

**University of Miami Bulletin, 2009 – 2010
Graduate Course Listing**

* 500 level courses appear in both the undergraduate and graduate course listing and may be considered undergraduate or graduate at the discretion of the department. Prerequisites, co-requisites and other course requirements are subject to change.

University of Miami Bulletin, 2009-2010
Graduate Course Listing
COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME501 Unified Medical Sciences I

3 credits

Fall Semester

Treatment of the basic biological and medical elements in physiological systems. The anatomy, physiology, biophysics, biochemistry and certain aspects of clinical medicine are unified with an emphasis on cellular and subcellular systems. Not open to BME undergraduates.

PREREQUISITE: PERMISSION OF COURSE COORDINATOR.

BME502 Unified Medical Sciences II

3 credits

Fall Semester

Treatment of the basic biological and medical elements in physiological systems. The anatomy, physiology, biophysics, biochemistry, and certain aspects of clinical medicine are unified with an emphasis on cardiovascular, renal, digestive, endocrine, and reproductive systems. Not open to BME undergraduates.

PREREQUISITE: PERMISSION OF COURSE COORDINATOR.

BME503 Unified Medical Science III

3 credits

Spring Semester

Treatment of the basic biological and medical elements in physiological systems. The anatomy, physiology, biophysics, biochemistry, and certain aspects of clinical medicine are unified with an emphasis on neural, sensory, and muscular systems. Not open to BME undergraduates.

PREREQUISITE: PERMISSION OF COURSE COORDINATOR.

BME506 ProEngineer Applications for Biomedical Engineering

1 credits

Spring Semester

Laboratory course for computer based two and three dimensional drawing and design based on ProEngineer. Parametric design, parts, features, assemblies for complex modeling. Applications in biomedical engineering design.

PREREQUISITE: BME 112, EEN 118

BME507 LabView Applications for Biomedical Engineering

1 credits

Spring Semester

Laboratory course for computer based instrumentation and design based on Labview. Virtual instrumentation, data acquisition and display, GPIB instrument control, biomedical applications in biosignal recording, and monitoring are discussed.

PREREQUISITE: BME 112, EEN 118.

BME511 Clinical Engineering

3 credits

Offered By Announcement Only

Clinical engineering concepts, medical instrumentation and systems, patient safety, requirements and regulations for medical devices, hospital organization, accreditation requirements, and related topics are discussed.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME512 Regulatory Control of Biomedical Devices

3 credits

Spring Semester

Regulatory agencies and requirements, Food and Drug Administration, 510(k) and premarket approval (PMA), international regulatory requirements, ISO 9000 series, CE, UL, product and process validation, quality engineering, quality improvement programs, rapid prototyping, packaging and sterilization, and project management are discussed.

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Graduate Course Listing
COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME520 Medical Imaging Systems

3 credits

Offered By Announcement Only

Engineering and scientific principles of medical imaging systems. The concepts of instrumentation and diagnostic applications of different techniques and systems are presented. Demonstrations or exhibitions of medical systems are given in the visits to clinic and research laboratories. Topics include digital image and image processing fundamentals, radiographic (X-ray, CT), magnetic resonance (MRI) and radio-isotopic (PET) systems, and associated image reconstruction techniques. Basic concepts and simulation of imaging systems are emphasized.

PREREQUISITE: EEN 118, 201, 307, BME 570 (CO-REQUISITE) OR EQUIVALENT.

BME521 Medical Imaging Applications

3 credits

Fall Semester

Medical applications of imaging systems and image processing techniques. Topics include image fundamentals (resolution, format, and storage), image processing fundamentals (transformation, compression, enhancement, segmentation, registration, and reconstruction), and image analysis fundamentals (calibration, quantification, correlation, linearity and depiction). Course includes dedicated computer laboratory projects and demonstrations given in clinical and research laboratories at the medical campus. Corequisite: BME 570 or equivalent.

PREREQUISITE: EEN 118, 201, 307. COREQUISITE: BME 570 OR EQUIVALENT.

BME522 Scanning Electron Microscopy in Biomedical Devices

3 credits

Fall & Spring Semester

Physics and operating principles of scanning electron microscope (SEM), transmission electron microscope (TEM), and optical light microscope. Biological tissue preparation, storage, fixation and digital image storage. Each student will learn to use the SEM in the design and/or analysis of a biomedical device.

PREREQUISITE: PERMISSION OF INSTRUCTOR

BME525 Special Problems

1- 3 credits

Fall & Spring Semester & First & Second Summer Session

Research and/or design projects consisting of an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: SENIOR OR GRADUATE STANDING; PERMISSION OF INSTRUCTOR.

BME526 Special Problems

1- 3 credits

Fall & Spring Semester

Research and/or design projects consisting of an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF THE INSTRUCTOR.

BME527 Special Problems

1- 3 credits

Fall & Spring Semester

Research and/or design projects consisting of an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF THE INSTRUCTOR.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME528 Engineering Hemodynamics

3 credits

Offered By Announcement Only

Fluid mechanics of circulation with emphasis given to function of the heart and its valves, systemic circulation including arterial flow, capillary, venous flows, pulmonary circulation including alveolar sheet flow. Particular stress is placed on the modeling of physiological events related to blood flow in cardiovascular devices and prostheses.

PREREQUISITE: MEN 309 OR EQUIVALENT.

BME529 Special Problems

1- 3 credits

Fall & Spring Semester & First & Second Summer Session

Research and/or design projects. Individual investigation of current problems.

Offered by special arrangement only.

PREREQUISITE: PERMISSION OF THE INSTRUCTOR.

BME531 Technical Entrepreneurship I

1 credits

Fall & Spring Semester

The first half of a two-semester sequence that simulates the work of a product development team to gain experience in technical entrepreneurship. The students propose product ideas, assess those collectively, select a few, form teams, define the product, and perform market analysis. The course is concluded with a business and technical development plan for the team's project. Lectures are presented on a variety of entrepreneurial topics.

PREREQUISITE: JUNIOR OR HIGHER STANDING.

BME532 Technical Entrepreneurship II

2 credits

Fall & Spring Semester

The second half of a two-semester sequence that simulates the work of a product development team to gain experience in technical entrepreneurship. The students complete the development of a working prototype and refine their marketing and business plan based on experience gained during the development phase. Lectures are presented on relevant entrepreneurial topics.

PREREQUISITE: JUNIOR OR HIGHER STANDING.

BME535 Advanced Biomaterials

3 credits

Offered By Announcement Only

Applications of biomaterials in different tissue and organ systems. Relationship between physical and chemical structure of materials and biological system response are discussed as well as choosing, fabricating, and modifying materials for specific biomedical applications.

PREREQUISITE: BME 335 OR PERMISSION OF INSTRUCTOR.

BME540 Microcomputer-Based Medical Instrumentation

3 credits

Offered By Announcement Only

Principles and design of microcomputer-based biomedical instruments, analog and digital signal conversion, microcomputer hardware and software design, algorithm development for medical applications, medical signal processing with microcomputers, software safety in life support systems, and current applications are discussed.

PREREQUISITE: EEN 304 AND 315, OR PERMISSION OF INSTRUCTOR.

BME541 Medical Electronic Systems Laboratory

2 credits

Spring Semester

Laboratory course for BME 540. Design of medical instruments integrated with microcomputers and telemetry devices. Corequisite: BME 540.

PREREQUISITE: COREQUISITE: BME 540.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME545 Biomedical Optical Instruments

3 credits

Fall Semester

Introduction to geometrical optics, light sources, detectors, and fiber optics with an emphasis on engineering aspects and medical applications. Fiber-optic delivery systems for medical applications, optics of the eye and visual instruments, and optical instruments used in medicine (microscopes, endoscopes, ophthalmic instruments) are discussed. Hands-on sessions in the laboratory are included.

PREREQUISITE: PHY 207, MTH 311 OR PERMISSION OF THE INSTRUCTOR.

BME546 Medical Applications of Lasers

3 credits

Spring Semester

Review of geometrical optics, fiber optics, wave optics, laser physics, and technology. Medical laser systems, optical properties of tissue, light propagation in tissue, laser-tissue interactions, and surgical applications of lasers are also covered. Hands-on sessions in the laboratory are included.

PREREQUISITE: PHY 207, MTH 311 OR PERMISSION OF THE INSTRUCTOR.

BME550 Rehabilitation Engineering

3 credits

Fall Semester

Principles of rehabilitation engineering with emphasis on currently used assistive devices for ambulation and hand motion. Human neural and muscle physiology, electromyography, functional electrical stimulation, artificial and biological sensors, control, and design aspects of active assistive devices for the active assistive devices for the handicapped are discussed.

PREREQUISITE: EEN 305 OR PERMISSION OF INSTRUCTOR.

BME560 Biomedical Transport Phenomena

3 credits

Fall & Spring Semester

Fundamentals of transport phenomena in biological systems including diffusio, osmosis, convection, electrophoresis, and transport with binding. Applications to cell electrophysiology and drug delivery. Introduction to physiological fluid flow in tissues.

PREREQUISITE: BME 310 OR PERMISSION OF INSTRUCTOR.

BME565 Principles of Cellular and Tissue Engineering

3 credits

Fall Semester

Introduction to cellular and tissue engineering. Current therapeutic approaches for lost/damaged tissue or organ function, tissue engineering strategies to replace/repair tissue or function: infusion of cells, production and delivery of tissue-inducing substances, cells placed on or within biomaterial scaffolds, examples of tissue engineering applications: skin, heart muscle, blood vessels, and blood.

PREREQUISITE: BIL 150, BME 335 OR PERMISSION OF INSTRUCTOR.

BME570 Introduction to Biosignal Processing

3 credits

Fall & Spring Semester

Course topics include quantitative description, analysis, and processing of biophysical and physiological (cardiovascular, neural, sensory, muscular, respiratory and other) signals using computers. Survey of time-frequency representations, correlation, convolution, coherence, filtering, averaging, and classification is also included.

PREREQUISITE: EEN 118, PRE OR CO REQUISITE: BME 440 OR PERMISSION OF INSTRUCTOR

BME571 Introduction to Biosignal Processing Lab

1 credits

Fall & Spring Semester

Laboratory course in conjunction with BME 570 course. Corequisite: BME 570.

PREREQUISITE: COREQUISITE: BME 570.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME575 Biomechanics II

3 credits

Offered By Announcement Only

Applications of linear and nonlinear viscoelastic concepts to the biomedical characteristics of biological tissues and structures at small and large deformations of blood flow, experimental methods of analysis, artificial organs, and life-support systems.

PREREQUISITE: BME 375.

BME581 Radiation Biology and Physics

3 credits

Fall Semester

The principles, methods, and results of radiation biology with physics applications in radiation therapy will be introduced in the course. The course will focus on mechanisms of radiation and biological system interaction, biological aspects of the foundation of radiation therapy, and mathematical models for radiobiological analysis. Corequisite or pererequisite: BME 502 or permission of instructor.

PREREQUISITE: PREREQUISITE OR COREQUISITE: BME 502 OR PERMISSION OF THE INSTRUCTOR.

BME582 Radiation Dosimetry

3 credits

Spring Semester

The principles and instrumentation of radiation dosimetry with focus on the applications in radiation therapy will be introduced in this course. The course will emphasize radiation dose computation algorithms and applications in treatment dose planning. The course will also cover a categorized dosimetric analysis of radiation therapy to different clinical conditions.

PREREQUISITE: BME 310, 581.

BME585 Bioelectromagnetism

3 credits

Offered By Announcement Only

Historical review of the discovery of the role of electric, magnetic, and electromagnetic fields in living systems. The survey of electro, magneto, and therapeutic devices are included as well as the interactions between electromagnetic fields and living tissues in both harmful and beneficial ways.

PREREQUISITE: EITHER BME 502 OR 503, OR PERMISSION OF INSTRUCTOR.

BME586 Dynamic Analysis of Biological Tissues

3 credits

Offered By Announcement Only

Dynamic analysis of biological tissues including characterization of viscoelastic properties of biological tissues using a Dynamic Mechanical Analyzer. Lab experiments are included.

PREREQUISITE: BME 375, 335 OR CONSENT OF INSTRUCTOR.

BME587 Finite Element Analysis for Engineers

3 credits

Fall & Spring Semester

Introduction to the finite-element method. Hands-on applications of FEMLAB software to the analysis of structural, thermal, chemical, electro-magnetic, optical, and fluid flow problems.

PREREQUISITE: MTH311 OR PERMISSION OF INSTRUCTOR

BME590 Special Topics

1- 3 credits

Fall & Spring Semester & First & Second Summer Session

Sub-titles describing the topics to be offered will be shown in parentheses in the printed class schedule following the title Special Topics.

PREREQUISITE: JUNIOR OR HIGHER STANDING.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME595 Graduate Research in Biomedical Engineering.

1- 3 credits *Fall & Spring Semester & First & Second Summer Session*
Research and design projects consisting of an individual investigation of current problems. Subject and credit to be arranged with the instructor.
PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME599 Cooperative Education.

1 credits *Offered By Announcement Only*
Practical application of classroom theory through alternating semester or summer employment with firms offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.
PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

BME605 M.S. Design Project I

3 credits *Fall & Spring Semester & First & Second Summer Session*
Comprehensive M.S. design project in biomedical engineering. Open only to students in the BS/MS program.
PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME606 M.S. Design Project II

3 credits *Fall & Spring Semester & First & Second Summer Session*
Continuation of BME 605 or additional M.S. design project in biomedical engineering. Open only to students in the BS/MS program.
PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME613 Application of Computers in Medicine

3 credits *Offered By Announcement Only*
Applications in the clinical and medical research laboratories for physiological data acquisition, analysis, and management of patient records. Differences among computer systems and languages for clinical and research activities are also covered.
PREREQUISITE: KNOWLEDGE OF PROGRAMMING AND PERMISSION OF INSTRUCTOR.

BME615 Advanced Engineering Hemodynamics

3 credits *Offered By Announcement Only*
Derivation and description of flow phenomena in the circulatory system from a fluid mechanical viewpoint. Topics include rheology of blood, arterial flow, aortic-valve phenomena, micro-circulation, venous flow, collapsible vessels, and blood flow in the lung.
PREREQUISITE: MEN 512 OR PERMISSION OF INSTRUCTOR.

BME617 Principles of Artificial Internal Organs

3 credits *Offered By Announcement Only*
Engineering and scientific principles applied to design and function of artificial internal organs. Devices that replace partial function of the renal, pulmonary, cardiovascular, urinary, and endocrine systems are examined. Corequisite: BME 502. Permission of instructor.
PREREQUISITE: COREQUISITE: BME 502. PERMISSION OF INSTRUCTOR.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME620 Engineering Hemorheology

3 credits

Offered By Announcement Only

Course topics include rheological concepts, general properties of flowing blood, blood viscosity and viscometers, flow properties of red and white blood cells, deformation of red blood cells and its effects on blood flow, viscoelastic property of blood cell membranes, blood cells in shear field, hemolysis, platelets and endothelial cells, platelet activation and aggregation, thrombosis formation and dissolution, cell/wall and cell/cell interactions, and sickle cell rheology.

PREREQUISITE: BME 501 OR PERMISSION OF INSTRUCTOR.

BME622 Biomedical Signal Processing

3 credits

Offered By Announcement Only

Applications of the digital signal processing techniques to biomedical signals originating from cardiovascular, respiratory, neural, sensory, and motor systems. Digital filtering, averaging, spectral analysis, signal estimation, detection, and classification are covered. Emphasis is placed Real-time and on-line applications.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME623 Neural Engineering

3 credits

Fall & Spring Semester

Biophysics of neural communication, quantitative electroencephalography and evoked potentials, sleep, seizure, anesthesia and intraoperative monitoring, neural stimulation, artificial and biological neural networks, cochlear and visual implants, brain and muscle stimulation.

PREREQUISITE: BME 503, 570 OR CONSENT OF INSTRUCTOR.

BME625 Special Problems

1- 3 credits

Fall & Spring Semester & First & Second Summer Session

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF THE INSTRUCTOR.

BME626 Special Problems

1- 3 credits

Fall & Spring Semester

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF THE INSTRUCTOR.

BME627 Special Problems

1- 3 credits

Fall & Spring Semester

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF THE INSTRUCTOR.

BME628 Advanced Topics

1- 3 credits

Fall & Spring Semester

Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME629 Advanced Medical Imaging

3 credits

Offered By Announcement Only

Analysis of contemporary medical imaging systems and the associated technologies. The course focuses on principles of advanced medical imaging systems. Topics include multimodality imaging, three-dimensional image reconstruction and visualization, clinical and research applications, and derivation and comparison of algorithms.

PREREQUISITE: BME 520 OR EQUIVALENT.

BME630 Advanced Topics

1- 3 credits

Fall & Spring Semester

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME631 Advanced Topics

1- 3 credits

Fall & Spring Semester

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME632 Advanced Topics

1- 3 credits

Fall & Spring Semester

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

BME640 Implantable Biomedical Devices

3 credits

Offered By Announcement Only

Development and advances in implantable materials and devices especially those used as electrically driven prostheses. Topics include pacemakers, defibrillators, catheters, neurological stimulators, heart assist, bone repair, and other diagnostic and therapeutic devices. The historical, medical significance, business, economic, and technical aspects of these devices and the associated instruments for monitoring are discussed. Fundamentals of electrochemical corrosion and stimulation as well the technology of implantable power sources are reviewed.

PREREQUISITE: PREREQUISITE OR COREQUISITE: BME 502 OR 503.

BME645 Biomedical Optical Imaging and Diagnostics

3 credits

Offered By Announcement Only

Review of geometrical optics, fiber optics, and tissue optics. Introduction to physical optics: interference, diffraction, and polarization; optical imaging resolution limits, super-resolution imaging, advanced optical microscopy, and optical coherence tomography (OCT). Imaging throughscattering tissue, imaging and diagnostics with polarized light, fluorescence, infrared, and Raman spectroscopy and applications are also discussed. Optical diagnostics using scattered light: laser Doppler flowmetry, and dynamic light scattering; and opto-chemical and evanescent wave sensors are also covered.

PREREQUISITE: BME 545 OR 546, AND PERMISSION OF THE INSTRUCTOR.

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COLLEGE OF ENGINEERING
BIOMEDICAL ENGINEERING

BME650 Biotransport in Porous Media

3 credits

Fall & Spring Semester

Continuum mixture theory and applications to mass transport in biological tissues, hydrogels, and other porous media. Mechano-electrochemical coupling phenomena in biological tissues and cells.

PREREQUISITE: MTH311, BME310, BME560, OR PERMISSION OF INSTRUCTOR

BME660 Fundamentals of Cellular and Tissue Engineering

3 credits

Spring Semester

Principles and advanced topics on cellular and tissue engineering. Topics include biodegradable and non-biodegradable biomaterials, cytokines, the traditional and stem cell-based tissue engineering approaches, bioreactors and special topics such as bone, cartilage and other tissues.

PREREQUISITE: BME 501 OR PERMISSION OF INSTRUCTOR.

BME680 Biomedical Engineering Seminar

0 credit

Fall & Spring Semester

Presentation of biweekly seminars by selected speakers and graduate students on current topics of interest in biomedical engineering. Attendance is required of all graduate students registered in biomedical engineering graduate programs.

PREREQUISITE: GRADUATE STANDING.

BME681 Radiation Therapy Physics

3 credits

Fall & Spring Semester

Application of radiation physics in the field of radiation therapy. The course will cover the relevant subjects of modern physics, the basic modalities and basic instrumentations of radiation therapy, the principles of particle transport and radiation dose computation and quality assurance of radiation therapy instruments. The subject of radiation protection will also be discussed.

PREREQUISITE: BME 581.

BME683 Radiation Therapy Physics Clinical Rotation

3 credits

Fall & Spring Semester

Students will observe clinical activities at a designated radiation therapy center for ten hours per week. Rotation includes observation of daily treatment, simulation, dose planning, physics quality assurance and routine physics support activities (special physics consultation, weekly physics chart check, monitoring radiation safety activities, support of brachytherapy procedures). Students will meet with the course instructor one and a half hours/week to discuss the schedule and the progress of the rotation activities. Students need to submit reports on each radiation therapy category.

PREREQUISITE: BME 681 OR PERMISSION OF INSTRUCTOR.

BME710 Master's Thesis

1- 6 credits

Fall & Spring Semester & First & Second Summer Session

The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

BME720 Research in Residence

0 credit

Fall & Spring Semester & First & Second Summer Session

Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in BME 710 (usually six credits). Credit not granted. May be regarded as full time residence.

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BIOMEDICAL ENGINEERING

BME725 Continuous Registration--Master's Study

0 credit *Fall & Spring Semester & First & Second Summer Session*
To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full time residence.

BME730 Pre-candidacy Doctoral Dissertation

1-12 credits *Fall & Spring Semester & First & Second Summer Session*
Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of BME 730 may be taken in a regular semester, nor more than six in a summer session.

BME740 Post-Candidacy Doctoral Dissertation

1-12 credits *Fall & Spring Semester & First & Second Summer Session*
Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in BME 740 may be taken in a regular semester, nor more than six credits in a summer session.
PREREQUISITE: ADMISSION TO CANDIDACY

BME750 Research in Residence

0 credit *Fall & Spring Semester & First & Second Summer Session*
Used to establish research in residence for the Ph.D., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE510 Structural Mechanics

3 credits *Offered By Announcement Only*
Analysis of stress and deformation of solids. Application to systems in the elastic and inelastic range. Topics include beams of special geometry and support, stress concentrations, stresses in elastic foundations, torsion, energy methods, failure theories, and brittle fracture.
PREREQUISITE: CAE 310 AND SENIOR STANDING.

CAE511 Advanced Structural Analysis

3 credits *Fall Semester*
General methods of indeterminate analysis. Elements of energy method in indeterminate analysis of axial, flexural torsional, and composite members. Basic flexural and stiffness methods and matrix development are also included.
PREREQUISITE: CAE 310.

CAE520 Advanced Design of Concrete Structures

3 credits *Spring Semester*
Design of reinforced concrete flat plates, flat slabs, two-way slabs, long columns, and slab-column connections are discussed. Deflections, crack widths, and background of current ACI Building Code are also included.
PREREQUISITE: CAE 320.

CAE521 Advanced Design of Steel Structures

3 credits *Fall Semester*
Steel framing systems, design of members and connections of braced and rigid frames, design for torsion, and design of steel-concrete composite members are discussed.
PREREQUISITE: CAE 321.

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COLLEGE OF ENGINEERING
CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE522 Design of Prestressed Concrete Structures

3 credits

Offered By Announcement Only

Materials and systems for prestressing, design of prestressed concrete members for flexure and shear, camber, deflection, and crack control are discussed. Design of continuous beams, compression members, two-way concrete floor systems, and the loss of prestress are also included. Prerequisite: CAE 320.

PREREQUISITE: CAE 320.

CAE523 Design of Masonry Structures

3 credits

Offered By Announcement Only

Masonry construction. Design of flexural and compression members, bearing walls, shear walls, diaphragms, and connections of masonry structures. Arches, vaults, and buttresses are also included.

PREREQUISITE: CAE 320.

CAE524 Design of Bridge Structures

3 credits

Offered By Announcement Only

Engineering principles of analysis and design of highway bridges. Topics include load types, failure modes, and design philosophies. Computation of design force envelopes via influence lines. Design of slabs, rolled beam, plate girder, reinforced concrete, and prestressed concrete bridges.

PREREQUISITE: CAE 310, 320, 321 OR PERMISSION OF INSTRUCTOR.

CAE525 Timber Structural Systems

3 credits

Offered By Announcement Only

Engineering properties of timber, design of tension, compression, and flexural members are covered. The design and detail of connections and hardware, and the design of timber systems and heavy timber construction is also included.

PREREQUISITE: CAE 310

CAE530 Water-Quality Control in Natural Systems

3 credits

Spring Semester

Water quality regulations, fate and transport processes, water-quality control in rivers, lakes, wetlands, oceans, and ground water are discussed.

PREREQUISITE: CAE 430. PREREQUISITE OR COREQUISITE: CAE 440.

CAE531 Surface-Water Hydrology

3 credits

Offered By Announcement Only

Rainwater characteristics, abstraction processes, surface-runoff, routing, and water-quality models. Design of stormwater-management systems, evapotranspiration, and regional water-management is also included as well as case studies.

PREREQUISITE: PREREQUISITE OR COREQUISITE: CAE 430.

CAE532 Ground-Water Hydrology

3 credits

Offered By Announcement Only

Governing equations of ground-water flow. Numerical modeling of ground-water flow. Analytic and semi-analytic solutions to the flow equations. Principle of superposition and method of images. Saltwater intrusion. Ground-water flow in the unsaturated zone. Engineered systems. Introduction to contaminant fate and transport in ground water.

PREREQUISITE: CAE 330.

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COLLEGE OF ENGINEERING
CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE540 Environmental Chemistry

3 credits

Spring Semester

Kinetics, equilibrium, acid-base, oxidation-reduction, and reaction chemistry applied to water and wastewater engineering.

PREREQUISITE: CHM 112 OR PERMISSION OF INSTRUCTOR.

CAE541 Environmental Microbiology

3 credits

Spring Semester

Classification of microorganisms. Microbial agents of infectious diseases and modes of disease transmission. Control of pathogens through water and waste treatment, food protection, and insect control. Microbial ecology and bioremediation systems. Laboratory exercises in microbiology.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE542 Solid and Hazardous Waste Engineering

3 credits

Fall Semester

Solid-waste characteristics, recycling, incineration, hazardous waste characteristics, prevention, and physical and chemical treatment are covered. Design projects are also included.

PREREQUISITE: CAE 340.

CAE543 Air Pollution Control Engineering

3 credits

Spring Semester

Fundamentals of air pollution and air quality; properties and control of particulates, volatile organic compounds, carbon monoxide, sulfur oxides, and nitrogen oxides; motor vehicle emissions; health and aesthetic effects (acid rain, visibility), laws and regulations, meteorology and pollutant transport in the atmosphere; indoor air pollution.

PREREQUISITE: MAE 303 AND CAE330 OR MAE 309 OR PERMISSION OF INSTRUCTOR.

CAE550 Advanced Highway Design

3 credits

Fall Semester

Functional classification and design volumes; Reviews of traffic, vehicle and roadway characteristics; Design controls, criteria and standards; Vertical alignments; Horizontal alignments; Compound curves; Cross sections; Climbing lanes; Earthwork computation; At-grade intersection; Interchange; Design consistency; GeoPak software implementation; Use of traffic simulation software as a design aid.

PREREQUISITE: CAE 450 OR EQUIVALENT.

CAE551 Urban Traffic Control

3 credits

Spring Semester

Traffic control devices; Detection systems; Installation and maintenance; Design of signal timing plans; Performance analysis of signalized intersections; Signal coordination; Actuated controllers; Computer simulation/optimization models; Adaptive traffic control and predictions; Ramp metering.

PREREQUISITE: CAE 450.

CAE553 Transportation Systems Planning and Demand Modeling

3 credits

Offered By Announcement Only

Transportation demand analysis and forecasting. Sampling techniques, collection and analysis of survey data. Disaggregate and aggregate models. Trip generation, distribution, modal split and assignment. Transportation network equilibrium. Transportation system management.

PREREQUISITE: IEN 311 OR CONSENT OF INSTRUCTOR.

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COLLEGE OF ENGINEERING
CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE560 Sustainable Construction

3 credits

Offered By Announcement Only

Drivers and foundations of sustainable construction. Principles of sustainable construction: integrated planning and design, life-cycle view of projects, resource selection and optimization, protection of the natural environment, toxics and pollutants elimination, durability and quality. Green building assessment initiatives, green building policies, and code impacts. Evaluation of the environmental impacts of construction operations. Innovative design and construction practices. Economic viability. Subtropical and coastal issue and opportunities. Case studies.

PREREQUISITE: SENIOR STANDING IN ARCHITECTURE OR ENGINEERING AND PERMISSION OF INSTRUCTOR

CAE570 Advanced Foundation Engineering

3 credits

Spring Semester

Rock and soil formation. Subsurface exploration. Advanced design and analysis of shallow and deep foundations. Design and analysis of cofferdams.

PREREQUISITE: CAE 470 OR PERMISSION OF INSTRUCTOR.

CAE580 Hospital and Health Care Facility Design

3 credits

First Summer Session

Planning, design, and construction of modern hospital and health care facilities. Design criteria for functional services, and required structural and patient safety. Design standards. Discussion of construction related topics and problems.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE581 Energy-Efficient Building Design

3 credits

Offered By Announcement Only

Concepts and methods of energy-efficient and environmentally-friendly building design. Topics include energy and sustainable design strategies, climate, passive and active solar design, passive cooling systems, day lighting, and computer simulation of energy flows in buildings. A quantitative understanding of energy fundamentals, examples from practice, and design exercises using computer simulation programs are emphasized.

PREREQUISITE: MAE 303 OR PERMISSION OF INSTRUCTOR.

CAE590 Special Topics

1- 3 credits

Offered By Announcement Only

Sub-titles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE591 Special Topics

1- 3 credits

Offered By Announcement Only

Sub-titles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE592 Special Topics

1- 3 credits

Offered By Announcement Only

Sub-titles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE593 Special Topics

1- 3 credits

Offered By Announcement Only

Sub-titles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE594 Special Topics

1- 3 credits

Offered By Announcement Only

Sub-titles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE595 Special Problems

1- 4 credits

Offered By Announcement Only

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

CAE599 Cooperative Education

1 credits

Offered By Announcement Only

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

CAE601 Engineering Scholarship

0 credit

Fall Semester

Principles of research in civil, architectural, and environmental engineering.

Survey of current department research, basics of literature review, writing engineering documents, presenting seminars, and research methodologies.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE602 Finite Element Methods

3 credits

Offered By Announcement Only

Variational principles and their application to finite element methods. Applications to: plane stress and plane strain, three-dimensional stress analysis, bending of plates, and axi-symmetric shells. Lecture, 3 hours.

PREREQUISITE: 500 LEVEL STRUCTURAL MECHANICS COURSE AND PERMISSION OF INSTRUCTOR.

CAE603 Master's Design Project I

3 credits

Fall & Spring Semester & First & Second Summer Session

Comprehensive design project in civil, architectural, or environmental engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE604 Master's Design Project II

3 credits

Fall & Spring Semester & First & Second Summer Session

Continuation of CAE 603.

PREREQUISITE: CAE 603.

CAE605 Master's Project

3 credits

Fall & Spring Semester & First & Second Summer Session

Project in civil, architectural, and environmental engineering. Course is required for the non-thesis master's student.

PREREQUISITE: PERMISSION OF ADVISORY COMMITTEE.

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COLLEGE OF ENGINEERING
CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE611 Theory of Elasticity

3 credits

Offered By Announcement Only

Analysis of stress, strain, and displacement in elastic solids. Basic equations of elasticity. Two-dimensional solutions of beams and other problems in rectangular and polar coordinates. Torsion of bars. Energy methods. Selected topics. Lecture, 3 hours.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE612 Structural Reliability

3 credits

Offered By Announcement Only

Development of structural safety concepts, design code applications, load process analysis, and interaction of load and resistance variability, Consideration is given to structural system serviceability and safety.

PREREQUISITE: IEN 311 AND PERMISSION OF INSTRUCTOR.

CAE613 Stability of Structures

3 credits

Offered By Announcement Only

Elastic and inelastic buckling of columns, frames and plates, lateral buckling of beams, beam-columns, and built-up columns energy methods (stability) background of various buckling provisions in the AISC and AISI specifications are discussed. Lecture, 3 hours.

PREREQUISITE: CAE 321, MTH 311.

CAE614 Structural Dynamics

3 credits

Offered By Announcement Only

Dynamic responses of structural elements in both the elastic and inelastic ranges. Lagrange's equations, energy models, numerical and analytical methods, vibrations of continuous systems (beams and plates) are discussed. Assigned readings.

PREREQUISITE: 500 LEVEL STRUCTURAL MECHANICS COURSE AND PERMISSION OF THE INSTRUCTOR.

CAE615 Plates and Shells

3 credits

Offered By Announcement Only

Analysis and design of plate structures. General Theory of circular and rectangular flat plates under lateral loads, membrane stresses and displacements in shells of revolution, symmetrically and unsymmetrically loaded, bending stresses in shells (rigorous and approximate solutions) are discussed. Lecture, 3 hours.

PREREQUISITE: 500-LEVEL STRUCTURAL MECHANICS COURSE.

CAE616 Fracture Mechanics

3 credits

Offered By Announcement Only

Theory of fracture mechanics for linear elastic and nonlinear material behavior, energy release rate, stress intensity factor, and J-integral with practical application to brittle fracture and fatigue. Case studies involving civil infrastructure such as bridges, buildings, pipelines and ships. Metallurgical aspects of fatigue and fracture.

PREREQUISITE: PERMISSION OF INSTRUCTOR

CAE630 Environmental Fluid Mechanics

3 credits

Offered By Announcement Only

The physical processes of mixing in aquifers, reservoirs, rivers, estuaries, and in the ocean. An introduction to the mathematical models used to simulate these processes is included.

PREREQUISITE: GRADUATE STUDENT STATUS, AND PERMISSION OF INSTRUCTOR.

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CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE631 Wastewater Treatment and System Design

3 credits

Offered By Announcement Only

Characterization of domestic wastewater and flows. Sources of wastewater and health considerations. Unit processes for treatment of wastewater including screening, sedimentation, filtration, flocculation floatation, activated sludge, disinfection, sludge digestion, and sludge disposal.

PREREQUISITE: CAE 440, 540, AND 541 OR PERMISSION OF INSTRUCTOR.

CAE632 Water Treatment and System Design

3 credits

Offered By Announcement Only

Drinking water treatment standards, philosophy of setting standards, public health aspects of organic and inorganic contaminants, basis for design of treatment facilities, design of unit processes for aeration, sedimentation, coagulation, filtration, softening, disinfection, and oxidation are covered. Theory of membrane processes, ion exchange, and water treatment plant residuals are also included.

PREREQUISITE: CAE 440, 540, AND 541 OR PERMISSION OF INSTRUCTOR.

CAE640 Treatment Kinetics and Unit Operations

4 credits

Offered By Announcement Only

A study of unit operations in which students test various water and waste treatment processes in the laboratory. Lecture material focuses on data interpretation and description of rate mechanisms.

PREREQUISITE: CAE 540, 542.

CAE643 Risk Analysis

3 credits

Offered By Announcement Only

Probabilistic risk assessment, Poisson processes, Bayesian methods, fault trees, contaminant transport models, and dose-response relationships for assessment of natural and technological risks.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE680 Indoor Environmental Modeling

3 credits

Offered By Announcement Only

Prediction of indoor environment using computational fluid dynamics techniques. Advanced topics in thermal comfort and indoor air quality. Basic concepts of turbulence modeling and numerical methods for natural, forced, and mixed convection and jet flows indoors. Simulation of air velocity, temperature, and contaminant concentrations in buildings. Comparison of the simulated results with measured data.

PREREQUISITE: CAE 330 OR PERMISSION OF INSTRUCTOR.

CAE690 Special Problems

1- 3 credits

Offered By Announcement Only

Research and/or design projects. Individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE695 Advanced Topics

1- 3 credits

Offered By Announcement Only

Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE696 Advanced Topics

1- 3 credits

Offered By Announcement Only

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE697 Advanced Topics

1- 3 credits

Offered By Announcement Only

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE698 Advanced Topics

1- 3 credits

Offered By Announcement Only

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

CAE710 Master's Thesis

1- 6 credits

Fall & Spring Semester & First & Second Summer Session

The student working on his/her Master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

CAE720 Research in Residence

1- 6 credits

Fall & Spring Semester & First & Second Summer Session

Used to establish research in residence for the thesis for the Master's degree after the student has enrolled for the permissible cumulative total in CAE 710 (usually six credits). Credit not granted. May be regarded as full-time residence.

CAE725 Continuous Registration--Master's Study

0 credit

Fall & Spring Semester & First & Second Summer Session

To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full-time residence.

CAE730 Pre-Candidacy Doctoral Dissertation

1-12 credits

Fall & Spring Semester & First & Second Summer Session

Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of CAE 730 may be taken in a regular semester, nor more than six in a summer session. six in a summer session. ix in a summer session.

CAE740 Post-Candidacy Doctoral Dissertation

1-12 credits

Fall & Spring Semester & First & Second Summer Session

Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in CAE 740 may be taken in a regular semester, nor more than six credits in a summer session.

PREREQUISITE: ADMISSION TO CANDIDACY

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CIVIL, ARCHITECTURAL, & ENVIRONMENTAL ENGINEERING

CAE750 Research in Residence

0 credit *Fall & Spring Semester & First & Second Summer Session*
Used to establish research in residence for the Ph.D. and D.A., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

ELECTRICAL & COMPUTER ENGINEERING

EEN500 Engineering Analytical Techniques

3 credits *Offered By Announcement Only*
Complex variables, analytic functions, power series, residue theorem, conformal mappings, series solution, Bessel functions, Legendre polynomials. singular value decomposition, vector, and matrix norms are discussed.
PREREQUISITE: MTH 311.

EEN502 Engineering Acoustics

3 credits *Fall Semester*
Introduction to basic principles of acoustics, methods of sound measurement, physiological, psychological acoustics, the acoustics of the major classes of musical instruments and speech, fundamentals of transducers, architectural acoustics, and the effects and control of noise are covered.
PREREQUISITE: EEN 336 OR PERMISSION OF INSTRUCTOR.

EEN503 Principles of Electro-optics

3 credits *Fall Semester*
Principles of optics, optical fibers, electro-optics, light wave propagation in anisotropic and periodic media, guided waves, and integrated optics are discussed. Electro-optic devices including sources and detectors, optical fiber communication, and optics for medical and biomedical applications are also covered.
PREREQUISITE: PHY 206, 207 AND EEN 301 OR EQUIVALENT.

EEN504 Optics and Fiber Communication

3 credits *Spring Semester*
Introduction to optics and fiber communication, light propagation in free space and waveguides, imaging, wave phenomena and diffraction, interferometer, spectrometer, holography, fiber coupling, and fiber communication are covered. Lecture, 1 1/2 hours; laboratory, 3 hours.
PREREQUISITE: EEN 301 OR PREREQUISITE OR COREQUISITE: BME 545.

EEN506 Solid-State Devices

3 credits *Offered By Announcement Only*
Principles of operation, properties and applications of semiconductor devices, junction, metal-semiconductor, metal-oxide-semiconductor, optoelectronic, bulk-effect, and charge-coupled are covered.
PREREQUISITE: EEN 405 OR PHY 520.

EEN507 Active Filter Design

3 credits *Spring Semester*
Active lowpass filter design, gain-tuning and passive-tuning, immittance calculations, high-frequency lowpass filters, frequency and time domain analysis of lowpass, highpass, bandpass, and bandstop filters are discussed. Classical filters and Active filter classification including gain-sensitivity limitations are also included.
PREREQUISITE: EEN 307.

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COLLEGE OF ENGINEERING
ELECTRICAL & COMPUTER ENGINEERING

EEN508 Digital Control Systems

3 credits

Offered By Announcement Only

Basic concepts relevant to the analysis and design of digital computer controlled systems. Sampling, z-transform, discrete transfer functions, discrete-time state space modeling, stability, reachability, and observability are discussed. Analysis and design in time and frequency domains, state feedback and observers, optimal control, estimation, and linear quadratic Gaussian design are also included.

PREREQUISITE: EEN 308.

EEN510 Passive Filter Design

3 credits

Offered By Announcement Only

Design of RLC passive filters, properties of positive-real functions, and Brune test are discussed. Design of driving-point and transfer immittances of RC, RL, LC, and RLC one-port and two-port networks are also covered as well as the design of Butterworth, Chebyshev, and elliptic ladder filters.

PREREQUISITE: EEN 307.

EEN511 Software Engineering

3 credits

Spring Semester

Software Development: Specification and analysis, methodologies, management and control. Advanced programming techniques: dynamic programming, fast data retrieval and sorting, enumerators, data structures, and data management. The limits of software engineering, computability and complexity analysis.

PREREQUISITE: EEN 318.

EEN512 Software Architecture

3 credits

Spring Semester

Examination of the building blocks of software systems. Design techniques to meet functional requirements. Component-based designs. Model representations. Analysis of designs for functionality, performance, reliability, reusability, and maintainability.

PREREQUISITE: EEN 318.

EEN513 Software Design and Testing

3 credits

Fall Semester

Design for testability. Software testing methods, processes, techniques and tools. Formal review techniques. Functional and structured testing methods. Unit-level and system-level testing. Integration, acceptance, regression, performance and stress testing. Verification and validation. Software quality assurance.

PREREQUISITE: EEN 318 AND SENIOR STANDING.

EEN514 Computer Architecture

3 credits

Spring Semester & First Summer Session

Computer data and instruction types, survey of existing architectures, and the interaction between hardware and software sub-systems are discussed. Advanced topics in computer architecture.

PREREQUISITE: EEN 414.

EEN516 Analog Integrated Circuits

3 credits

Fall Semester

Analysis and design of analog integrated circuits with emphasis on MOS technology. Design of operational amplifiers, comparators, sample and hold circuits, and voltage references are discussed. Fundamentals of data converters and CAD methods for analog integrated circuits are also covered.

PREREQUISITE: EEN 306.

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ELECTRICAL & COMPUTER ENGINEERING

EEN518 Modern Control Theory

3 credits

Offered By Announcement Only

State-space modeling of continuous-time systems, stability, reachability, observability, performance, robustness measures in controller design, State feedback and observers are discussed. Optimal control, estimation, and Linear quadratic Gaussian design are also included.

PREREQUISITE: EEN 308.

EEN519 Design of Computing Languages

3 credits

Offered By Announcement Only

Major features of modern programming languages with emphasis on design and software efficiency. Interaction between language design and the design of its compiler are included.

PREREQUISITE: EEN 218.

EEN521 Computer Operating Systems

3 credits

Fall Semester

The design and implementation of operating systems. Virtual memory and memory management, resource allocation, device drivers, process creation, control, communications and scheduling, file systems, data protection, security, parallel processing and time-sharing. The class includes a significant operating system implementation project.

PREREQUISITE: EEN 318

EEN525 Antennas and Propagation

3 credits

Offered By Announcement Only

Principles of electromagnetic radiation and diffraction, fundamentals of antennas, wire, loop, and micro-strip antennas, array antennas, beam-forming. propagation characteristics in the mobile and indoor environments, path loss, link budget, fading, and diversity are covered.

PREREQUISITE: EEN 301.

EEN532 VLSI Systems

3 credits

Fall Semester

Fundamentals of MOS Technology in VLSI. System data, control flow, structures, design, layout, maskmaking, fabrication, packaging, and testing of VLSI chips are discussed. Highly concurrent Very Large Scale Integration computational systems are also covered.

PREREQUISITE: EEN 304 AND 305.

EEN533 Random Signals and Noise

3 credits

Fall Semester

Probability models, Bayes' theorem, Limit theorems of Laplace and Poisson, functions of random variables, Central limit theorem, conditional expectation and estimation, Stochastic processes, stationarity and ergodicity, cross-spectral analysis, filtering, and prediction are discussed.

PREREQUISITE: IEN 310 OR EEN 310.

EEN534 Communication Networks

3 credits

Fall Semester

Principles of digital communications, Local Area Networks (LANs), Wide Area Networks (WANs), Open systems Intercommunication (OSI), Internet reference models, internet architecture and protocols, packet switching and routing, and network performance are discussed.

PREREQUISITE: EEN 310 OR IEN 310.

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ELECTRICAL & COMPUTER ENGINEERING

EEN536 Digital Signal Processing

3 credits

Offered By Announcement Only

Fast Fourier transform, design, implementation, realization of digital filters, finite wordlength effects, decimation, interpolation, multirate signal processing, and Discrete Hilbert transform are covered.

PREREQUISITE: EEN 436.

EEN537 Principles of Artificial Intelligence

3 credits

Fall Semester

Search techniques, game trees, exhaustive vs. cutoff search, natural language processing, augmented transition networks, knowledge representation, cognitive aspects, semantic networks, problem-solving, expert systems, and AI machines are covered.

PREREQUISITE: EEN 218.

EEN538 Introduction to Digital Image Processing

3 credits

Fall Semester

Digital image representation. Image smoothing, sharpening, and transformations. Color image processing. Encoding of digital images. High level image segmentation and description techniques. Processing of image sequences.

PREREQUISITE: EEN 307 AND MTH 210.

EEN539 Digital Communications

3 credits

Offered By Announcement Only

Principles for the analysis and design of digital communications systems. Nyquist sampling, signal space representation, digital modulation techniques and optimal receiver design, ISI channels, error control coding, convolutional codes, Viterbi decoder, and wireless applications.

PREREQUISITE: EEN 404

EEN540 Digital Speech and Audio Processing

3 credits

Spring Semester

Introduction to human speech production, hearing, and perception. Digital speech and audio signal analysis in time and frequency, speech and audio coding, speech synthesis and recognition, language modeling, design of systems for human-machine interaction are also covered.

PREREQUISITE: EEN 436 OR CONSENT OF INSTRUCTOR.

EEN542 Digital Integrated Circuits

3 credits

Spring Semester

Design and operation of state-of-the art digital integrated circuits. Circuit simulation methods using CAD programs, various TTL, CMOS, ECL, and I²L families are discussed.

PREREQUISITE: EEN 304, 306.

EEN546 Reliable Digital System Design

3 credits

Offered By Announcement Only

Topics include descriptive technique for digital systems, synchronizer failure and metastability estimation, design for testability, and estimating digital system reliability. Computer-Aided Engineering (CAE) tools are also covered. Not open to students with credit in EEN 454. Offered only for Graduate students.

PREREQUISITE: EEN 316.

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COLLEGE OF ENGINEERING
ELECTRICAL & COMPUTER ENGINEERING

EEN548 Machine Learning

3 credits

Offered By Announcement Only

Fundamentals of intelligent system design and strategies of learning capability simulation. Selected case studies of learning systems for engineering applications are included.

PREREQUISITE: EEN 218 AND MTH 309 OR PERMISSION OF INSTRUCTOR.

EEN552 Power Electronics

3 credits

Fall Semester

Analysis and design of solid-state power electronic circuits including DC/DC, AC/DC and DC/AC converters, controller design, power electronics applications, and associated laboratory experiments.

PREREQUISITE: EEN 306, EEN 311

EEN553 Neural Networks

3 credits

Offered By Announcement Only

Artificial neural network algorithms and structures, learning process, perceptron, least-mean-square algorithms, multilayer perceptron, error back-propagation, radial-basis function networks, the Hopfield network, and self-organizing systems are discussed.

PREREQUISITE: IEN 310 OR EEN 310.

EEN555 Microwave Transistor Amplifier Design

3 credits

Fall Semester

Analysis and design of transistor amplifiers and oscillators at microwave frequencies. Scattering parameter methods, stability considerations, matching networks, and narrowband and broadband techniques are discussed. Computer aided design methods for microwave transistor amplifiers are also included.

PREREQUISITE: EEN 306.

EEN562 Wireless and Cellular Communication

3 credits

Fall Semester

Wireless Channel Characterization: path loss, shadowing, fading, frequency-selective channels, Doppler spread, and delay spread. Diversity techniques: frequency, time and space diversity. Multiple Antenna Systems: space-time coding, beamforming and layered space-time system. Digital Modulation: adaptive modulations and Orthogonal Frequency Division Multiplexing (OFDM). Cellular Concept: frequency reuse, co-channel interference and handoff. Multiple Access Methods: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and random access. CDMA: spreading codes, RAKE receiver, multiuser detection and power control.

PREREQUISITE: EEN 404.

EEN563 Wireless Communication Lab

1 credits

Offered By Announcement Only

Computer simulation of path loss, shadowing and fading in wireless channels, performance of various digital modulation methods in both Gaussian and wireless channels, diversity methods, equalization methods including zero-forcing, minimum mean-square error (MMSE) and decision-feedback equalization (DFE), co-channel interfacing in cellular systems, space-time coding. Orthogonal Frequency Division Multiplexing (OFDM) systems, spreading codes for Code Division Multiple Access (CDMA) systems, and matched-filter receiver and multiuser detector for CDMA systems. Measurement of wireless signals in various environments.

PREREQUISITE: PREREQUISITE OR COREQUISITE: EEN 562.

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ELECTRICAL & COMPUTER ENGINEERING

EEN564 Wireless Networks

3 credits

Spring Semester

Introduction of wireless channels and network. Introduction of medium access control: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA) and Carrier Sense Multiple Access. Wireless data networks: IEEE 802.11 (WiFi), IEEE 802.16 (WiMax) and Bluetooth. Wireless network layer: mobile IP and mobile ad-hoc networks. Wireless transport layer: mobile TCP. Wireless Cellular systems: network structure and call processing of GSM and CDMA systems.

PREREQUISITE: EEN 534 OR 575 OR PERMISSION OF THE INSTRUCTOR

EEN565 Introduction to Information Theory and Coding

3 credits

Offered By Announcement Only

Entropy, conditional entropy, mutual information, source coding, Huffman code arithmetic code, channels and channel capacity, error detection, error correction, and Hamming codes are discussed. An introduction to linear block codes and cyclic codes is included.

PREREQUISITE: IEN 310 OR EEN 310.

EEN567 Database Design and Management

3 credits

Spring Semester

Database systems design, modeling, implementation, management methodologies, and techniques. Different database systems are addressed including relational, object-oriented, object-relational, and distributed database systems. Internet (WWW) technology, data warehousing, and online analytical processing applications of database management systems and hands-on experience with commercial database systems is also included.

PREREQUISITE: EEN 218

EEN568 Internet Computing II

3 credits

Fall Semester

Java programming for client/server networking, multi-threading, database connectivity, and servlets. Principles and practices used for accessing back-end databases through web applications. Use of eXtensible Markup Language (XML) for processing.

PREREQUISITE: EEN 368.

EEN570 Network Client-Server Programming

3 credits

Spring Semester

Introduction to server-client systems and programming. Advanced server-client design and implementation based on distributed component object model in Windows and UNIX.

PREREQUISITE: EEN 218 OR EQUIVALENT.

EEN571 Interactive Multimedia Computing

3 credits

Spring Semester

Multimedia fundamentals including hardware, software, standards, concepts and issues, compression, decompression, user interface design, query by content and multimedia indexing are discussed.

PREREQUISITE: EEN 318

EEN572 Object-Oriented and Distributed Database Management Systems

3 credits

Offered By Announcement Only

Object-Oriented modeling concepts in languages and database systems. Object-Oriented database systems. Semantic data models, nested-relational, object-relational databases. Distributed database system. Federated Databases. Application to engineering design problems.

PREREQUISITE: EEN 567 OR EQUIVALENT.

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EEN573 Network Computing

3 credits

Spring Semester

Internet and Intranet architecture: scalability, language independence, and high availability. High performance computing: clustering and performance analysis. Integration through standards: object management model, reference object model, and Interface Definition Language (IDL). Directory services.

PREREQUISITE: EEN 368 AND 567.

EEN574 Agent Technology

3 credits

Offered By Announcement Only

Agent definition and applications, agent modeling, theories, agent representation using KIF (Knowledge Interchange Format), agent behavior, ethical and emotional agents, agent communication languages (KQML (Knowledge Query and Manipulation Language)), agent development environments and tools, agent systems (cooperative agents, interface agents, information agents, learning agents, believable agents, agents for workgroups, mobile agents), and agent case studies are covered.

PREREQUISITE: EEN 537 OR EQUIVALENT.

EEN575 Data Network Design and Management

3 credits

Spring Semester

Networking fundamentals and current technologies. Data network planning, analysis, design, and management techniques. Different network technologies are addressed and contrasted in terms of topology, performance, and scope of real applications. Network management systems are investigated including fault, configuration, security, and performance management. Network management information bases, protocols, and hands-on experience with network equipment and network management systems are also included.

PREREQUISITE: EEN 310 OR IEN 310.

EEN576 Internet and Intranet Security

3 credits

Fall Semester

Security issues and applications for securing internet and intranet-based information exchange. Secure information models, security tools, security services, security protocols, electronic commerce, virtual private networks, firewalls, and security versus cost tradeoffs are covered.

PREREQUISITE: EEN 368.

EEN577 Data Mining

3 credits

Offered By Announcement Only

Introduction to the general principles of inferring useful knowledge from large data sets. Data mining algorithms, including inferring rules, linear regression, decision trees, association rules, and predictive models. Evaluation of data mining algorithms, including training, testing, prediction, comparison, cost, and cross-validation. Data mining applications.

PREREQUISITE: EEN 567 OR EQUIVALENT.

EEN578 E-Commerce Technology

3 credits

Offered By Announcement Only

Tools and techniques providing the foundation for the design, implementation, and deployment of e-commerce systems. Search engines, information retrieval for e-commerce, e-commerce interfacing design, and e-commerce systems case studies are also included.

PREREQUISITE: EEN 368

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ELECTRICAL & COMPUTER ENGINEERING

EEN579 Mobile Computing

3 credits

Offered By Announcement Only

Mobile computing and proxy architectures, mobile web protocols, mobile user interfaces, applications, systems-ware adaptations, mobile databases, transactions, data synchronization, privacy, authentication, and security are covered.

PREREQUISITE: EEN 368.

EEN580 Electrical and Computer Engineering Internship

1- 3 credits

Fall & Spring Semester

Analysis, design, and research experience obtained at an operating and recognized industry. Approved project jointly supervised and assessed by departmental faculty and industrial partner.

PREREQUISITE: PERMISSION OF ADVISOR.

EEN581 Special Problems

1- 3 credits

Fall Semester

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

EEN582 Special Problems

1- 3 credits

Spring Semester

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

EEN583 Special Problems

1- 3 credits

First Summer Session

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

EEN584 Special Problems

1- 3 credits

Second Summer Session

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

EEN585 Special Problems

1- 3 credits

Offered By Announcement Only

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

EEN586 Multimedia Networking

3 credits

Fall Semester

Fundamentals of Multimedia networking. Current techniques in multimedia delivery over networks. Quality of service provisioning for multimedia networking applications. Stored video streaming. Multicasting. Multimedia transport and delivery services. Emerging protocols, applications and standards.

PREREQUISITE: EEN 534 OR 575.

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EEN587 Multimedia Databases

1- 3 credits

Fall Semester

Introduction to the fundamental concepts and techniques pertinent to multimedia databases. Introduction to a variety of techniques and emerging innovative solutions to represent, store, index, retrieve, integrate, and manipulate data in various media type(s) to construct multimedia databases.

PREREQUISITE: EEN 567 OR PERMISSION OF INSTRUCTOR. PREREQUISITE OR COREQUISITE: EEN 571.

EEN590 Special Topics in Information Technology

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Information Technology.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN591 Special Topics in Information Technology

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Information Technology.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN592 Special Topics in Audio Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Audio Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN593 Special Topics in Audio Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Audio Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN594 Special Topics in Computer Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Computer Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR - 1 COUPON

EEN595 Special Topics in Computer Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Computer Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN596 Special Topics in Computer Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Computer Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN597 Special Topics in Electrical Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Electrical Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN598 Special Topics in Electrical Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Electrical Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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EEN599 Special Topics in Electrical Engineering

1- 3 credits

Offered By Announcement Only

Lecture courses in selected areas of specialization within Electrical Engineering.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN607 Advanced Active Filter Design

3 credits

Offered By Announcement Only

Continuation of EEN 507. Design of active high-pass, band-stop, and all-pass filters, tunable filters, frequency discriminators, and oscillators. Optimum filters and frequency transformations are also included.

PREREQUISITE: EEN 507.

EEN608 Adaptive Control Theory

3 credits

Offered By Announcement Only

Stochastic control, parameter estimation, system identification techniques, Kalman filtering, design and model-reference, self-tuning, and adaptive control systems for both continuous and discrete time systems based on Lyapunov and hyperstability techniques are discussed.

PREREQUISITE: EEN 508 OR 518.

EEN615 M. S. Design Project I

3 credits

Fall & Spring Semester

Comprehensive M.S. design project in electrical or computer engineering. Open only to students in the BS/MS dual-degree program.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN616 M.S. Design Project II

3 credits

Fall & Spring Semester

Continuation of EEN 615. Open only to students in the BS/MS dual-degree program.

PREREQUISITE: EEN 615.

EEN634 Modeling and Analysis of Computer Networks

3 credits

Offered By Announcement Only

Elements of queueing theory, performance analysis of protocols, flow and congestion control, random access schemes, routing algorithms, and integrated services digital networks (ISDN) are discussed.

PREREQUISITE: EEN 534.

EEN635 Advanced Electronics

3 credits

Offered By Announcement Only

Current topics in electronic design including filter design using striplines and microstrip structures, switching, mixing, and modulation using microwaves transistors. Advanced computer aided design methods are also included.

PREREQUISITE: EEN 555.

EEN636 Advanced Digital Filter Design

3 credits

Offered By Announcement Only

Continuation of EEN 536. Adaptive digital filter design, frequency and time domain analysis using discrete transforms including Walsh, Haar, and slant optimum filters and frequency transformations are covered.

PREREQUISITE: EEN 536.

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EEN638 Computer Vision

3 credits

Spring Semester

Principles of computer vision. Segmentation, shape and texture analysis, 3D scene analysis, polyhedral scenes, time-varying image analysis, parallel processing algorithms, matching, and recognition are covered.

PREREQUISITE: EEN 538 OR PERMISSION OF INSTRUCTOR

EEN653 Pattern Recognition and Neural Networks

3 credits

Offered By Announcement Only

Statistical pattern classification, feature extraction, cluster analysis, neural net models, Hopfield net, competitive learning, multi-layer perceptron, and the Boltzmann machine are discussed.

PREREQUISITE: EEN 538 OR PERMISSION OF INSTRUCTOR.

EEN656 Information Theory

3 credits

Offered By Announcement Only

Measure of uncertainty and entropy, two dimensional sources, noisy channels, mutual and transinformation, equivocation, efficiency and channel capacity, minimum redundancy coding, error-detecting, error-correcting codes, continuous channel without memory. Gaussian additive noise, sampling theorem, and vector space are covered.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN671 Advanced Interactive Multimedia Information Systems

3 credits

Fall Semester

Multimedia data models, advanced content-based retrieval, indexing, architecture design, management of networked multimedia systems, simultaneous access, and display of audio, video, and graphics information in centralized and distributed environments are covered.

PREREQUISITE: EEN 571.

EEN681 Advanced Problems

1- 3 credits

Fall Semester

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN682 Advanced Problems

1- 3 credits

Spring Semester

Research and/or design projects through an individual investigation of of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN683 Advanced Problems

1- 3 credits

First Summer Session

Research and/or design projects through an individual investigation of of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN684 Advanced Problems

1- 3 credits

Second Summer Session

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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EEN689

1- 3 credits

Fall Semester

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN690 Advanced Topics in Information Technology

1- 3 credits

Offered By Announcement Only

Subject matter offering in information technology based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN691 Advanced Topics in Information Technology

1- 3 credits

Offered By Announcement Only

Subject matter offering in information technology based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN692 Advanced Topics in Audio Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in audio engineering based upon student demand and availability. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN693 Advanced Topics in Audio Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in audio engineering based upon student demand and availability. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN694 Advanced Topics in Computer Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in computer engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN695 Advanced Topics in Computer Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in computer engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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EEN696 Advanced Topics in Computer Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in computer engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN697 Advanced Topics in Electrical Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in electrical engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN698 Advanced Topics in Electrical Engineering

1- 3 credits

Offered By Announcement Only

Subject matter offerings in electrical engineering based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN699 Advanced Topics

1- 3 credits

Offered By Announcement Only

Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

EEN710 Master's Thesis

1- 6 credits

Fall & Spring Semester

The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

EEN720 Research in Residence

0 credit

Fall & Spring Semester

Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in EEN 710 (usually six credits). Credit not granted. May be regarded as full time residence.

EEN725 Continuous Registration--Master's Study

0 credit

Fall & Spring Semester

To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full time residence.

EEN730 Pre-Candidacy Doctoral Dissertation

1-12 credits

Fall & Spring Semester & First & Second Summer Session

Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of EEN 730 may be taken in a regular semester, nor more than six in a summer session.

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EEN740 Post-Candidacy Doctoral Dissertation

1-12 credits *Fall & Spring Semester & First & Second Summer Session*

Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in EEN 740 may be taken in a regular semester, nor more than six credits in a summer session.

PREREQUISITE: ADMISSION TO CANDIDACY

EEN750 Research in Residence

0 credit *Fall & Spring Semester*

Used to establish research in residence for the Ph.D., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

INDUSTRIAL ENGINEERING

IEN501 Manufacturing Analysis and Design I

3 credits *Offered By Announcement Only*

Analysis of Production Systems stressing diagnosis of problems associated with work measurement, manufacturing methodologies, and their interaction with cost factors.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

IEN502 Manufacturing Analysis and Design II

3 credits *Offered By Announcement Only*

Analysis of production systems stressing diagnosis of problems of quality and production control, utilizing quantitative techniques and analytical methods.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

IEN505 Robotics

3 credits *Fall Semester*

Fundamentals of robotics including kinematics and dynamics, trajectory planning, sensors and actuators, robotic vision, and case studies. Building your own robot is an integral part of hands-on laboratory exercises. Matlab controltoolbox and image analysis toolbox will be extensively used for design and analysis.

PREREQUISITE: IEN 306 OR PERMISSION OF INSTRUCTOR.

IEN507 Design of Manufacturing Systems

3 credits *Spring Semester*

State-of-the-art techniques and tools relevant to the design, analysis, and control of modern manufacturing systems. Topics include modeling of manufacturing systems, tools for manufacturing system analysis, manufacturing system planning and scheduling, and lean manufacturing systems.

PREREQUISITE: IEN 465 OR PERMISSION OF INSTRUCTOR.

IEN509 Automated Assembly

3 credits *Fall Semester*

Fundamentals of automated assembly including parts transfer systems and feeders, parts orientation and grasping techniques, product design for automated assembly (DFA), assembly robots, and performance and economics of assembly systems.

PREREQUISITE: IEN 406 OR PERMISSION OF INSTRUCTOR.

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IEN512 Statistical Quality Control and Quality Management

3 credits

Fall Semester

Principles and practices of quality control in industry. Engineering and administrative aspects of quality control programs, process control, and acceptance sampling. Application of quantitative methods to the design and evaluation of engineering and industrial systems and processes are discussed as well as concepts of Total Quality Management.

PREREQUISITE: IEN 311 (MAS 311) OR IEN 312 (MAS 312).

IEN513 Quality Management in Service Organizations

3 credits

Fall Semester

Course examines the issues of quality and productivity management in the service sector. Topics covered include the development and use of questionnaires, service industry applications of quality such as in banking, insurance, healthcare, transportation, government, public utilities, and retail trade.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

IEN524 Decision Support Systems in Industrial Engineering

3 credits

Spring Semester

Theory and application of decision support systems in industrial engineering. Topics include the study of model-based, data-based, knowledge-based, and communication-based decision support systems. Emphasis is placed on the selection process of the appropriate systems for various decision problems in industrial environments.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

IEN547 Computer Simulation Systems

3 credits

Spring Semester

Computer simulation and the development of simulation models. Application of discrete and continuous system simulation languages to systems studies is also included.

PREREQUISITE: IEN 442 (MAS 442) OR PERMISSION OF INSTRUCTOR.

IEN551 Accident Prevention Systems

3 credits

Spring Semester

Introduction to the basic principles of accident prevention and how to apply the safety engineering approach to the design of industrial accident prevention systems.

PREREQUISITE: IEN 351 OR PERMISSION OF INSTRUCTOR.

IEN557 Ergonomics and Human Factors Engineering

3 credits

Fall Semester

The study of human capacities and limitations with emphasis on human performance in system design. Topics include design of displays and controls, workload, job design, human information processing, anthropometry, workplace design, biomechanics, task analysis, and research techniques in human factors engineering. Lecture, 3 hours.

PREREQUISITE: IEN 312 (MAS 312) OR PERMISSION OF INSTRUCTOR.

IEN558 Industrial Hygiene I

3 credits

Fall Semester

Recognition of occupational chemical health hazards. Evaluation methods and analytical procedures used to determine level of exposure to chemical and toxic hazards. Control measures and compliance with OSHA requirements with special emphasis on industrial ventilation, and other methods of control are included.

PREREQUISITE: ((CHM 111 OR 151) AND SENIOR STANDING) OR PERMISSION OF INSTRUCTOR.

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IEN559 Industrial Hygiene II

3 credits

Spring Semester

Recognition of physical occupational health hazards and evaluation methods and instruments used in measuring exposure levels with special emphasis on physical hazards. Protective measures and compliance with OSHA requirements is also included. Lecture, 3 hours.

PREREQUISITE: ((CHM 111 OR 151) AND SENIOR STANDING) OR PERMISSION OF INSTRUCTOR.

IEN565 Design of Integrated Manufacturing Systems

3 credits

Offered By Announcement Only

The design of integrated manufacturing systems including concepts of production planning and control, forecasting techniques, inventory systems, production planning and scheduling methods, material requirement planning, plant layout and facility location, design principles of material handling, new trends in batch, and discrete-parts are discussed.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

IEN568 Materials Handling and Facilities Planning

3 credits

Spring Semester

Analysis and design of production and service facilities, emphasis on material handling requirements. Capacity requirements, facility location, layout, storage systems and warehousing are discussed.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

IEN570 Engineering Management

3 credits

Spring Semester

Integrating engineering discipline into the social and economic considerations of managing systems. Tools and techniques used by engineering managers including engineering project life cycle, role playing, communication, decision-making in engineering management, and managing change in engineering organizations are discussed.

PREREQUISITE: IEN 311 (MAS 311) OR IEN 312 (MAS 312) OR PERMISSION OF INSTRUCTOR.

IEN571 Engineering Entrepreneurship

3 credits

Spring Semester

The conversion of technological know-how and engineering theories into business enterprises. The role of technology in creating wealth, connecting technology with market, the role and characteristics of entrepreneurs, starting a business and the business plan, innovation, industrial and service organizations, and the new business environment.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

IEN572 Management of Technology

3 credits

Fall Semester & Second Summer Session

Engineering, Science and Management Principles contributing to the development of a successful framework for Managing technology within an organization, nationally, or internationally. The process of technological innovations, technological planning and forecasting, and socio-economic changes.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

IEN590 Special Topics in Industrial Engineering

1- 3 credits

Offered By Announcement Only

Sub-titles describing the topics are shown in parentheses in the class schedule, following the title "Special Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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IEN591 Dean's Seminar: Entrepreneurship

1 credits

Offered By Announcement Only

Weekly seminar given by guest speakers on topics including process of management, marketing, planning, R & D, financing, taxation, governmental regulations, and international commerce.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

IEN594 Master's Capstone Design Project

3 credits

Fall Semester

A capstone design project for students in the five-year BSIE/MSIE program. Integration of Industrial Engineering principles and techniques in the design and improvement of production and service systems is emphasized. Offered for students in this program only.

PREREQUISITE: METHODS ANALYSIS, APPLIED PROBABILITY AND STATISTICS AND SENIOR STANDING.

IEN595 Special Problems

1- 3 credits

Offered By Announcement Only

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

IEN596 Special Problems

1- 3 credits

Offered By Announcement Only

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

IEN599 Cooperative Education

1 credits

Offered By Announcement Only

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

IEN601 Advanced Industrial Engineering Concepts

3 credits

Fall Semester

The application of advanced concepts of Industrial Engineering to modern systems with an emphasis on the solution of real world problems.

PREREQUISITE: IEN 301 OR PERMISSION OF INSTRUCTOR.

IEN607 New Product Development and Introduction

3 credits

Fall Semester

Dynamics of converting ideas into marketable products, selecting products, and defining their specifications to achieve competitive advantage. Product development steps are examined critically in the context of real case studies. Topics include the process of fostering a creative environment for new products and processes, planning for innovation, process of product patenting, organizing the technical effort, integration of functions, risk assessment and evaluation, and management techniques for improving manufacturing operations.

PREREQUISITE: GRADUATE STANDING.

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IEN612 Design of Experiments

3 credits

Fall Semester

Design and analysis of experiments, randomized blocks, Latin Squares, factorials, multiple correlation and regression, and application to response surfaces are discussed. 3 hours.

PREREQUISITE: IEN 311 OR MAS 311 OR EQUIVALENT.

IEN613 Quality Through Planned Experimentation

3 credits

Offered By Announcement Only

Sequential experimentation and guidance on how to build the sequence and use graphical methods to ascertain how much the planned changes contribute to the variation in the data. Experimentation is presented as a system in the context of a model to improve quality, and integrate statistical process control (SPC) with methods of design. Examples presented contain problems often encountered in actual experimentation in a manufacturing or a service facility. Not open to students with credit in IEN 612.

PREREQUISITE: IEN 311 OR PERMISSION OF INSTRUCTOR.

IEN614 Advanced Quality Control

3 credits

Offered By Announcement Only

Advanced topics in variables and attributes acceptance sampling and control charting. Statistical and economical design of control chart and sampling plan. Sampling design and analysis with inspection and measurement errors. Product liability prevention. Value engineering. Quality costs. Metrology. Military standards. Quality manuals. Customer and vendor relations. Total quality control concepts.

PREREQUISITE: IEN 512.

IEN617 Quality Through Design

3 credits

Offered By Announcement Only

The integrated processes and teamwork essential to success with products are presented. All activities of product development are covered. Topics include concept of a new region, concurrent engineering, competitive benchmarking, house of quality, robust design, and production preparation. Special emphasis is placed on the integration of quality function deployment and Taguchi's quality engineering into total development.

PREREQUISITE: IEN 612 or MAS 603.

IEN641 Applied Operations Research

3 credits

Offered By Announcement Only

Inventory theory, queueing theory, optimization models, and linear and dynamic programming for deterministic and probabilistic cases. Emphasis is placed on applications.

PREREQUISITE: IEN 441 OR PERMISSION OF INSTRUCTOR.

IEN642 Linear Programming and Extensions

3 credits

Fall Semester

Formulation, solution, postoptimality analysis of linear programming problems; revised simplex, parametric programming, decomposition of large-scale systems. Use of computer packages. Introduction to integer programming, network flows, and nonlinear programming applications.

PREREQUISITE: LINEAR ALGEBRA OR EQUIVALENT.

IEN643 Integer Programming and Network Flows

3 credits

Offered By Announcement Only

Computationally effective approaches to integer optimization, cutting planes, implicit enumeration, network flows, single commodity, and multi-commodity flows are covered.

PREREQUISITE: MAS 647/ IEN642.

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IEN644 Nonlinear and Dynamic Programming

3 credits

Offered By Announcement Only

Solution of nonlinear optimization problems by classical procedures and search algorithms. Recursive optimization using computationally effective techniques is also included.

PREREQUISITE: MTH 112 OR EQUIVALENT.

IEN645 Stochastic Processes

3 credits

Fall Semester

Introduction to discrete state Markov processes and renewal processes with applications to queueing, replacement, and reliability problems.

PREREQUISITE: MAS 311, IEN 311, MTH 524 OR EQUIVALENT.

IEN646 Queueing Models

3 credits

Offered By Announcement Only

Formulation, solution, and application of models useful in the analysis of waiting lines.

PREREQUISITE: MAS 311, IEN 311, OR MTH 524 OR EQUIVALENT.

IEN651 System Safety Engineering

3 credits

Fall Semester

Understanding system safety, evaluating a system for its state of safety over its life cycle, determining if that state is acceptable, and evaluating counter-measures for their effectiveness in bringing the system to an acceptable state are discussed. Presenting quantitative methods that may be used in safety data analysis is also included.

PREREQUISITE: IEN 311 AND 351.

IEN655 Human Factors in Management of Technology

3 credits

Offered By Announcement Only

Implications of the influx of computer and automation technologies into work settings for behavior within organizations. Human factors issues associated with the implementation of technology including hardware and software design, job design, and workplace design. Organizational issues such as decision-making, communication, and human centered design of products.

IEN656 Human Information Processing and System Design

3 credits

Spring Semester

Understanding the capabilities of humans as information processors in relation to system design, including job and equipment (hardware and software) design. Course topics include attentional capacity, vigilance, mental workload, verbal and non-verbal perception, speech recognition, decision making, skilled performance, human reliability, and process control.

PREREQUISITE: IEN 557.

IEN657 Ergonomics and Occupational Biomechanics

3 credits

Spring Semester

Effects of human factors in the improvement of performance of systems. Human capacities, capabilities, and limitations as derived from anatomical, physiological, and psychological principles are applied to the design of tools and equipment. Incorporation of all factors into systems design to achieve better system performance is emphasized

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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IEN658 Ergonomics and Special Populations

3 credits

Spring Semester

Ergonomic issues relevant to design for older adults and special populations such as the handicapped. Primary emphasis is placed on work environments, transportation and communication systems, and home environments. Topics include cognitive and physiological characteristics of special populations, workplace design, job and equipment design, rehabilitation engineering, clinical ergonomics, and legislation such as the ADA. Lecture, 3 hours.

PREREQUISITE: IEN 557.

IEN659 Work Physiology

3 credits

Offered By Announcement Only

Physiological responses to occupational work including aspects of endurance, fatigue, recovery, and the energy cost of work. Application of work physiology to job design and personnel assignment is included.

PREREQUISITE: IEN 557 OR PERMISSION OF INSTRUCTOR.

IEN660 Productivity Measurement and Evaluation

3 credits

Fall Semester

Basic concepts. Productivity measurement approaches at international, national, industry, and company levels. Latest measurement models for manufacturing companies. Relationships between total and partial productivities, profit and total productivity. Productivity evaluation: theory and methodology.

PREREQUISITE: IEN 360 OR PERMISSION.

IEN661 Engineering Cost Management

3 credits

Fall Semester

Issues of cost management, including activity based costing of engineering projects. A detailed study of how to separate, identify, understand and manage the major activities performed, and how these activities relate to customer needs. Overall view of costs associated with products, processes, and customers.

PREREQUISITE: Graduate standing.

IEN662 Productivity Planning and Improvement

3 credits

Fall Semester

Planning and improvement as part of the productivity cycle. Concepts and tools. Productivity planning and improvement in manufacturing and non-manufacturing companies: technology, materials, employee, product, and task based techniques. The PIP package.

PREREQUISITE: IEN 360 OR PERMISSION.

IEN663 Project Management Techniques

3 credits

Fall Semester

Techniques and Tools in Project Management. Use of network flow techniques including PERT/CPM, planning, systems concepts, time management, conflicts, cost and resource control, tradeoff analysis.

PREREQUISITE: IEN 311 OR EQUIVALENT.

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IEN664 Supply Chain Management

3 credits

Offered By Announcement Only

Supply Chain Management focuses on the flow of products, information, and money throughout the supply chain. An overview of issues, opportunities, tools, and approaches is provided. Emphasis is placed on business processes, system dynamics, control, design and re-engineering, and on the relationship between the supply chain and the company's strategic position relative to its clients and its competition. The dimensions of inter-corporate relationships with partners, including decision-making, incentives, and risk are also covered.

PREREQUISITE: IEN 465 OR PERMISSION OF INSTRUCTOR.

IEN665 Advanced Production Systems

3 credits

Spring Semester

Quantitative, heuristic and computer methods applied to problems of production planning, work force balancing and capacity expansion. Sequencing and scheduling models. Advanced Material Requirements Planning (MRP II). Just In Time production systems (JIT). Master Production Scheduling (MPS). Optimize Production Technology (OPT). KANBAN production planning system. Learning curve theory. Advanced forecasting and time-series analysis.

PREREQUISITE: IEN 465 OR PERMISSION OF INSTRUCTOR.

IEN672 Strategic Management of Technology

3 credits

Fall & Spring Semester

Advanced topics in the management of technology emphasizing the relationship between technology and competitiveness in the global marketplace. Technology development in the U.S., Japan, and Europe, industrial R & D, strategic technological planning, and conditions for successful implementations. Case studies are used with individual and group assignments.

PREREQUISITE: IEN 572 OR PERMISSION OF INSTRUCTOR.

IEN691 Industrial Engineering Seminar

0 credit

Spring Semester

Oral presentation and discussion of current topics in Industrial Engineering.

IEN692 Industrial Engineering Seminar II

0 credit

Spring Semester

Oral presentation and discussion of current topics of Industrial Engineering.

IEN694 Master's Project

3 credits

Fall & Spring Semester

A capstone project for M.S. students in the non-thesis option.

IEN695 Special Problems

1- 3 credits

Offered By Announcement Only

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

IEN696 Special Problems

1- 3 credits

Offered By Announcement Only

Research and/or design projects through an individual investigation. of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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Graduate Course Listing
COLLEGE OF ENGINEERING
INDUSTRIAL ENGINEERING

IEN699 Advanced Topics

1- 3 credits

Offered By Announcement Only

Subject matter offerings based upon student demand and availability of faculty.

Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

PREREQUISITE: PERMISSION OF INSTRUCTOR.

IEN710 Master's Thesis

1- 6 credits

Fall & Spring Semester & First & Second Summer Session

The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

IEN720 Research in Residence

0 credit

Fall & Spring Semester & First & Second Summer Session

Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in IEN 710 (usually six credits). Credit not granted. May be regarded as full time residence.

IEN725 Continuous Registration--Master's Study

0 credit

Fall & Spring Semester & First & Second Summer Session

To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full time residence.

IEN730 Pre-Candidacy Doctoral Dissertation

1-12 credits

Fall & Spring Semester & First & Second Summer Session

Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of IEN 730 may be taken in a regular semester, nor more than six in a summer session.

IEN740 Post-Candidacy Doctoral Dissertation

1-12 credits

Fall & Spring Semester & First & Second Summer Session

Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in IEN 740 may be taken in a regular semester, nor more than six credits in a summer session.

PREREQUISITE: ADMISSION TO CANDIDACY

IEN750 Research in Residence

0 credit

Fall & Spring Semester & First & Second Summer Session

Used to establish research in residence for the Ph.D. and D.A., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

MECHANICAL & AEROSPACE ENGINEERING

MAE501 Methods of Engineering Analysis

3 credits

Fall Semester

Analysis of engineering systems in equilibrium and motion. Examples considered from mechanical, electrical, thermal and fluids engineering. Mathematical theory and computer methods for obtaining numerical solutions are developed for various cases involving discrete and continuous systems. Lecture, 3 hours.

PREREQUISITE: MAE 412, MTH 311 OR PERMISSION OF THE INSTRUCTOR.

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Graduate Course Listing
COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE502 Vibrations

3 credits

Fall Semester

Basic theory of free and forced vibrations of mechanical systems with and without damping. Applications to systems with one and several degrees of freedom are included.
PREREQUISITE: MAE 202, 207, 412 OR PERMISSION OF INSTRUCTOR.

MAE503 Internal Combustion Engines

3 credits

Fall Semester

Course discusses engine types, characteristics, and operation. Topics include performance factors, fuel combustion, power cycles, knock and engine variables, exhaust emissions, fuel metering, compressors, and turbines.
PREREQUISITE: MAE 303, SENIOR STANDING, OR PERMISSION OF INSTRUCTOR.

MAE505 Design for Manufacturability

3 credits

Fall Semester

Manufacturing concerns at design stage. Design theory and methodology. Statistical considerations in geometric dimensioning, tolerances, reliability-based design, and quality control. Producibility, design for assembly, and value engineering. Life cycle costs and optimum design using nonlinear programming and Taguchi approaches. Hands on projects on machine tools.
PREREQUISITE: MAE 341 AND 342 OR CONSENT OF INSTRUCTOR.

MAE506 Nuclear Engineering

3 credits

Offered By Announcement Only

Course topics include a review of neutron physics, chain reactions, reactor theory, steady state operation, and reactor kinetics. Control, long term reactivity changes, materials, heat transfer, and shielding are also included. Lecture, 3 hours.
PREREQUISITE: SENIOR STANDING IN MECHANICAL AND AEROSPACE ENGINEERING OR PERMISSION OF INSTRUCTOR.

MAE507 Advanced Mechanics of Solids

3 credits

Spring Semester

Courses discusses the basic elements of elasticity, plasticity, and viscoelasticity. Application to mechanical systems at rest and in motion are included.
PREREQUISITE: MAE 202, 207, SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

MAE508 Intermediate Heat Transfer

3 credits

Spring Semester

Course discusses steady and unsteady heat transfer by conduction, convective heat transfer in laminar and turbulent fluid flow, natural convection, and heat transfer by radiation.
PREREQUISITE: MAE 310.

MAE509 Hydrogen Energy

3 credits

Fall Semester

Evaluation of new energy sources, need for an intermediary system, hydrogen energy system, hydrogen as energy carrier, hydrogen production methods, hydrogen storage and distribution, utilization of hydrogen by residential, commercial, transportation, and industrial sectors are discussed as well as environmental, safety, and economical considerations.
PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

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COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE510 Fundamentals of Solar Energy Utilization

3 credits

Spring Semester

Fundamentals basic to the design and performance analysis of thermal systems for the capture and utilization of Solar Energy.

PREREQUISITE: MAE 303, MTH 211 AND PHY 207.

MAE511 Engineering Fracture Mechanics

3 credits

Offered By Announcement Only

Course addresses the consequence of fracture including some illustrative applications of fracture mechanics, Griffith's fracture theory, review of relevant results from solid mechanics, the three basic modes of fracture, stress intensity factor, introduction to elasto-plastic and dynamic fracture, fatigue crack propagation, fracture and non-destructive evaluation procedures.

PREREQUISITE: MAE 207, SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

MAE512 Intermediate Fluid Mechanics

3 credits

Fall Semester

Course topics include conservation of mass, momentum, and energy, potential flow, viscous laminar and turbulent flows, the Reynolds analogy, and Boundary-layer approximations. Gas dynamics are also discussed.

PREREQUISITE: MAE 309.

MAE513 Kinematics for Robotics

3 credits

Offered By Announcement Only

Geometry of unconstrained plane motion with applications to linkage design. Topics include type and number synthesis, introduction to 3-D mechanism with applications to robotics, graphical, analytical, and computer techniques, including the use of analysis software.

PREREQUISITE: MAE 202, SENIOR STANDING, OR PERMISSION OF INSTRUCTOR.

MAE514 Advanced Internal Combustion Engines Experimental Studies

3 credits

Spring Semester

Experimental mechanical engineering as it pertains to internal combustion engines. The principal measurements necessary to analyze the operation of an internal combustion engine are covered. Emphasis is placed on experiment planning, data interpretation, and error analysis.

PREREQUISITE: MAE 503 OR PERMISSION OF INSTRUCTOR.

MAE516 Introduction to Composite Materials

3 credits

Offered By Announcement Only

Course provides an introduction to composite materials and terminology. Topics include advantages offered by composite materials, current aerospace, automotive, and bio-mechanics applications, experimental results, analytical models, and effects of impact and fatigue loads. The environment's impact on composite materials' performance and design procedures are discussed. Case studies examining composite materials as efficient replacements are also included.

PREREQUISITE: MAE 207, SENIOR STANDING, OR PERMISSION OF INSTRUCTOR.

MAE517 CAD Applications Using Interactive Computer Graphics

3 credits

Offered By Announcement Only

Computer methods and graphics in the engineering design process. Introduction to available engineering analysis codes, principles of computer graphics, and interactive graphical methods in problem solving. Mathematics for 2-D and 3-D graphical manipulation. Programming project work is required.

PREREQUISITE: SENIOR STANDING OR PERMISSION OF INSTRUCTOR.

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Graduate Course Listing
COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE518 Chemical and Process Engineering A

3 credits

Offered By Announcement Only

Course analyzes single and multi-stage concentration processes in the liquid-solid systems such as crystallization and drying. Processes apart from equilibrium, controlled diffusion, mathematical treatment, and equipment design are also discussed.

PREREQUISITE: MAE 310, 311. COREQUISITE: MAE 508.

MAE519 Chemical and Process Engineering B

3 credits

Offered By Announcement Only

Stagewise equilibrium separation processes in liquid-liquid systems such as distillation, rectification, absorption, and extraction. Application of phase equilibria and balance equations, mathematical treatment, and equipment design.

PREREQUISITE: MAE 310, 311, 308.

MAE520 Air Pollution

3 credits

Spring Semester

Course topics include fundamentals of air pollution, air quality, properties of air pollutants, effect of pollutants on the environment, analysis and modeling, diffusion of pollutants, and air pollution control.

PREREQUISITE: MAE 303, 309/CAE 330 OR PERMISSION OF INSTRUCTOR.

MAE521 Exhaust Emission Control

3 credits

Spring Semester

Course topics include automotive emissions, air pollution, combustion of homogeneous mixtures, emission control systems, Federal emission standards, and emission instrumentation and measurement. Lecture, 2 hours; Laboratory, 3 hours.

PREREQUISITE: SENIOR ENGINEERING STANDING OR PERMISSION OF INSTRUCTOR.

MAE538 Computer-Aided Air Conditioning Design and Energy Management

3 credits

Offered By Announcement Only

Course topics include equipment and components, air conditioning system, all-air systems, air-and-water systems, all water systems, heat recovery systems, cogeneration systems, heat pump systems, central heating and cooling, energy management, and computer applications.

PREREQUISITE: MAE 405 OR 408 OR PERMISSION OF INSTRUCTOR.

MAE539 Heating, Ventilating and Air Conditioning System Design

3 credits

Fall Semester

Course topics include basic HVAC systems, multizone systems, dual-duct systems, terminal reheat systems, variable air volume systems, induction and induction reheat systems, special applications, hydronic systems, unitary and heat pump systems, hydronic heat recovery systems, cooling and heating load calculation duct and piping design, overall system design, and integration.

PREREQUISITE: MAE 405 OR 408 OR PERMISSION OF INSTRUCTOR.

MAE540 Energy Conversion

3 credits

Spring Semester

Course topics include energy conversion, utilization, present and projected consumption of energy, thermodynamic principles, nuclear energy, fission and fusion reactions, hydroelectric power, and solar energy. Alternative energy sources, the hydrogen economy, and the energy-environment-economy system are also discussed.

PREREQUISITE: SENIOR STANDING IN MECHANICAL AND AEROSPACE ENGINEERING OR PERMISSION OF INSTRUCTOR.

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COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE541 Two-Phase Flow Fundamentals and Design

3 credits

Offered By Announcement Only

Course topics include two-phase flow fundamentals for thermal design, heat transfer, pressure drop analysis of two-phase flows in tube and around tube bundles, heat transfer design correlations in boiling, evaporation, and condensation. Classifications of heat vapor generation and vapor condensation, heat exchangers for air-conditioning and refrigeration, enhancement of boiling, condensation, evaporation heat transfer, and fouling of heat exchangers are also discussed. Design examples are included.

PREREQUISITE: MAE 303 AND 310 OR PERMISSION OF INSTRUCTOR.

MAE550 Product Safety Engineering

3 credits

Offered By Announcement Only

Product safety for the designer and the design review process. Topics include hazard analysis of products including use of regulatory and voluntary standards and analytical tools such as fault tree analysis. Constraints imposed by product liability law, design techniques, and process requirements to minimize hazards are also discussed.

PREREQUISITE: SENIOR STANDING IN ENGINEERING OR PERMISSION OF INSTRUCTOR.

MAE551 Special Problems

1- 3 credits

Fall & Spring Semester & First & Second Summer Session

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

MAE552 Special Problems

1- 3 credits

Fall & Spring Semester & First & Second Summer Session

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

MAE570 Aero Propulsion

3 credits

Fall Semester

Definition of the atmosphere, propulsion basics, rocket fundamentals, turbine fundamentals, gas turbine cycles, component matching, math and computer models, aircraft missions, cycle section, reliability, and durability are analyzed.

PREREQUISITE: MAE 303, 309.

MAE571 Introduction to Aerospace Control

3 credits

Spring Semester

Course topics include modeling of Aerospace systems, properties of state space realizations, coordinate transforms solution of state equations, controllability, observability, equivalent realizations, model reduction, stability, optimal control, and estimation.

PREREQUISITE: MAE 415 OR PERMISSION OF INSTRUCTOR

MAE590 Special Topics

1- 4 credits

Fall Semester

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

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MECHANICAL & AEROSPACE ENGINEERING

MAE591 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE592 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE593 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE594 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE595 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE596 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE597 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE598 Special Topics

1- 4 credits

Offered By Announcement Only

Subtitles describing the topics will be shown in parentheses in the class schedule, following the "Special Topics."

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE599 Cooperative Education

1 credits

Fall & Spring Semester & First & Second Summer Session

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

PREREQUISITE: PERMISSION OF DEPARTMENT CHAIRMAN.

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Graduate Course Listing
COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE601 Advanced Heat Transfer--Conduction and Radiation

3 credits

Spring Semester

Advanced analytical methods of solutions of boundary value problems of steady, periodic, and unsteady heat conductions. Topics include techniques of transient point, line, and plane sources and sinks, thermodynamics of radiative equilibrium, radiative exchange, geometrical factors, network, and other methods. Lecture, 3 hours.

PREREQUISITE: MAE 508 OR PERMISSION OF INSTRUCTOR.

MAE602 Advanced Heat Transfer--Convection

3 credits

Spring Semester

The analogy between heat, mass, and momentum transfers. Topics include the transfer mechanism, heat transfer to liquid metals, boiling and condensation mechanisms, heat transfer in two-phase flow, ablation heat transfer, transpiration, film cooling, and heat exchanges. Lecture, 3 hours.

PREREQUISITE: MAE 508 OR PERMISSION OF INSTRUCTOR.

MAE605 Finite Element Methods in Mechanical and Aerospace Engineering

3 credits

Spring Semester

Finite-element analysis methods for static and dynamic analysis of mechanical and aerospace structures, heat transfer analysis, and fluid flow applications. Primary emphasis is placed on underlying mechanics and numerical techniques. Consideration is also given to the use of existing programs, such as ANSYS, NASTRAN and FIDAP, designing proper meshes, and choosing the proper element. A term project is included.

PREREQUISITE: MAE 501, 507 OR PERMISSION OF INSTRUCTOR.

MAE606 Experimental Methods in Fluid Mechanics

3 credits

Offered By Announcement Only

Course topics include methods of flow visualization, laser techniques in measurement of wall motions, conduit compliance, Newtonian and non-Newtonian properties of fluids, measurement of unsteady flow and pressure, laser Doppler anemometry, ultrasound Doppler velocimetry, electro-magnetic flowmetry, measurement of steady and unsteady wall shear stresses and boundary layers.

PREREQUISITE: ADVANCED STANDING IN FLUID MECHANICS.

MAE610 Fluid Dynamics in Porous Media

3 credits

Offered By Announcement Only

Course discusses the properties and principles of flow in porous media. Topics include groundwater flow, with reference to transpiration cooling, use of flow nets for the computation of the velocity field, and how geohydrology affects groundwater flow. Groundwater resource evaluation, groundwater contamination, and discussion of field data are included.

PREREQUISITE: MAE 512, OR CAE 630.

MAE611 Gas Dynamics

3 credits

Offered By Announcement Only

Course analyzes one-dimensional compressible flow with effects of area change, friction, heat transfer, and combustion. Supersonic diffusers, wind tunnels, compression shocks, and methods of small perturbations are also discussed.

PREREQUISITE: MAE 512.

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COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE612 Viscous Fluid Flow

3 credits

Spring Semester

Course discusses derivations and exact solutions of Navier-Stokes equations, approximations at low Reynolds numbers and low Mach numbers, boundary layer theory, stability, and turbulence. Lecture, 3 hours.

PREREQUISITE: MAE 512.

MAE613 Transport Phenomena

3 credits

Offered By Announcement Only

Course topics include laws of molecular transfer, the kinetic theory explanation of molecular transfer phenomena, introduction to turbulence, and molecular transfer in laminar and turbulent flows with experimental results. A unified treatment of salient aspects of momentum, heat, and mass transfer including the relationship between rate and conservation equations are also discussed.

PREREQUISITE: MAE 309, MTH 311 OR PERMISSION OF INSTRUCTOR.

MAE614 Computational Fluid Dynamics

3 credits

Spring Semester

Incompressible flow equations in rectangular co-ordinates. Topics include basic computational methods for incompressible flow, three dimensional flows, compressible flow equations in rectangular coordinates, basic computational methods for compressible flows, treatment of shocks, artificial viscosities, convergence, other mesh systems, programming, testing, and information processing.

PREREQUISITE: MAE 512.

MAE615 Turbulence

3 credits

Offered By Announcement Only

The nature and origin of turbulence. Topics include turbulent transport of momentum and heat, dynamics of turbulence, Boundary-free shear flows, Wall-Bounded shear flows, statistical description of turbulence, turbulent transport, Spectra dynamics, and methods and techniques of measurements in turbulent flows.

PREREQUISITE: MAE 512.

MAE620 Linear Robust Control

3 credits

Offered By Announcement Only

Analysis of multivariable systems in the frequency domain. Topics include norms on signals and systems, uncertainty models, closed loop transfer matrices for performer specifications, role of weighting matrices, and synthesis of Robust controllers in State-Space.

PREREQUISITE: EEN 518 OR PERMISSION OF INSTRUCTOR.

MAE625 Advanced Aerospace Structures

3 credits

Offered By Announcement Only

Elastic analysis of aerospace structures. Topics include failure modes and criteria, buckling, matrix methods for analysis, plane truss design, Energy and Castigliano methods for statically indeterminate structures, and torsion and bending of asymmetrical thin-walled open and closed sections. The use of computer packages to solve moderately sized problems of analysis and design of trusses, plane frames, torsion, plane stress, and combinations structures is also included.

PREREQUISITE: MAE 470 OR 507 OR PERMISSION OF INSTRUCTOR.

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COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE630 Mechanical Systems Optimization

3 credits

Spring Semester

Optimization as an element of the engineering design process. Topics include comparative examination of unconstrained algorithms, as well as development and application of methods for constrained optimization problems. Case studies which demonstrate the theory and application of mathematical programming as a design tool are also included.

PREREQUISITE: MAE 501 OR PERMISSION OF INSTRUCTOR.

MAE635 Expert Systems in Mechanical and Aerospace Engineering

3 credits

Offered By Announcement Only

Application of artificial intelligence techniques to problem solving in Mechanical Engineering. Coverage of AI programming languages and paradigms, expert systems technology, as well as applications of expert system to the processes of design, operations, maintenance, and simulation are included.

PREREQUISITE: MAE 501 OR PERMISSION OF INSTRUCTOR.

MAE640 Continuum Mechanics

3 credits

Fall Semester

Course discusses concepts that are common to all continuous media. Topics include elements of tensor analysis, motion, deformation, vorticity, material derivatives, mass and the continuity equation, and balance of linear and angular momentum as well as energy. Stress and its geometric characterization, constitutive equations of solid and fluid type behavior, virtual work, fundamental applications, and the Clausius-Duhem inequality are also covered.

PREREQUISITE: MAE 507 OR 512 OR PERMISSION OF THE INSTRUCTOR.

MAE641 Vibration of Continuous Systems

3 credits

Fall Semester

Mathematical modeling and formulation of continuous vibration problems. Exact and approximate analytical methods of solution. Numerical methods of solution. Case studies and current literature on vibration of continuous systems.

PREREQUISITE: MAE 502 OR CONSENT OF INSTRUCTOR.

MAE651 Master's Project

3 credits

Fall & Spring Semester & First & Second Summer Session

A required project for M.S. students in the non-thesis option.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE652 Master's Capstone Project

4 credits

Fall & Spring Semester & First & Second Summer Session

A required project for the five year BSME/MSME program.

PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE680 Graduate Colloquium

0 credit

Fall & Spring Semester

Presentations by selected speakers of weekly programs dealing with topics of interest in Mechanical Engineering. Attendance is required of all students registered in Mechanical Engineering graduate programs.

PREREQUISITE: GRADUATE STANDING.

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COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE692 Special Problems

1- 3 credits *Fall & Spring Semester & First & Second Summer Session*
Research and/or design projects consisting of individual investigation of current problems. Offered by special arrangement only.
PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE697 Advanced Topics

1- 3 credits *Offered By Announcement Only*
Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".
PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE698 Advanced Topics

1- 3 credits *Offered By Announcement Only*
Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".
PREREQUISITE: PERMISSION OF INSTRUCTOR.

MAE710 Master's Thesis

1- 6 credits *Fall & Spring Semester & First & Second Summer Session*

MAE710 Master's Thesis

1- 6 credits *Fall Semester*
The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

MAE720 Research in Residence

0 credit *Fall & Spring Semester & First & Second Summer Session*

MAE720 Research in Residence

0 credit *Fall Semester*
Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in MAE 710 (usually six credits). Credit not granted. May be regarded as full time residence.

MAE725 Continuous Registration--Master's Study

0 credit *Fall Semester*

MAE730 Pre-Candidacy Doctoral Dissertation

1-12 credits *Fall & Spring Semester & First & Second Summer Session*
Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of MAE 730 may be taken in a regular semester, nor more than six in a summer session. six in a summer session.

MAE740 Post-Candidacy Doctoral Dissertation

1-12 credits *Fall & Spring Semester & First & Second Summer Session*
Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in MAE 740 may be taken in a regular semester, nor more than six credits in a summer session.
PREREQUISITE: ADMISSION TO CANDIDACY

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COLLEGE OF ENGINEERING
MECHANICAL & AEROSPACE ENGINEERING

MAE750 Research in Residence

0 credit

Fall Semester

Used to establish research in residence for the Ph.D. and D.A., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.