery of the techniques and manipulations emphasized in CH 2640 and CH 2650 would be advantageous.

CH 2670. EXPERIMENTAL CHEMISTRY IV.

Cat. I
The synthesis, isolation, and characterization of inorganic compounds are emphasized. Syntheses of main group compounds, classical transition metal complexes, and organotransition metal compounds are included. In addition to reinforcing and building on standard techniques of synthesis and characterization, several new techniques are introduced: synthesis under inert atmosphere, measurement of magnetic susceptibility by NMR, and cyclic voltammetry. Some exposure to ^{13}C NMR is also provided. The final experiment of the course requires the student to design a synthesis for a compound selected from a list provided, based on strategies learned in the course.

INORGANIC AND PHYSICAL CHEMISTRY COURSES

CH 3410. PRINCIPLES OF INORGANIC CHEMISTRY.

Cat. I
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 Pourbaix 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 3510. CHEMICAL THERMODYNAMICS.

Cat. I
The content of this course will be the development of the principles of classical thermodynamics. The laws of thermodynamics will be developed by using a series of increasingly complex model systems and a universal equation of state is formulated which incorporates the relationships illustrated by these model systems. Using this equation it will be possible to appreciate that thermodynamic laws are applicable to all systems of matter, regardless of their complexity. Finally, the principles developed are applied to problems of a chemical nature, focusing on predicting the spontaneity of chemical reactions.

The material in this course will be of greatest interest to those students enrolled in the basic sciences including biology, chemistry, and physics, and in applied fields such as chemical engineering, materials science and biotechnology.

Recommended background: Students should be familiar with the material covered in the freshman general chemistry and math sequences. Familiarity with differential equations would be an asset.

CH 3530. QUANTUM CHEMISTRY.

Cat. I
An introduction to quantum mechanics with applications to atomic and molecular species. 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.

This course is normally for students in their third year.

CH 3550. CHEMICAL DYNAMICS.

Cat. I
This course deals in a general way with the interactions between energy and molecules, and considers how energetic and structural considerations affect the outcome of molecular interactions. The manipulation of kinetic data and results is stressed. Selected topics from both organic and inorganic chemistry are analyzed in terms of reaction thermodynamics, rates and mechanisms.

Students are expected to be familiar with thermodynamics, equilibria, reaction rates and the Periodic Table of the elements.

The following three courses, CH 4110, CH 4120, and CH 4130, are a three-term sequence intended to provide a strong emphasis in biochemistry. As background for this sequence, CH 1010, CH 1020, CH 1030, CH 1040, CH 2310, CH 2320, and CH 2330, or their equivalents, are recommended.

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.

CH 4120. BIOCHEMISTRY II.

Cat. I
Oriented around biological membranes, this course begins with a discussion of electron transport and the aerobic production of ATP followed by a study of photosynthesis. The study of the biosynthesis of lipids and steroids leads to a discussion of the structure and function of biological membranes. Finally the membrane processes in neurotransmission are discussed.

Recommended background: CH 4110.

CH 4130. BIOCHEMISTRY III

Cat. I
This course presents a thorough analysis of the biosynthesis of DNA (replication), RNA (transcription), and proteins (translation) and of their biochemical precursors. Proteins and RNAs have distinct lifetimes within the living cell; thus the destruction of these molecules is an important biochemical process that is also discussed. In addition to mechanistic studies, regulation of these processes is covered.

Students who have received credit for CH 4130 or BB 4910 prior to Term A 2000 may not receive credit for the other course.

CH 4150. EXPERIMENTAL BIOCHEMISTRY.

Cat. I
The experiments in this laboratory course have been designed to acquaint the students with the basic skills necessary to perform biochemical studies. The course will cover, for instance, protein purification from different biological sources, subcellular fractionation, enzyme kinetics (K_m , V_{max} , Hill coefficient; specific activity, effector-protein interaction, etc.), exclusion and ion exchange chromatography, electrophoresis and immunodetection.

Recommended background: CH 4120.

CH 4160. MEMBRANE BIOPHYSICS.

Cat. II
This course will focus on different areas of biophysics with special emphasis on membrane phenomena. The biomedical-biological importance of biophysical phenomena will be stressed. The course will begin with the introduction of the molecular forces relevant in biological media and subsequently develop the following topics: Membrane Structure and Function; Channels, Carriers and Pumps; Nerve Excitation and related topics; and Molecular Biophysics of Motility.

Recommended background: prior knowledge of Biochemistry (CH 4110, CH 4120), Mechanics (PH 1110) and Electricity (PH 1120).

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

CH 4190. REGULATION OF GENE EXPRESSION*Cat. I*

This course will cover the biochemical mechanisms involved in regulation of gene expression, modifications of DNA structures that influence transcription rates, transcriptional regulation by protein binding, post-transcriptional modifications of RNA including splicing and editing, regulation of translation including ribosome binding and initiation of translation, and factors that control the half-lives of both mRNA and protein. During the course, common experimental methods will be explored, including a discussion of the information available from each method.

Recommended background CH 4110, CH 4120, CH 4130, BB 4010

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.

This course will be offered in 2004-05 and in alternating years thereafter.

CH 4420. INORGANIC CHEMISTRY II.*Cat. II*

Complexes of the transition metals are discussed. Covered are the electronic structures of transition metal atoms and ions, and the topological and electronic structures of their complexes. Symmetry concepts are developed early in the course and used throughout to simplify treatments of electronic structure. The molecular orbital approach to bonding is emphasized. The pivotal area of organotransition metal chemistry is introduced, with focus on complexes of carbon monoxide, metal-metal interactions in clusters, and catalysis by metal complexes.

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

This course will be offered in 2004-05 and in alternating years thereafter.

CH 4520. CHEMICAL STATISTICAL MECHANICS.*Cat. II*

This course deals with how the electronic, translational, rotational and vibrational energy levels of individual molecules, or of macromolecular systems, are statistically related to the energy, entropy, and free energy of macroscopic systems, taking into account the quantum mechanical properties of the component particles. Ensembles, partition functions, and Boltzmann, Fermi-Dirac, and Bose-Einstein statistics are used. A wealth of physical chemical phenomena, including material related to solids, liquids, gases, spectroscopy and chemical reactions are made understandable by the concepts learned in this course.

Recommended background: CH 3510 and CH 3530, or equivalent, and mathematics through differential and integral calculus.

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

CH 4550. POLYMER CHEMISTRY.*Cat. II*

Fundamentals of polymer science and technology based on organic polymers. The principal mechanisms of polymerization including radical, ionic and condensation, are covered in detail. Characterization of polymers by physical means. Mechanical behavior including bulk and solution properties of polymers. Polymer syntheses and modifications including block and graft copolymerization.

Structure, property and end use applications of plastic materials. Plastics processing, testing and technology. Survey of commodity plastics as well as engineering resins including their applications and economic considerations. Presentation of trade and technical literature in the field.

Recommended background: CH 2310 and CH 2320 or equivalent.

This course will be offered in 2004-05 and in alternating years thereafter.

GRADUATE CHEMISTRY COURSES OF INTEREST TO UNDERGRADUATES**CH 501. CHEMISTRY OF THE MAIN GROUP ELEMENTS.**

An advanced course in recent developments in selected areas if the chemistry of the elements other than transition metals. Topics covered may include electron deficient compounds and main group organometallics; the preparation, reactions and physical properties of these compounds.

CH 502. BIOINORGANIC CHEMISTRY.

This graduate course addresses current topics in bioinorganic chemistry, with emphasis on the structure and function of metalloenzymes of d-block metal ions. Active site structures of myoglobin and hemoglobin, blue copper proteins and hemocyanin, iron-sulfur cluster proteins, and the nitrogenase enzyme are discussed. The applications of a variety of physical methods (including electronic absorption spectroscopy, FTIR, multinuclear NMR, EPR, Resonance

Raman spectroscopy, EXAFS, and electrochemical methods) to the elucidation of metalloprotein structure/function are discussed.

Recommended background: Knowledge of the fundamental concepts and theories of d-metal chemistry and of various spectroscopic methods.

CH 516. CHEMICAL SPECTROSCOPY.

Advanced topics in identification of organic species and determination of molecular structure by spectroscopic methods.

Methods covered include ^1H - and ^{13}C -NMR, mass spectrometry and infrared and UV-visible spectroscopy. This course is concerned only with interpretation of spectra and does not cover techniques obtaining them; there is no laboratory.

CH 533. PHYSICAL ORGANIC CHEMISTRY.

Mechanics of representative organic reactions, and the methods used for their evaluation. Structural, electronic, and stereochemical influences on reaction mechanisms are explored. Emphasis is on the various techniques used to obtain insights into mechanisms, and on the interplay of data and interpretation.

CH 534. ORGANIC PHOTOCHEMISTRY.

Introduction to the photophysical and photochemical consequences of light absorption by molecules. Experimental techniques, excited state description, photochemical kinetics and energy transfer are among the topics discussed in relation to the primary photochemical reactions in simple and complex molecules.

CH 538. MEDICINAL CHEMISTRY.

This course will focus on the medicinal chemistry aspects of drug discovery from an industrial pharmaceutical Research and Development perspective. Topics will include Chemotherapeutic Agents (such as antibacterial, antiviral and antitumor agents) and Pharmacodynamic Agents (such as antihypertensive, antiallergic, antiulcer and CNS agents).

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

CH 539. MOLECULAR PHARMACOLOGY.

The course will begin with a review of human physiology emphasizing the endocrine, nervous, and lymphatic systems, and including a discussion of the psychoneuroimmunology controversy. Understanding communication between cells requires study of the variety of chemical messengers, their storage, release, action on their target receptors, and eventual fate. This study will include discussion of the location and nature of the variety of receptors. Understanding the effects of messengers necessitates a detailed study of the molecular structure and function of ion channels which will include an application to the nerve impulse. Intercellular and intracellular communication are brought together by a discussion of the molecular mechanisms of receptor-effector coupling. The molecular structures of the acetylcholine receptor and of rhodospin will be used as illustrations. The concepts of agonist and antagonist will be reinforced by a discussion of selected drugs. Nonreceptor blocking will be illustrated in a study of local anesthesia. Study of the neuroactive peptides will lead to a discussion of drug addiction and alcoholism as receptor mediated pathologies. A segment on the role ion cotransport systems play in bodily regulation will include an analysis of the molecular action of the loop diuretics as another example of nonreceptor blockers. This course is designed to compliment the "Medicinal Chemistry" course and will emphasize general principles and the underlying molecular structures.

Recommended background: knowledge of the material covered in one of the following is recommended: (a) CH 4110 and CH 4120, or (b) 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 Huckel 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 described 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:

Florescence 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 $n\pi$ and π excited states.

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 2001. ANALYTICAL MECHANICS II.

Cat. I

This course provides an introduction to the relationship between analysis, design, and the behavior of materials under load. Theory and applications are developed that utilize simple and combined stress-strain behavior of members subjected to axial, torsional, and flexural loadings, with applications to beams, trusses, rigid frames, shafts, and tension and compression structures.

Recommended background: CE 2000.

CE 2002. INTRODUCTION TO ANALYSIS AND DESIGN.

Cat. I

This course develops an understanding of classical and modern structural analysis. Topics include loading systems, and the analysis of statically determinate and statically indeterminate beams, frames, trusses, structural floor systems for buildings, bridges, and other structural assemblies.

Recommended background: CE 2000 and CE 2001.

Suggested background: CE 1030.

CE 2020. SURVEYING.

Cat. I

This course develops fundamental skills in the theoretical and practical aspects of plane surveying through the use and care of modern instruments and the associated computations. Topics include the classification of errors incurred in observed field data and necessary correction applications, the use and care of surveying equipment, traversing, differential leveling, stadia and mapping, and electronic data transfer. Computer applications are used where appropriate.

CE 3006. DESIGN OF STEEL STRUCTURES.

Cat. I

This course covers the theory and practice of structural steel design. The structural design process for beams, columns, trusses, frames, and connections is based on Load and Resistance Factor Design (LRFD) specifications of the American Institute of Steel Construction.

Recommended background: CE 2002 and CE 3010.

Suggested background: CE 1030.

CE 3008. DESIGN OF REINFORCED CONCRETE STRUCTURES.

Cat. I

This course covers the theory and practice of reinforced concrete design. The structural design process for beams, columns, slabs, frames, flat slabs, footings, and retaining walls uses the ultimate strength design codes of the American Concrete Institute.

Recommended background: CE 2002 and CE 3010.

Suggested background: CE 1030.

CE 3010. STRUCTURAL ENGINEERING.

Cat. I

This course provides an understanding of the practice of structural engineering. It builds upon the fundamental skills developed in CE 2000, CE 2001, and CE 2002 to present the principles of structures and their elements. The course provides a perspective for dealing with the issues of strength, stiffness, and stability. Although wood is the principle material used to develop the study of the interrelationship between analysis and design of structural systems, structural steel and reinforced concrete systems are also discussed. It also introduces students to the use of building codes for design criteria. The role of the structural engineer in the design process and cost factors are also discussed.

Recommended background: CE 2000, CE 2001, and CE 2002.

Suggested background: CE 1030.

CE 3020. PROJECT MANAGEMENT.

Cat. I

This course presents the fundamental concepts and process of project management applied to public and private works. The principle focus of the course is the management of civil engineering projects including planning, scheduling, organization and control, as well as management concepts of leadership, motivation, trust, project team development, division of work, and conflict resolution. Ancillary engineering and construction practices involving financial practices, construction documents, contract negotiation and administration, quality and safety control, insurance and bonding are covered.

Recommended background: CE 1030.

CE 3021. COST ESTIMATING, SCHEDULING AND PROJECT CONTROL.

Cat. II

This course presents the fundamental concepts and processes by which the cost and time of execution of civil engineering projects are established. It emphasizes the importance of decisions made at the early stages of design on final project cost. The relationship between time and cost is examined in detail. Topics include: construction methods, quantity surveying, resource pricing, activity planning, resource allocation, financial analysis, bidding, job cost accounting and cost control with extensions to operating and maintenance costs. Commercial software for project scheduling, cost estimating, and cost control is used in this course.

Recommended background: CE 1030 and CE 3020.

Offered in 2004-05 and in alternating years thereafter.

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 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 2004-05 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.

Recommended background: CE 2000 and CE 2001.

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.

Suggested background: CE 2020.

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 Highway Drainage, Soil Engineering for Highway Design, Bituminous Materials, Design of Flexible and Rigid 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, provides 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 covered include: environmental impact of population growth and energy demand, water resources, water chemistry, water quality standards, environmental microbiology, wastewater characteristics, receiving water quality and dissolved oxygen budgets, water pollution abatement, sludge management, solids and hazardous waste management, and an introduction of air and noise 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 water quality 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 to the student 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, plane 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 3020.

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 2004-05 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 topics 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 planner board member should be familiar will be examined in detail.

COMPUTER SCIENCE

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 programming or most advanced computer science or computer engineering courses. Such background may be obtained by taking CS 1005 or CS 1006 followed by CS 2005.

Recommended background: none.

This course will be offered in 2004-05 and in alternating years thereafter.

CS 1005. INTRODUCTION TO PROGRAMMING.*Cat. I*

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. I*

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, conditional, and recursive control structures; primitive and complex data types; 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. I*

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. I*

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 assembly language programming, microprogramming, and logic circuits.

Topics include the functional organization of computer hardware, the functions of assemblers, linkers, and loaders, representations of numbers in computers, basic assembly language instruction sets, addressing modes, stacks and procedures, low-level I/O, concepts and examples of microprogramming, and logic circuits.

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. I*

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 CS 501.

Recommended background: none.

CS 2135. PROGRAMMING LANGUAGE CONCEPTS.*Cat. I*

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. I*

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. I*

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. I*

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.

Recommended background: CS 2005 and CS 2011.

CS 3041. HUMAN-COMPUTER INTERACTION.*Cat. I*

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 computability 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 3257. 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 2004-05 and in alternating 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 characterizations 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 2004-05 and in alternating 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 2004-05 and in alternating 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.

Intended audience: computer science and computer engineering majors.

Undergraduate credit may not be earned both for this course and CS 542.

Recommended background: CS 3431 and knowledge of software engineering, such as CS 3733.

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

CS 4513. DISTRIBUTED COMPUTING SYSTEMS.*Cat. I*

This course extends the study of the design and implementation of operating systems begun in CS 3013 to distributed and advanced computer systems.

Topics include principles and theories of resource allocation, file systems, protection schemes, and performance evaluation as they relate to distributed and advanced computer systems.

Students may be expected to design and implement programs that emphasize the concepts of file systems and distributed computing systems using current tools and languages.

Intended audience: computer science and computer engineering majors.

Recommended background: CS 3013 and a knowledge of probability, such as provided by MA 2631.

CS 4514. COMPUTER NETWORKS: ARCHITECTURE AND IMPLEMENTATION.*Cat. I*

This course introduces principles and current trends in computer networks. The ISO Reference Model will be used as the framework with the course progressing through the physical, data link, network, transport, session, and presentation layers with specific examples and standards cited throughout for point-to-point, satellite, packet-radio, and local area networks.

Topics include motivation and objectives of computer networks, overview of network architectures, layered architectures, performance analysis, virtual circuits, datagrams, routing flow control, local area networks, internetworking, end-to-end communication, virtual terminal, file transfer protocols, and client-server programming.

Students will be expected to design and implement projects such as simulation of the network/transport layer functions, routing, congestion control, an Ethernet controller, applications using TCP/IP or remote procedure calls.

Intended audience: computer science and computer engineering majors.

Undergraduate credit may not be earned both for this course and for CS 513.

Recommended background: CS 3013 and some knowledge of probability.

CS 4515. COMPUTER ARCHITECTURE.*Cat. II*

This course explores modern computer architectures in terms of instruction sets and the organization of processors, controllers, memories, devices, and communication links.

Topics include an overview of computer systems, theoretical foundations, modern computer system components, pipelining of instruction sets, multifunction pipelines, parallel computer organization.

Students will be expected to design and implement programs which simulate significant components of modern computer architectures.

Intended audience: computer science and computer engineering majors.

Recommended background: CS 2011 or EE 2801, and CS 3013.

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

CS 4533. TECHNIQUES OF PROGRAMMING LANGUAGE TRANSLATION.*Cat. II*

This course studies the compiling process for high-level languages.

Topics include lexical analysis, syntax analysis, semantic analysis, symbol tables, intermediate languages, optimization, code generation and run-time systems.

Students will be expected to use compiler tools to implement the front end, and to write a program to implement the back end, of a compiler for a recursive programming language.

Intended Audience: computer science and computer engineering majors

Recommended Background: CS 2136 and CS 3133.

This course will be offered in 2004-05 and in alternating years thereafter.

CS 4731. COMPUTER GRAPHICS.*Cat. I*

This course studies the use of the computer to model and graphically render two- and three-dimensional structures.

Topics include graphics devices and languages, 2- and 3-D object representations, and various aspects of rendering realistic images.

Students will be expected to implement programs which span all stages of the 3-D graphics pipeline, including clipping, projection, arbitrary viewing, hidden surface removal and shading.

Intended audience: computer science majors.

Undergraduate credit may not be earned both for this course and for CS 543.

Recommended background: CS 2223 and MA 2071.

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 alternating 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.

Topics: Basic concepts of electrical circuits, linear circuit analysis, op-amp circuits, simple transients, phasor analysis, amplifiers, frequency response, filters.

Recommended background: high school physics, and MA 1022 (concurrent).

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.

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 2011, 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 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 pn 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: EE2011.

EE 2311. CONTINUOUS-TIME SIGNAL AND SYSTEM ANALYSIS.

Cat. I

This course provides an introduction to time and frequency domain analysis of continuous time signals and linear systems. Topics include signal characterization 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, linear and circular convolution, characterization of FIR and IIR discrete-time systems, 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, manufacturability, testing, and evaluation. Student work in small teams and are encouraged to use creativity to solve specific but 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 microprocessors are used to solve problems that require interactions 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: EE2022 (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 3113. 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 analysis, 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 circuitry. 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 aggregated 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. 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.

Suggested background: EE 2312

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.

Topics: sound, applied acoustics, devices and systems associated with the recording and reproduction of speech and music. Feedback amplifiers. Measurement of sound; techniques for the control of acoustic noise. Selected laboratory exercises.

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

EE 3311. PRINCIPLES OF COMMUNICATION SYSTEMS.

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. Pulse shaping and intersymbol interference 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 modem transmission schemes.

Recommended background: MA 1024, EE 2311 and EE 2312.

EE 3501. ELECTRICAL ENERGY CONVERSION.

Cat. I

This course is designed to provide a cohesive presentation of the principles of electric 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.

Topics: Review of poly-phase circuits. Transducers and instrumentation for power and energy measurements. Rotating machines. Electromechanical transients and stability. Switchgear equipment. Selected laboratory experiments.

Recommended background: EE 2111.

EE 3503. POWER ELECTRONICS.

Cat. I

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. I

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. I

This course provides a basic introduction to the principles of real-time digital signal processing (DSP). Topics include: structured 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 3711. INTRODUCTION TO ELECTRO-OPTICS.

Cat. I

The aim of this course is to give students the opportunity to acquire a fundamental understanding of optoelectronics and principles of optoelectronic device operation.

At the completion of this course the students should achieve an understanding of wave phenomena and an appreciation of basic optical components. The students will obtain a background in modulation of light and a working knowledge of display devices based on photoluminescence and cathodoluminescence, and will gain insight into light emitting diodes, LED materials and liquid crystal display. A review of the concept of lasers will be presented, leading to an appreciation of the different laser types, especially the semiconductor laser. The students will be given a working knowledge of the optical fiber categories and operation as well as critical aspects of fiber optical communication systems. Additional applications may be covered in student projects.

Recommended background: PH 1140, EE 2311, EE 2201.

EE 3801. ADVANCED LOGIC DESIGN.

Cat. I

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 2011.

EE 3803. MICROPROCESSOR SYSTEM DESIGN (FORMERLY INTRODUCTION TO MICROPROCESSOR SYSTEMS).

Cat. I

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. I.

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 testbenches 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. I

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 sequence of courses and will draw illustrative examples of electronic circuit applications from other courses.

Topics: carrier transport processes in semiconductor materials. Carrier lifetime. Theory of p-n junctions. Bipolar transistors internal theory, dc characteristics, charge control, Ebers-Moll relations; high frequency and switching characteristics, hybrid- π model; n- and p-channel MOSFETS, CMOS.

Recommended background: EE 2201.

EE 3902. INTRODUCTION TO VLSI DESIGN.

Cat. I

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. I

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 exposed. 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 2621.

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.

Topics: Solution of large scale linear networks: nodal analysis and matrix factorization, analysis of symmetrical and unsymmetrical faults, contingency analysis. Solution of large scale nonlinear systems: the Newton-Raphson method, bus modeling, power flow analysis. Optimization problems in power systems: economic dispatch and state estimation.

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, microcontrollers, 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 3803 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.

Topics: integrated circuit building blocks: current mirrors and sources, differential amplifiers, voltage references and multipliers, output circuits. Computer-aided simulation of circuits. Layout of integrated circuits. Design and analysis of such circuits as operational amplifiers, phase-locked loops, FM detectors, and analog multipliers. Laboratory exercises.

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 Kirchoff'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 graphics 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, but ample opportunity exists 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 radioisotope 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 centroid 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: Statics (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 will 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: Statics (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.

Topics covered include: steady-state and transient conduction exemplified by heat transfer to and from buried pipes, heat losses through furnace walls, response of thermocouple devices, and the effect of adding fins to increase heat transfer rates. Contact resistance. Natural and forced convection. Heat exchanger analysis and design. Convection accompanied by boiling and condensation. Blackbody radiation. Thermal radiation within an enclosure including diffuse and gray surfaces. Radiation accompanied by conduction and with motion.

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 flows, fluid resistance and basic boundary layer theory will also be considered.

Recommended background: basic physics, basic differential equations and vectors; third year students.

ES 3011. CONTROL ENGINEERING I.*Cat. I*

Characteristics of control systems. Mathematical representation of control components and systems. Laplace transforms, transfer functions, block and signal flow diagrams. Transient response analysis. Introduction to the root-locus method and stability analysis. Frequency response techniques including Bode, polar, and Nichols plots.

This sequence of courses in the field of control engineering (ES 3011) 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 2300, ME 3320), 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 flame spread, fire penetration, 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, plume 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 553. 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 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 phenomenology 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 2004-05 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 2004-05 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 important 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 firesafety 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 firesafety 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 2004-05 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 design. Accident investigation theory and failure analysis techniques such as fault trees and event sequences are presented. Fire dynamics and computer modeling are applied to assess possible fire scenarios and the effectiveness of fire protection measures. The products liability aspects of failure analysis are presented. Topics include products liability 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 2004-05 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.

GEOSCIENCES

GE 2341. GEOLOGY.

Cat. I

Students of this course will examine the fundamental principles of physical geology including the materials, structures, and surface features of the earth and the processes which produced them. Emphasis will be placed on the interrelationship of people and environment and applications to various fields of technology. The course includes field trips and a significant laboratory component.

HUMANITIES AND ARTS

Art History/Architecture

AR 1111. INTRODUCTION TO ART HISTORY.

Cat. I

How do we understand a work of art? Through readings and the study of objects at the Worcester Art Museum, the student will survey the major developments in world art and be introduced to various critical perspectives in art history. Students will learn how art historians work with primary materials and formulate arguments. No previous knowledge of art is required. (Formerly HU 1014.)

AR 2111. MODERN ART.

Cat. I

The successive phases of modern art, especially painting, are examined in light of the late-19th-century break with the 600-year old tradition of representation.

Topics covered include: non-objective art and abstraction—theory and practice, primitivism in modern art, surrealism and the irrational, the impact of photography on modern painting, cubism and collage, regionalism and abstract expressionism as American art forms, Pop art and popular culture, and the problem of concept versus representation in art. (Formerly AR 2300.)

AR 2113. TOPICS IN 19TH- AND 20TH-CENTURY ARCHITECTURE.

Cat. I

This course considers the built environment in a non-technical way. It explores changes in architectural style as responses to the industrial transformation of Europe and America and to changing ideas about the purpose of art. The focus will vary from year to year and may concentrate on new uses of past styles, the architecture and planning of the industrial city, the careers of the great modern architects from Wright to Mies, or current topics in design. The central topic will remain the development of the Modern Movement in architecture. Students will use local buildings to learn the methods of architectural history and explore the aesthetic effects of architecture.

AR 3112. MODERNISM, MASS CULTURE, AND THE AVANT-GARDE.

Cat. I

What is the role of art to be in the modern world? Can art be a vehicle for social change, or should art be a self-critical discipline that pursues primarily aesthetic ends? What is the relationship between art and mass culture? Using primary sources, this course focuses on some of the theorists and artistic trends since the mid-nineteenth century that have sought to resolve this dilemma. These include: Ruskin, Morris and the Arts and Crafts Movement; Art For Art's Sake; the German Werkbund and the Bauhaus; American industrial design.

AR/ID 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 an acquaintance with the visual arts, is helpful.

This course will be offered in 2004-05 and in alternating years thereafter.

English

EN 1221. INTRODUCTION TO DRAMA: THEATRE ON THE PAGE AND ON THE STAGE.

Cat. I

The plays studied will give the student an understanding of the forms of drama, the styles of theatre performance and production, and the emergence of new forms and styles. Types of drama studied could 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, Raleigh, 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 American literature and to black cultural expression.

This course will be offered in 2004-05 and in alternating years thereafter.

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 playwriting, 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.

Opportunities will exist in this course for studying the plays as literature, for aspects of production and performance, and for their adaptability to film. The WPI library of video recordings will be available for such work.

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

EN 2224. SHAKESPEARE: NOTHING BUT LOVE.*Cat. II*

The course focuses on conflicts between personal desire and societal responsibility in such plays as *As You Like It*, *Antony and Cleopatra*, and *The Winter's Tale*.

Through written work and in-class performances, students will examine how Shakespeare both maintains and subverts traditional ideas about marriage and sexual practice. These analyses will take into account contemporary views on gender roles and identity including the early modern cultural "ideal" of the "chaste, silent, and obedient" woman. Students will study Shakespeare's work as literature and also through performance and film adaptations. The WPI library of video recordings will be available for such work.

This course will be offered in 2004-05 and in alternate years thereafter.

EN 2231. AMERICAN LITERATURE: THE RAVEN, THE WHALE, AND THE WOODCHUCK.*Cat. I*

Emerson challenged the young nation in "The American Scholar" (1837): If our writers were "free and brave," with words "loaded with life," they would usher in a "new age." The incredibly rich literature that soon followed created an "American Renaissance." This was the Age of Reform (1836-65) in more than literature. Writers were caught up in such burning issues as abolitionism, Union vs. secession, and women's rights. Authors studied may include Emerson, Thoreau, Poe, Fuller, Douglass, Melville, Whitman, and Dickinson.

EN 2232. AMERICAN LITERATURE: TWAIN TO WORLD WAR I.*Cat. I*

This survey course covers developments in American literature, particularly the movement towards Realism, during the period of turbulent change between the end of the Civil War and the early years of the twentieth century. Topics will include the rebellion against post bellum sentimentalism, the rise of regional writing, the emerging literature of social protest, and literary responses to advances in science, industry, and urban life. Attention will be given to the works of Mark Twain, a prime exponent of turn-of-the-century literary trends, as well as to other pioneer realists (James and Crane).

EN 2233. AMERICAN LITERATURE: MODERNISM TO THE PRESENT.*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 represents the literary response to the broad intellectual, social, and cultural changes that mark the history of those years of ferment in the United States. The course 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 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.

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

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 rhetorical roots of the concept, assesses its popular and commercial manifestations, and explores the ironies, paradoxes, and continuities 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, Studs Terkel, and Archibald MacLeish.

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.

This course will be offered in 2004-05 and in alternating years thereafter.

EN 2238. AMERICAN REALISM.*Cat. I*

By examining authors who reacted against the so-called "genteel 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 2004-05 and in alternating years thereafter.

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 alternating 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 Brecht'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 purposed 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-relations 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, Euripedes, Aristophanes, the Renaissance, the Restoration, Moliere, Ibsen, Strindberg, Shaw, Pirandello, and others.

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

EN 3223. FORMS IN MODERN DRAMA.

Cat. II

The study of the forms in 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 Grotowski and Brook.

This course will be offered in 2004-05 and in alternating 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 alternating 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.

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

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

This course will be offered in 2004-05 and in alternating 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 2004-05 and in alternating years thereafter.

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.

This course will be offered in 2004-05 and in alternating 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 3225 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. I

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 audiotapes 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 1871 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 2004-05 and in alternating years thereafter.

Recommended background: GN 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 alternating years thereafter.

Recommended background: GN 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.

HI 1312. INTRODUCTION TO AMERICAN SOCIAL HISTORY.*Cat. I*

An introduction to the historical study of American society. It addresses two questions: What is social history? And how do social historians work?

HI 1313. INTRODUCTION TO THE STUDY OF FOREIGN POLICY AND DIPLOMATIC HISTORY.*Cat. I*

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.

HI 1314. INTRODUCTION TO EARLY AMERICAN HISTORY.*Cat. I*

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.

HI 1321. INTRODUCTION TO EUROPEAN SOCIAL HISTORY.*Cat. I*

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.

HI 1322. INTRODUCTION TO EUROPEAN CULTURAL HISTORY.*Cat. I*

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.

HI 1331. INTRODUCTION TO THE HISTORY OF SCIENCE.*Cat. I*

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.

HI 1332. INTRODUCTION TO THE HISTORY OF TECHNOLOGY.*Cat. I*

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.

HI 1341. INTRODUCTION TO GLOBAL HISTORY.*Cat. I*

An introduction to the study of global history since 1500. Topics include global expansion, the Columbian exchange, and the slave trade; Renaissance, Reformation, 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.

HI 2311. AMERICAN COLONIAL HISTORY.*Cat. I*

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.

HI 2313. AMERICAN HISTORY, 1789-1877.*Cat. I*

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.

HI 2314. AMERICAN HISTORY, 1877-1920.*Cat. I*

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 "laissez-faire," and the diverse sources and nature of late 19th- and early 20th-century reform movements.

HI 2315. THE SHAPING OF POST-1920 AMERICA.*Cat. I*

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.

HI 2316. AMERICAN FOREIGN POLICY FROM WOODROW WILSON TO THE PRESENT.*Cat. I*

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.

HI 2317. LAW AND SOCIETY IN AMERICA, 1865-1910.*Cat. I*

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.

HI 2321. EUROPE FROM THE FRENCH REVOLUTION TO WORLD WAR I.*Cat. I*

A survey of the 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; liberalism, democracy, and socialism; national unification of Italy and Germany; the coming of World War I.

No prior knowledge of European history is required.

HI 2322. EUROPE SINCE WORLD WAR I.*Cat. I*

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, contemporary Europe.

No prior knowledge of European history is required.

HI 2324. INDUSTRY AND EMPIRE IN BRITISH HISTORY.*Cat. I*

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.

HI 2325. MODERN FRANCE.*Cat. II*

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 2004-05 and in alternating years thereafter.

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.

HI 2331. AMERICAN SCIENCE AND TECHNOLOGY TO 1859.*Cat. I*

A survey, stressing the development of a scientific community, 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.

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.

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.

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.

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 2003-04 and in alternating 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 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 2004-05 and in alternating 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 2314, American History, 1877-1920; or HI 2315, The Shaping of Post-1920 America.

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.

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 3323. 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, Psycho-analysis, 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 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.

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. TOPICS IN IMPERIAL AND POSTCOLONIAL HISTORY.*Cat. II*

This seminar course examines topics in the history of European imperialism, colonialism, and the postcolonial aftermath. Topics vary each year among the following: culture and imperialism, the expansion of Europe, the economics of empire, travel and exploration narratives, imperialism in literature and anthropology, decolonization in Asia and Africa, postcolonial studies. Readings will include primary and secondary sources.

This course will be offered in 2004-05 and in alternating years thereafter.

HI 3342. TOPICS IN COMPARATIVE CIVILIZATIONS.*Cat. II*

This seminar course compares and contrasts major religious, philosophical, social, and political themes in different civilizations. Comparisons will vary each year but may be drawn from Asia, the Indian subcontinent, the Middle East, Africa, and indigenous cultures of the Americas. It examines the historical foundations of these civilizational differences and draws comparisons with common features of Western civilization. One important goal of the course is to enhance student appreciation of non-Western values and traditions.

This course will be offered in 2004-05 and in alternating years thereafter.

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.

Humanities

The courses listed below are general humanities courses and are intended to provide conceptual introductions to the major disciplines within the humanities. Students will encounter the basic methods of critical analysis and discussion required for the future investigation of the specific area they choose for their humanities and arts Sufficiencies. These courses emphasize patterns of thought, methods of inquiry, appropriate vocabulary, and critical attitudes needed to appreciate most fully various areas in the humanities; they are not intended as surveys or historical overviews. Consequently, in each course the subject matter used to develop and illustrate key concepts and approaches will change regularly. Practice in analytic thinking and writing will be a significant part of each course. The skills generated by these courses will greatly aid students in developing their themes and will be essential for the completion of the Sufficiency in the final IS/P seminar.

HU 1411. INTRODUCTION TO AMERICAN STUDIES.*Cat. II*

This interdisciplinary course introduces students to three or four basic American Studies methodologies. Emphasis will vary according to the instructor, but usually the course will cover the following: the particular historical, cultural context (at the community and/or national level) of a few literary texts; the relationship of American art to literature in a specific time period; analysis of popular culture entertainments in market-and-message terms of production and reception. This course provides a beginning for a Sufficiency in American Studies. For a description of the American Studies sequence and offerings, see the Sufficiency section of the Undergraduate Catalog.

Suggested background: an interest in American history and American expression.

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

HU 1412. INTRODUCTION TO ASIA.*Cat. I*

After an introduction to the enormous literature on China and Japan, the course will focus on the historical development of the ASEAN group (Thailand, Singapore, Malaysia, Indonesia, Philippines, Brunei, and Vietnam). This interdisciplinary course will concentrate on common elements within this very diverse association: colonial residues; similar models of economic development; cultural/religious linkages; influences from China, Japan and the U.S. Especially appropriate for Sufficiencies in Global Studies, U.S. Foreign Policy, British Colonial history and literature, or Religion, and as a background for students planning IQPs in Asia.

HU 2441. 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 democratization, or African literature and art.

Suggested background: HI 1341 Introduction to Global History.

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

HU 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. Racism, 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 alternating years thereafter.

HU 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 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 alternating years thereafter.

Suggested background: previous courses in humanities such as AR 1111, GN 1222, GN 2223, GN 2224, HI 1322, HI 1331, HI 1341, HI 2334, MU 2612, RE 2723 or equivalent.

HU 4411. SENIOR SEMINAR IN INTERNATIONAL STUDIES.*Cat. I*

This course is designed to integrate each student's international courses, projects, and experiences in a capstone seminar in International Studies. Students will reflect on what they have learned in their previous courses and international experiences. They will assess what happened to them overseas, why it happened, and how it might be understood. They will also prepare a paper with an instructor in their area of international studies that integrates their previous academic courses. Students will also explore how they might translate their courses and experiences into future personal and professional opportunities.

Recommended background: previous courses in international studies, such as HI 1341 and HU 3411, and completion of an international IQP or an international educational exchange.

HU—AAS-50. AMERICAN ANTIQUARIAN SEMINAR.*ISP*

Each fall the American Antiquarian Society and five Worcester colleges sponsor a research seminar at the Antiquarian Society library. The seminar is conducted by a scholar familiar with the Society's holdings in early American history, and the seminar topic is related to his or her field of research.

Selection is highly competitive. The ten participating students are chosen by a screening committee made up of representatives of the five participating colleges: Assumption College, Clark University, College of the Holy Cross, WPI, and Worcester State College.

The seminar topic and research methods combine several disciplines, and students from a wide variety of majors have participated successfully in this unique undergraduate opportunity.

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.

Recommended background: basic knowledge of reading music.

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.

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 2004-05 and in alternating years thereafter.

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 alternating years thereafter.

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 2004-05 and in alternating years thereafter.

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 Tchaikowsky.

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

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 also 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. 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 2004-05.
- MU 4624 Introduction to Jazz Theory
Cat. II. This seminar will be offered in 2003-2004.
- 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 2004-05.
- MU 4629 Music of the Twentieth-Century
Cat. II. This seminar will be offered in 2003-2004.

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.

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).

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, Hobbes, Locke, Rousseau and Marx, as well as numerous contemporary philosophers.

Suggested background: familiarity with basic concepts in philosophy (as in PY/RE 1731).

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

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.

Suggested background: knowledge of key terms and concepts as given in PY/RE 1731 and PY/RE 2731.

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

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 relation 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 2004-05 and in alternating years thereafter.

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 2003-04 and in alternating years thereafter.

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.

This course will be offered in 2004-05 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.

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.

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 2004-05 and in alternating years thereafter.

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.

Religion

RE/PY 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.

RE 2721. RELIGION AND CULTURE.

Cat. I

The purpose of this course is to examine how the two institutions of religion and culture interact and mutually influence one another. To do this a variety of definitions of religion and culture will be presented as well as an analysis of how religion interacts with such cultural phenomena as economics, politics, the state, war and the basic problem of social change. The purpose of this is to obtain a variety of perspectives on both religion and culture so that one can begin to articulate more clearly the different influences that occur in the development of one's own personal history and the culture in which one lives.

Suggested background: knowledge of key terms and concepts as given in PY/RE 1731.

RE 2722. THE PROBLEM OF EVIL.

Cat. I

Notions of good and evil shape many of our day to day religious and philosophical claims and arguments. This course concerns questions and approaches to what is often called "evil," through a study of classical and contemporary texts and problems. The focus of the course will vary, but will include metaphysical, moral, and political ideas about kinds and relations of goods and evils from different religious and philosophical perspectives. This study takes into account notions of error, ignorance, wrong-doing, freedom and responsibility evident in contemporary religious and philosophical debate.

RE 2723. RELIGIONS OF THE WEST.

Cat. II

The purpose of this course is to examine, from an historical, doctrinal, scriptural and philosophical perspective, major Western religions. The course will focus primarily on Judaism, Christianity and Islam. Other religions will be examined. The course will attend to the social context in which these religions developed and will examine their continuing influence on Western society.

Suggested background: RE/PY 1731 and RE 2721.

This course will be offered in 2004-05 and in alternating years thereafter.

RE 2724. RELIGIONS OF THE EAST.

Cat. II

The purpose of this course is to examine, from the perspectives of history text, practice, and philosophy, some or all of the following religions: Hinduism, Buddhism, Taoism, Confucianism, and Shinto. The course will attend to the social context in which these religions began, their relations with their culture, their rituals and their continuing influences in the East and West.

Suggested background: PY/RE 1731 and RE 2721.

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

RE/PY 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.

RE 3721. TOPICS IN RELIGION.

Cat. I

The purpose of this course is to expose students to somewhat more advanced or specialized study in religion. The focus will vary, but the material will be drawn from a particular religious thinker, a particular religious tradition or a particular historical or contemporary problem.

Suggested background: three other courses in religion.

RE/PY 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 RE/PY 2731 or PY 2712.

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 Maria 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. II

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.

This course will be offered in 2004-05 and in alternating years thereafter.

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 Cortázar, Rosario Castellanos, Elena Poniatowska, will be discussed.

Recommended background: SP 3521 (Advanced Spanish I) and SP 3522 (Advanced Spanish II) or equivalent.

SP/ID 3525. SPANISH AMERICAN FILM/MEDIA: CULTURAL ISSUES.

Cat. II

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.

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

SP/ID 3526. COMPARATIVE BUSINESS ENVIRONMENTS.*Cat. II*

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. ID3052 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.

This course will be offered in 2004-05 and in alternating years thereafter.

SP/ID 3527. TECHNICAL AND BUSINESS SPANISH*Cat. I*

The course focuses on the linguistic concepts, terminology, and grammar involved in business and technical Spanish. Students will be required to produce and edit business documents such as letters, job applications, formal oral and written reports, etc. The objective of this course is to help students develop the basic written and oral communication skills to function in a business environment in Latin America and the Caribbean.

Recommended background: SP 2521 and SP 2522.

Writing**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 helpfully 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 purposed 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 WR/EN 3214.

WR/EN 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-relations 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.

WR/EN 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.

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

This course is open to students accepted to off-campus IQP centers and programs. The course introduces students to research design, methods for social science research, and analysis. It also provides practice in specific research and field skills using the project topics students have selected in conjunction with sponsoring agencies. Students learn to develop social science hypotheses based upon literature reviews in their topic areas and apply concepts drawn from social psychology, anthropology, sociology, economics and other areas as appropriate. Students make presentations, write an organized project proposal, and develop a communication model for reporting their project findings.

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 2004-05 and in alternating years thereafter.

ID/SP 3525. SPANISH AMERICAN FILM/MEDIA: CULTURAL ISSUES.*Cat. II*

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.

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

ID/SP 3526. COMPARATIVE BUSINESS ENVIRONMENTS.*Cat. II*

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. ID3052 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.

This course will be offered in 2004-05 and in alternating years thereafter.

ID/SP 3527. TECHNICAL AND BUSINESS SPANISH*Cat. I*

The course focuses on the linguistic concepts, terminology, and grammar involved in business and technical Spanish. Students will be required to produce and edit business documents such as letters, job applications, formal oral and written reports, etc. The objective of this course is to help students develop the basic written and oral communication skills to function in a business environment in Latin America and the Caribbean.

Recommended background: SP 2521 and SP 2522.

RH 3111. THE STUDY OF WRITING.*Cat. I*

This course introduces students to issues in the study of writing such as the history and uses of literacy, the relationship of thought to language, the role of writing in producing knowledge, and research on composing. The focus of the course will be on professional and academic writing. The course will be organized around a series of interrelated research questions: How do writers in professional and academic settings know when they have something to write about? How do they define a problem to investigate? How do they define or construct an audience to address? How do they locate their work in relation to others' work? How do they know which forms of writing to use? Why do they write in the first place? What functions does writing perform?

RH 3112. RHETORICAL THEORY.*Cat. I*

Rhetoric concerns both the art of mastering the available means of persuasion and the study of how oral, written, and visual communication projects the intentions of individuals and groups, makes meanings, and affects audiences. The purpose of this course therefore is two-fold. It is intended to help students become more effective communicators by learning about the rhetorical situation and various rhetorical techniques. And it is designed to help them understand how various forms of communication work by learning some of the strategies of rhetorical analysis.

RH 3211. RHETORIC OF VISUAL DESIGN.*Cat. I*

This course explores how visual design is used for purposes of identification, information, and persuasion. It looks at many modes of visual communication, such as icons, logos, trademarks, signs, product packaging, infographics, posters, billboards, ads, exhibits, graffiti, page layout, films, television, videogames, and web sites. The course provides an overview of the history of graphic design movements, as well as analytical tools to understand how visual design encodes messages and the role visual communication plays in contemporary culture.

MANAGEMENT

MG 1100. FINANCIAL ACCOUNTING.*Cat. I*

This course provides a tool for business communication, as accounting is an important language of business. Students are introduced to the accounting process, its underlying concepts, and the techniques of preparing and analyzing financial statements. Students are also introduced to issues in accounting for assets, liabilities, and stockholders' equity. The course demonstrates the employment of accounting data by users outside the firm, and the application of accounting numbers in financial analyses and market decisions.

MG 1250. PERSONAL FINANCE.*Cat. I*

This course is designed to help the student make well-informed judgments when faced with personal financial decisions. Such decisions are growing in number and complexity, and both individuals and families need a considerable degree of financial expertise in order to utilize optimally their limited incomes.

Principal topics include: insurance (medical, life, automobile and disability), consumer credit, estate planning, taxation, personal investments (real estate, securities, etc.), social security legislation and personal financial planning.

MG 1900. INTRODUCTION TO BUSINESS IN AN INTERNATIONAL ENVIRONMENT.*Cat. I*

This course focuses on the operation of a company conducting business in an international environment. It addresses cultural differences and their importance in international trade and in such business functions as operations, human resources, marketing and accounting. MG 1900 is an appropriate course for all WPI students regardless of a major.

Students may not receive credit for both MG 1050 and MG 1900.

MG 2101. MANAGEMENT ACCOUNTING.*Cat. I*

This course is intended to familiarize the student with the wide variety of ways in which accounting data are used by management as a tool for the attainment of predetermined organizational objectives. The emphasis of the course is on the application of accounting data, rather than on its preparation, and particular 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 2003-04 and in alternating 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 basic knowledge and processes required of managers, 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 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 current 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 2004-05 and in alternating 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 transformational 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/IE 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. I*

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 structures. Students may not receive credit for both MG 4701 and MG 3740.

Recommended background: MG 2710 and MG 3700.

Students may not receive credit for both MG/IE 3740 and MG 3740.

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 391X 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. II*

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 alternating 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 2004-05 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 2850 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 4740. E-BUSINESS STRATEGY, ARCHITECTURE AND DESIGN.*Cat. II*

The course focuses on the linkage between organizational strategy and networked information techniques to implement a rich variety of business models in the national and global contexts connecting individuals, businesses, governments, and other organizations to each other. It provides an introduction to e-business strategy and the development and architecture of e-business solutions and their technical components. The course will cover how businesses and consumers use the Internet to exchange information and initiate transactions. Both theoretical concepts and practical skills with appropriate development tools will be addressed within the scope of the class. Students will develop a business plan and put that plan into action through development of an e-business website using commercially available development tools.

Recommended background: CS 1005, CS 1006 or MG 2720 or ability to program in a higher level programming language

This course will be offered 2004-05 and in alternating years thereafter.

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 performance and monitoring, systems reliability and quality change management, backup and recovery, security, new technology assessment and implementation, staffing and staff development. Through case studies and mini-projects students will analyze existing structures in industry IS organizations.

Recommended background: MG 3700.

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 2850, MG 2950, 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 1/3 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 1031. INTRODUCTION TO ANALYSIS I.

Cat. I

This course provides the fundamentals of mathematical thinking and writing for mathematical proof in analysis. Topics covered include mathematical logic, set theory, functions, cardinality, topology of the real line, limits of sequences.

MA 1032. INTRODUCTION TO ANALYSIS II.

Cat. I

This course uses the tools developed in MA 1031 to explore the theory of differentiability and introduces the Riemann integral. Topics covered include limits and continuity of functions, the intermediate value theorem, differentiation, mean value theorems, l'Hopital's rule, antiderivatives, the Riemann integral, Riemann integrability.

Recommended background: MA 1031

MA 1033. INTRODUCTION TO ANALYSIS III.

Cat. I

This course develops the theory of integration and provides an introduction to series of numbers and series of functions. Topics covered include the Fundamental Theorem of Calculus, integration by parts, change of variable, series, convergence tests, rearrangements

of series, sequences and series of functions, power series, Taylor series.

Recommended background: MA 1032

MA 1034. INTRODUCTION TO ANALYSIS IV.

Cat. I

The course provides a rigorous introduction to multivariable analysis. Topics covered include vector algebra, functions of several variables, partial derivatives, gradient, multiple integrals, Green's theorem, Stokes' theorem, divergence theorem. Recommended background: MA 1033

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.

This course is design 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 2201/CS 2022. DISCRETE MATHEMATICS.

Cat. I

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.

Recommended background: None.

MA 2210. MATHEMATICAL METHODS IN DECISION MAKING.

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 2251. 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 2004-05 and in alternating 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 3273.

Recommended background: MA 2071. This course will be offered in 2003-04 and in alternating 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 1024, MA 2051 and MA 2071.

MA 2611. 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 1022.

MA 2612. APPLIED STATISTICS II.

Cat. I

This course is a continuation of MA 2611.

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 2611.

MA 2621. 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 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.

Recommended background: MA 1024.

Undergraduate credit may not be earned both for this course and for MA 2621.

MA 3211. THEORY OF INTEREST.

Cat. I

An introduction to actuarial mathematics is provided for those who may be interested in the actuarial profession.

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 3212. 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: survival functions and life tables; life insurance; life annuities; net premiums; and premium reserves.

Recommended background: MA 3211 and MA 2621, or MA 2631.

MA 3231. LINEAR PROGRAMMING.

Cat. I

This course considers the formulation of real-world optimization problems as linear programs, the most important algorithms for their solution, and techniques for their analysis.

Topics covered include: the primal and dual simplex algorithms, duality theory, parametric analysis, network flow models and, as time permits, bounded variable linear programs or interior methods.

Undergraduate credit may not be earned both for this course and for MA 4231.

Recommended background: MA 2071.

MA 3233. 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 2004-05 and in alternating 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 alternating 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 2004-05 and in alternating years thereafter.

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 2004-05 and in alternating 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, extension fields and properties of finite fields. Recommended background: MA 2073.

This course will be offered in 2003-04 and in alternating 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 Riemann-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 alternating 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 2004-05, 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.

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

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 2621 or MA 2631.

This course will be offered in 2003-04 and in alternating 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 4033. An ability to write computer programs in a scientific language is assumed.

This course will be offered in 2004-05, 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 single 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 2251 and MA 3832.

This course will be offered in 2004-05 and in alternating 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*

MECHANICAL ENGINEERING

For a detailed description of each of these courses, check the video tape index at the Gordon Library.

The second digit in mechanical engineering course numbers is coded as follows:

- 0 — General mechanical engineering
- 1 —
- 2 —
- 3 — Design
- 4 — Thermal—fluids
- 5 — Engineering mechanics
- 6 — Fluid mechanics—hydraulics
- 7 — Aerospace
- 8 — Materials
- 9 — Engineering experimentation

ME 1520. THE TECHNOLOGY OF ALPINE SKIING.*Cat. II*

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 stepping, 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 trail 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, rolling, drawing, EDM, PM, welding, casting, and machining are developed through a combination of class work and manufacturing laboratory experience. The laboratory experience includes an experimental component measuring and analyzing a manufacturing process and system. Each student is required to fabricate and assemble his/her own Stirling engine.

This course is recommended for all majors, for students who plan to utilize the manufacturing laboratory facilities as part of their MQP work, or for those students who wish a fundamental background in materials processing.

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 basic 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.

Recommended background: ME 1800 Materials Selection and Manufacturing Processes, and ES 2001 Introduction to Materials Science.

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 failure 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 cams 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: reversible 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*

In typical mathematics courses, students learn principles and techniques by solving many short and specially prepared problems. They rarely gain experience in formulating and solving mathematical equations that apply to real life engineering problems. This course will give students this type of applied mathematical experience.

The course emphasizes the application of basic laws of nature as they apply to differential elements which lead to differential equations that need to be solved; all of these ideas are used in higher level engineering science courses such as fluid mechanics, heat transfer, elasticity, etc. Emphasis will be placed on understanding the physical concepts in a problem, selecting appropriate differential elements, developing differential equations, and finding ways to solve these equations. Limitations on the mathematical solutions due to assumptions made will be considered.

Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), dynamics (ES 2503).

ME 3502. ADVANCED MECHANICS OF MATERIALS.*Cat. I*

An intermediate level course in stress analysis suitable for students in engineering mechanics, design, and materials sciences.

Topics included are: non-symmetric bending, torsion of non-circular bars, pressure vessels, elastic stability, energy methods in mechanics, beams on elastic foundations and other advanced topics in stress analysis.

Recommended background: Ordinary Differential Equations (MA 2051), statics (ES 2501), stress analysis (ES 2502).

ME 3506. REHABILITATION ENGINEERING.*Cat. I*

The course exposes the students to the use of technology to design devices to ameliorate the handicaps of individuals with disabilities. This course focuses on the design process for assistive devices including defining the problem, setting design criteria, developing preliminary designs, selecting, analyzing and testing a final design. Human factors are integrated into all phases of the design process.

Topics include: 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 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 that challenge through the development of a broad systems perspective and an 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, kinetics, materials, heat transfer, 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, electro-thermo-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 networks 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.*Cat. I*

A first course in the science and engineering of heavier-than-air flight vehicles.

Topics covered include: application of fluid mechanic 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 airfoil 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), astronautics (ME 2713), 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 aero engines, including gas turbines (turbojets, turbofans, turboprops), ramjets, and scramjets. Performance of specific engine components such as inlets, 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 2004-05 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 irons, 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), materials processing (ME 2820), 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 laboratory periods 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 sensing devices, experiment 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, force/torque/strain 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 offering. Students may also consult with their academic advisor or the Mechanical Engineering department office.

Recommended background: mathematics (MA 2051), thermo-fluids (ES 3001, ES 3003, ES 3004), mechanics (ES 2501, ES 2502, ES 2503), materials (ES 2001).

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 modelling, CAD modelling, 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).

This course will be 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 THERMOMECHANICAL DESIGN AND ANALYSIS.*Cat. II*

Current state-of-the-art computer based methodologies used in the design and analysis of thermomechanical 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, thermomechanics of fiber optic telecommunication cables, high-energy beam interactions with materials, shape memory alloys, microelectronics, MEMS and mechatronics.

Recommended background: MA 2051, ES 2001, 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/BE 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 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 2501, ES 2502, ES 2503, ME 3501), mathematics (MA 2051).

This course will be 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 4506. MECHANICAL VIBRATIONS.*Cat. I*

This course is an introduction to the fundamental concepts of mechanical vibrations, which are important for design and analysis of mechanical and structural systems subjected to time-varying loads. The objective of the course is to expose the students to mathematical modeling and analysis of such systems

Topics covered include: formulation of the equations of motion using Newton's Laws, D'Alembert's Principle and energy methods; prediction of natural frequency for single-degree-of-freedom systems; modeling stiffness characteristics, damping and other vibrational properties of mechanical systems; basic solution techniques by frequency response analysis and convolution integral methods. Examples may include analysis and design for transient passage through resonance; analysis and design of vibration measurement devices; introductory rotordynamics. The course is mainly focused on analysis of single-degree-of-freedom systems, however a basic introduction into multidegree-of-freedom systems is also presented. Computer-based project may be suggested.

Recommended background: Ordinary Differential Equations (MA 2501), Statics (ES 2501), Dynamics (ES 2503).

ME 4512. INTRODUCTION TO THE FINITE ELEMENT METHOD.*Cat. I*

This course serves as an introduction to finite element analysis (FEA) for stress analysis problems. Finite element equations are developed for several element types from stiffness and energy approaches and used to solve simple problems. Element types considered include spring, truss, beam, two-dimensional (plane stress/strain and axisymmetric solid), three-dimensional and plates. Stress concentrations, static failures, and fatigue failures are considered for each element type. Emphasis will be placed on knowing the behavior and usage of each element type, being able to select a suitable finite element model for a given problem, and being able to interpret and evaluate the solution quality. A commercial, general-purpose finite element computer program is used to solve problems that are more complex. Projects are used to introduce the use of FEA in the iterative design process.

Recommended background: Mathematics (MA 2051, MA 2071), Mechanics (ES2501 & ES 2502 or CE2000 & CE2001).

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; inviscid flow 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 (ME 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).

This course will be offered in 2004-05 and in alternating years thereafter.

ME 4712. SUPERSONIC AERODYNAMICS.*Cat. II*

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).

This course will be offered in 2004-05 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 shock waves and 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).

This course will be 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 alternative 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 3004), heat transfer (ES 3003), control engineering (ES 3011), astronautics (ME 2713), rocket and spacecraft propulsion (ME 3715), aerospace structures (ME 4715).

This course will be offered in 2004-05 and in alternating years thereafter.

ME 4813. CERAMICS.*Cat. II*

A course which develops an understanding of the structure-property relationships 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 a function of several robotic variables and levels, and it includes the use of experimental design techniques and analysis of variance.

Recommended background: manufacturing (ME 1800), kinematics (ME 3310), control (ES 3011), and computer programming.

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).

This course will be offered in 2004-05 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 metallography.

This course will be offered in 2004-05 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).

This course will be offered in 2004-05 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 analyzes 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 review 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 birefringence; basic video, imaging, and digital image processing.

Recommended background: mathematics (MA 2051), experimentation (ME 3901).

Suggested background: physics (PH 1140).

This course will be offered in 2004-05 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 1011 and MS 1021 will appear on the WPI transcript as a zero credit course with a grade. Successful completion of MS 1011 and MS 1012 earns 1/9 unit in MS 1012. Successful completion of MS 1021 and MS 1022 earns 1/9 unit in MS 1022.

ML 1011. FOUNDATIONS OF OFFICERSHIP I.*Cat. I (0 units w/grade)*

Introduction to issues and competencies that are central to a commissioned officer's responsibilities. Establishes a framework for understanding officership, leadership, and Army values. Additionally, the semester addresses "life skills" including fitness and time management.

Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also required.

ML 1012. FOUNDATIONS OF OFFICERSHIP II.*Cat. I (1/9 unit after completion of 1011 and 1012)*

This course continues the studies begun in ML 1011. 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).

Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also required.

ML 1021. BASIC LEADERSHIP I.*Cat. I (0 units w/grade)*

ML 1021 expands upon the fundamentals introduced in the previous term by focusing on communications, leadership, and problem solving. "Life skills" lessons in this semester include: problem solving, goal setting, interpersonal communication skills, and assertiveness skills.

Participation in leadership laboratories and participation in off-campus training sessions (field training exercise) is also required.

ML 1022. BASIC LEADERSHIP II.*Cat. I (1/9 unit after completion of 1021 and 1022)*

ML 1022 continues by providing cadets with interesting lessons yielding immediately useful skills. The course also gives accurate information about life in the Army, including the organization of the Army, employment benefits, and work experiences of junior officers.

ML 2011. INDIVIDUAL LEADERSHIP STUDIES I*Cat. I (1/12 unit)*

Introduces students to team building techniques. Students build upon the basic leader principals and leadership development methodologies to refine their understanding of leadership. How to build teams, how to influence, how to communicate, how and when to make decision, and creative problem-solving.

Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required

Recommended background: ML1022

ML 2012. INDIVIDUAL LEADERSHIP STUDIES II.*Cat. I (1/12 unit)*

The curriculum focuses on building character. Where years one, three and four focus on mastering definitions, concepts, ideas and principles, year two focuses on direct, physical experiences. Year two centers on giving cadets the opportunity to apply, practice and experience leadership principles. Cadets are asked to reflect upon their actions and those of others.

Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.

Recommended background: ML 2011

ML 2021. LEADERSHIP AND TEAMWORK I.*Cat. I (1/12 unit)*

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.

Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.

Recommended background: ML2012

ML 2022. LEADERSHIP AND TEAMWORK II.*Cat. I (1/12 unit)*

This course covers small unit movement and military tactics. It combines previous study in weapons, 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.

Participation in leadership laboratories and participation in off-campus training session (field training exercise) is also required.

Recommended background: ML 2021

ML 2091. LEADERSHIP TRAINING COURSE.

Cat. I (1/6 unit)

LTC puts each cadet through 24 days of pushing themselves to the mental and physical limits, while enhancing leadership, problem solving and teamwork skills. Cadets are put through extensive leadership training, which includes leadership reaction scenarios; Land Navigation exercises, first aid training. Cadets must pass the Army Fitness Test (APFT) in order to graduate.

ML 3011. LEADERSHIP AND PROBLEM SOLVING I.

Cat. I (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. Promoting and developing communication skills and teamwork are addressed. Examines leadership of small units conducting conventional combat operations and tactical 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

Participation in leadership labs and participation in an off-campus training session (field training exercise) is also required.

Recommended background: Students must have completed the basic course or ROTC Leadership Training course and have signed a personal contract with the US Army. Department Head approval is required.

ML 3012. LEADERSHIP AND PROBLEM SOLVING II.

Cat. I (1/6 unit)

Student learns how to conduct crisis planning and management. Discussion of roles and functions of combat arms, combat support, and combat service support branches. Case studies of small-unit operations are studied. Introduction to Army special operations, military 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.

Attendance at monthly labs and formal social functions is required. Students write self-evaluations through this course. Students are graded on their performance during leadership practical exercises.

Recommended background: ML 3011

ML 3021. LEADERSHIP AND ETHICS I.

Cat. I (1/6 unit)

ML 3021 is designed to continue the development as leaders by presenting instruction in the three foundational areas of leadership, interpersonal communication, and values and ethics. The leadership module contains an examination of Army leadership doctrine followed by expansion on key leadership concepts and provide feedback for cadet leadership self-development efforts.

ML 3022. LEADERSHIP AND ETHICS II.

Cat. I (1/6 unit)

The main thrust of the communication module is the opportunity for cadets to present an information briefing and receive feedback from both instructor and fellow students. The last module of the term contains lessons that focus on values, ethics, ethical decision-making, consideration of others, and spiritual needs.

Attendance at monthly labs, attendance at formal social functions and an off-campus weekend leadership exercise is required.

Recommended background: ML 3021

ML 3023. NATIONAL ADVANCED LEADERSHIP CAMP.

Cat. I (1/6 unit)

NALC puts each cadet through 32 days of intensive individual, squad and platoon-level training to assess his/her leadership potential. Each cadet is measured against 23 leadership dimensions in such subjects as physical stamina, technical competence, delegation, decisiveness, problem analysis and the several Army values, among others. Instruction and evaluation at NALC is progressive, building skills in individual subjects like the Army Physical Fitness Test, basic military skills and land navigation, followed by such skill-building exercises as Individual Tactical Training.

ML 4011. LEADERSHIP AND MANAGEMENT I.

Cat. I (1/6 unit)

ML 4011 begins with a series of lessons designed to enable the cadets to make informed career decisions as they prepare their accessions documents. Lessons concentrate on Army operations and training management, communications and leadership skills and support the beginning of the final transition from cadet to lieutenant. The course focuses cadets, early in the year, on attaining knowledge and proficiency in several critical areas they will need to operate effectively as Army officers. These areas include: the Army's training management system, coordinating activities with staffs, and counseling skills. While the proficiency attained in each of these areas will initially be at the apprentice level,

cadets will continue to sharpen these skills as they perform their roles as cadet officers in the ROTC battalion and as new lieutenants after commissioning. At the end of this semester cadets should possess the fundamental skills, attributes, and abilities to operate as competent leaders in the cadet battalion and confidently shoulder the responsibilities entrusted to them.

ML 4022. LEADERSHIP AND MANAGEMENT II.

Cat. I (1/6 unit)

This Course focuses on completing the transition from cadet to lieutenant. As an expansion of the Ethics instruction in ML 3021, the course starts with an examination of unit ethical climate and the commander's role as the moral anchor of the unit. This is followed by a module addressing military law and leadership. The next module reinforces previous instruction on the organization of the Army and introduces how the Army organizes for operations from the tactical to strategic level. This is followed by instruction on administrative and logistical management that focuses on the fundamentals of soldier and unit level support. Next is a short module that focuses on preparing cadets for their forthcoming commissioning and military service. At the core of this semester is the Advanced Course's Capstone Exercise. This twelve-lesson exercise directly reinforces all modules from this term, and also incorporates and reinforces many learning objectives from modules throughout the entire curriculum. The Capstone Exercise requires cadets, both individually and collectively, to apply their knowledge to solve problems and confront situations commonly faced by junior officers. Upon completion of this course the cadets will be prepared to shoulder the responsibility of being a commissioned officer in the United States Army.

Three lab exercises and participation in the military staff ride is required.

ML 4023. OFFICERSHIP.

Cat. I (1/6 unit)

This course is a continuation of ML 4022.

ML 4024. TRANSITION TO LIEUTENANT.

Cat. I (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: ML4023

PHYSICAL EDUCATION

PE 1001. INTRO TO GOLF & TENNIS.

Cat. I (1/12 unit)

Introduction to the sports through skill development and play.

PE 1002. INTRO TO VOLLEYBALL & SQUASH.

Cat. I (1/12 unit)

Introduction to the sports through skill development and play.

PE 1003. INTRO TO BOWLING & BADMINTON.

Cat. I (1/12 unit)

Introduction to the sports through skill development and play.

PE 1004. INTRO TO TABLE TENNIS, GOLF, & TENNIS.

Cat. I (1/12 unit)

Introduction to the sports through skill development and play.

PE 1005. INTRO TO RECREATIONAL SPORTS.

Cat. I (1/12 unit)

This summer course introduces students to various sports through skill development and play. Possible sports taught include badminton, bowling, golf, racquetball, squash, swimming, table tennis, tennis, and volleyball.

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)

For the beginner and intermediate swimmer. Students will learn about water recreational activities and how to remain safe while participating in them. Opportunity to learn the necessary means for safety in/near water and basic rescue techniques. Fee required.

PE 1011. TOUCH FOOTBALL.

Cat. I (1/12 unit)

Introduction to basic rules and individual/team skill development with practical application through game competition.

PE 1012. BASKETBALL.*Cat. I (1/12 unit)*

Introduction to basic rules and individual/team skill development with practical application through game competition.

PE 1013. SOFTBALL.*Cat. I (1/12 unit)*

Introduction to basic rules and individual/team skill development with practical application through game competition.

PE 1014. BEGINNING TENNIS.*Cat. I (1/12 unit)*

Instruction will focus on basic strokes and techniques. Rules, strategy and play will be integrated as students' skills develop.

PE 1015. BADMINTON & TABLE TENNIS.*Cat. I (1/12 unit)*

Instruction will focus on basic strokes and techniques. Rules, strategy and play will be integrated as students' skills develop.

PE 1016. SQUASH & RACQUETBALL.*Cat. I (1/12 unit)*

Instruction will focus on basic strokes and techniques. Rules, strategy and play will be integrated as students' skills develop.

PE 1017. BEGINNING SWIMMING.*Cat. I (1/12 unit)*

For the non-swimmer to intermediate swimmer. Instruction in the basic stroke techniques to learn to swim, improve skills and develop survival skills.

PE 1018. CO-ED VOLLEYBALL.*Cat. I (1/12 unit)*

Introduction to basic rules and individual/team skill development with 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. INTERMEDIATE TENNIS.*Cat. I (1/12 unit)*

Designed for the student with basic skills in tennis. In-depth instruction in skill development and strategy with game competition.

PE 1027. INTERMEDIATE SWIMMING.*Cat. I (1/12 unit)*

For the intermediate to advanced swimmer. Class will offer instruction geared toward creating efficient swimming. Swimming for Fitness will be introduced. Completion of Beginning Swimming (PE 1017) is recommended for this class; however students who pass a competency test administered by the instructor will be admitted.

PE 1055. PHYSICAL CONDITIONING.*Cat. I (1/2 unit)*

This course will teach basic strength training principles and techniques. Students will develop and implement an individualized conditioning program.

PE 1056. LIFEGUARDING I.*Cat. I (1/12 unit)*

PE 1057. LIFEGUARDING II.
Cat. I (1/12 unit)
This class is based on the Red Cross Manual for Lifeguarding. Red Cross fee and books are required. The Lifeguard I course is the first part of a two course requirement (Lifeguarding I and II) for a student to be certified in CPR for the Professional Rescuer, First Aid, AED, Oxygen Administration and Lifeguarding.
Recommended background: PE 1007

PE 1059. WEIGHT TRAINING PROGRAM FOR WOMEN.*Cat. I (1/2 unit)*

This introductory course is designed to acquaint women with 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. SWIMMING FOR FITNESS.*Cat. I (1/12 unit)*

For the intermediate to advanced swimmer. This class is geared toward swimming for fitness purposes. Workouts will be administered each class period with students developing the knowledge to create workouts for themselves.

PE 1100. PHYSICAL EDUCATION EQUIVALENCY.*Cat. I (1/12 unit)*

Credit by equivalent activity in one of five categories: 1) WPI athletic team participation, 2) club sports, 3) approved courses not offered at WPI, 4) individualized program at WPI, 5) Proficiency testing. Advanced approval by the Physical Education Department Head is necessary.

PHYSICS

The second digit in physics course numbers is coded as follows.

- 1 — General physics
- 2 — Theoretical mechanics, statistical physics, kinetic theory, etc.
- 3 — Electricity and magnetism, electromagnetic theory
- 4 — Quantum mechanics
- 5 — Particular topics
- 6 — Laboratory

INTRODUCTORY PHYSICS SEQUENCE

There are four course topics in the introductory physics sequence. The four topics are Classical Mechanics (PH 1110/PH 1111), Electricity and Magnetism (PH 1120/PH 1121), 20th Century Physics (PH 1130), and Oscillations and Waves (PH 1140). Each course includes a laboratory component.

Students should take either PH 1110 or PH 1111, but not both; similarly, either PH 1120 or PH 1121, but not both. The primary difference between the PH 1110-PH 1120 option and PH 1111-PH 1121 is that the material in PH 1111-PH 1121 is treated somewhat more formally and rigorously than in PH 1110-PH 1120, thus presuming a better-than-average mathematics background. The recommended mathematics background for each course is indicated in the respective course description and should be considered carefully in each case.

Because the topics covered in the two mechanics and in the two electricity and magnetism courses are the same, it is possible to cross over from one sequence to the other. For example, PH 1120 could be taken after PH 1111, or, upon consulting with the course instructor, PH 1121 could be taken after successful completion of PH 1110. Finally, it should be noted that any combination of the first two introductory courses provides adequate preparation for both of the remaining courses in 20th Century Physics (PH 1130), and Oscillations and Waves (PH 1140).

The courses in classical mechanics and electricity and magnetism are regarded as essential preparation for many fundamental engineering courses as well as for further work in physics. PH 1130 gives a first introduction to 20th century physics and is designed to provide a context for the appreciation of present-day advances in physics and high-technology applications. PH 1140 deals in depth with oscillating systems, a topic area of fundamental importance in physics, and whose engineering applications span the range from electromagnetic oscillations to the mechanical vibrations of machinery and structures.

PH 1110. GENERAL PHYSICS—MECHANICS.*Cat. I*

Introductory course in Newtonian mechanics.

Topics include: kinematics of motion, vectors, Newton's laws, friction, work-energy, impulse-momentum, for both translational and rotational motion.

Recommended background: concurrent study of MA 1021.

PH 1111. PRINCIPLES OF PHYSICS—MECHANICS.*Cat. I*

An introductory course in Newtonian mechanics that stresses invariance principles and the associated conservation laws.

Topics include: kinematics of motion, vectors and their application to physical problems, dynamics of particles and rigid bodies, energy and momentum conservation, rotational motion.

Recommended background: concurrent study of MA 1023 (or higher).

Students with limited prior college-level calculus preparation are advised to take PH 1110.

PH 1120. GENERAL PHYSICS—ELECTRICITY AND MAGNETISM.*Cat. I*

An introduction to the theory of electricity and magnetism.

Topics include: Coulomb's law, electric and magnetic fields, capacitance, electrical current and resistance, and electromagnetic induction.

Recommended background: working knowledge of the material presented in PH 1110 or PH 1111 and concurrent study of MA 1022.

PH 1121. PRINCIPLES OF PHYSICS—ELECTRICITY AND MAGNETISM.*Cat. I*

An introduction to electricity and magnetism, at a somewhat higher mathematical level than PH 1120.

Topics include: Coulomb's Law, electric fields and potentials, capacitance, electric current and resistance, magnetism, and electromagnetic induction.

Recommended background: working knowledge of material covered in PH 1111 and concurrent study of MA 1024 (or higher). Students concurrently taking MA 1022 or MA 1023 are advised to take PH 1120.

PH 1130. INTRODUCTION TO 20TH CENTURY PHYSICS.*Cat. I*

An introduction to the pivotal ideas and developments of twentieth-century physics.

Topics include: special relativity, photoelectric effect, X-rays, Compton scattering, blackbody radiation, DeBroglie waves, uncertainty principle, Bohr theory of the atom, atomic nuclei, radioactivity, and elementary particles.

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.

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.

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.

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: electric field produced by charge distributions, electrostatic potential, electrostatic energy, magnetic force and field produced by currents and by magnetic dipoles, introduction to Maxwell's equations and electromagnetic waves.

Recommended background: introductory electricity and magnetism, vector algebra, integral theorems of vector calculus as covered in MA 2251.

PH 2501. PHOTONICS.*Cat. II*

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 2004-05 and in alternating 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 alternating 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 2004-05 and in alternating 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 physical principles 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 2600 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 Schrodinger 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 3501. 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 electrodynamics at the intermediate level.

This course will be offered in 2004-05 and in alternating 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 2004-05 and in alternating 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 alternating 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 alternating 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.

Lagrangian and Hamiltonian formulations. Central force motion. Rigid body dynamics. Theory of small oscillations. Poisson brackets, Hamilton-Jacobi theory. Continuous systems.

PH 514. QUANTUM MECHANICS I.

Schrodinger wave equation. Harmonic oscillator, hydrogen atom, potential wells, approximation methods.

PH 515. QUANTUM MECHANICS II.

Perturbation theory. Angular momentum. Spin. Scattering theory. Dirac equation.

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.

SOCIAL SCIENCE AND POLICY STUDIES

The second digit for courses in this department has the following meaning:

- 1 — Economics
- 2 — Sociology
- 3 — Political Science and Law
- 4 — Psychology
- 5 — System Dynamic

SS 1110. INTRODUCTORY MICROECONOMICS.*Cat. I*

The course focuses upon the implications of reliance upon markets for the allocation of resources in a society, at the household, firm, and community level. Outcomes of current market systems are examined in terms of the efficient use of natural and other economic resources, as well as their impact upon the environment, fairness, and social welfare. Of special interest in these analyses is the role of prices in the determination of what commodities are produced, their means of production, and distribution among households. In cases where current market outcomes have features subject to widespread criticism, such as the presence of excessive pollution, risk, discrimination, and poverty, the analysis is extended to suggest economic solutions. There are no prerequisites for the course.

SS 1120. INTRODUCTORY MACROECONOMICS.*Cat. I*

This course is designed to acquaint students with the ways in which macroeconomic variables such as national income, employment and the general level of prices are determined in an economic system. It also includes a study of how the techniques of monetary policy and fiscal policy attempt to achieve stability in the general price level and growth in national income and employment. The problems of achieving these national goals (simultaneously) are also analyzed. The latter half of the course stresses economic issues in public policy and international trade.

SS 1202. SOCIOLOGICAL CONCEPTS AND COMPARATIVE ANALYSIS.*Cat. I*

The aim of this course is to give students a general idea of the nature of sociology while illustrating concepts using examples from a variety of societies to enhance one's comparative perspective. The secondary theme of the course is to focus on what the field of sociology can offer those interested in the social implications of technological change and the social processes that shape science and technology. The course begins with a review of the debate over the nature of technology, whether it is more properly viewed as an aspect of social structure or culture, an integral part of society or a force external to it. Cases drawn from around the world and different technical fields are then developed both to address these questions and to illustrate various ways in which one might go about studying society-technology interaction effects. Classic sociological issues such as the distribution of wealth and power, intergroup relations, family structures and the nature of community are all covered as the cases unfold. The cases covered range from the impact of disasters on different kinds of communities to a comparative analysis of the space agencies of Europe, the U.S. and Japan, and the different kinds of technology they tend to produce. Such observations are placed in the context of their differing processes of modernization and international positions. This course is appropriate preparation for many types of IQP's.

SS 1203. SOCIAL PROBLEMS AND POLICY ISSUES.*Cat. II*

The goal of this course is to examine various problematic features of the emerging post-modern social organization and contemporary social issues. The course involves an examination of both the process whereby public consensus is shaped and of the "life cycle" of a social problem. Social movements, cultural values, institutional structures, media interpretation and political authorities all get attention in the study of this process whereby some objective conditions come to be considered social problems requiring public action and others do not. Attention is also given to the warring conservative, liberal and radical perspectives on the nature of each social problem, their relative importance and what a proper response to them would be.

Several specific problem areas are addressed in detail as illustrations. These may include subsets of energy, welfare, environmental racism, homelessness, the crisis in education, environmental problems, international conflict, the end of work debate, changes in unionism and advanced capitalism, the role and limitations of national government, global environmental issues, the challenges facing the American family and the relationship between drugs and crime. These issues have all been featured in one or more offering of the course in recent years. The students in each class will be given some choice as to which topics are covered as illustrations so long as they are in text.

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 alternating 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 54.

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. II*

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.

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

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 order 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 2004-05, 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, judgment 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 cause 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

the 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 54.

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 alternating 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 computer simulation 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 sub-sections. Students will be required to complete modeling assignments working in groups and take in-class quizzes on modeling issues.

Recommended background: SS1510, or permission of instructor.

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

This course is open to students accepted to off-campus IQP centers and programs. The course introduces students to research design, methods for social science research, and analysis. It also provides practice in specific research and field skills using the project topics students have selected in conjunction with sponsoring agencies. Students learn to develop social science hypotheses based upon literature reviews in their topic areas and apply concepts drawn from social psychology, anthropology, sociology, economics and other areas as appropriate. Students make presentations, write an organized project proposal, and develop a communication model for reporting their project findings.

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 alternating 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. It pays special attention to the impact of production and consumption of material goods upon the quantity and quality of environmental goods. The analysis focuses on

the challenges presented in mixed 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 2004-05 and in alternating years thereafter.

SS 2120. 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 2120 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 2004-05 and in alternating years thereafter.

SS 2121. GOVERNMENT BUDGETS AND FISCAL POLICY.

IS/P 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 2125. 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 sectorial policies, the choice of monetary and fiscal policies, rapid population growth, and urbanization and urban 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., Costa Rica 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 alternating years thereafter.

SS 2207. CREATIVITY AND THE SCIENTIFIC COMMUNITY.

Cat. II

An interdisciplinary course that examines the continuing tension between individual originality and the research community. It provides an introduction to some 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 taken 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 2004-05 and in alternating years thereafter.

May be included in certain Humanities and Arts Sufficiency programs. See page 54.

SS 2208. THE SOCIETY - TECHNOLOGY DEBATE.

Cat. II

A course which considers what one means when they say 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 alternating years thereafter.

May be included in certain Humanities and Arts Sufficiency programs. See page 54.

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 theme: the 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 2004-05 and in alternating years thereafter.

SS 2304. GOVERNMENTAL DECISION MAKING AND ADMINISTRATIVE LAW.

Cat. II

The course addresses the role of technical expertise in political decision making. Politicians 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 alternating 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 great 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 2004-05 and in alternating 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 have 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 layer depletion, loss of 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 policy in which the focus of concern 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. Typically, 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, ICOLP (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 alternating 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. Alternatively, 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 alternating 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 IQPs in educational settings will find this course particularly useful. Instructional methods will 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 alternating 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 extinct. Topics will include, but not be limited to: (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 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 1401 or SS 1402.

This course will be offered in 2003-04 and in alternating 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 both the uniqueness and interdependence of peoples 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 influences 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 2004-05 and in alternating 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 models of large-scale systems and the partitioning 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: SS1520.

This course will be offered in 2003-04 and in alternating 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: SS1520.

This course will be offered in 2003-04 and in alternating 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 presently engaged in planning projects to carry out such analyses. It is run "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 "Creativity and Scientific Community" or "The Technology-Society Debate" 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 alternating 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 student presentations. Classical system dynamics models will be replicated and discussed. Students will read, evaluate, and report on research papers representing the latest developments in the field of system dynamics. They will also complete a term project that addresses a specific problem using the system dynamics method.

Recommended background: SS 1520 and SS 2530.

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

