

### **EE 101 CREATIVITY AND DESIGN IN ELECTRICAL AND COMPUTER ENGINEERING. (3)**

This course provides an introduction to the process and application of creative design and problem solving within science and engineering. Emphasis is placed on applications and case studies in the areas of electrical and computer engineering. Several laboratory-based engineering problems are used to provide practical settings in which to apply and evaluate constraint- and product-focused strategies for creative design and problem solving. In addition to technical and aesthetic considerations, ethical and cultural influences on the creative process will also be discussed.

### **EE 167 FUNDAMENTALS OF NANOTECHNOLOGY AND APPLICATIONS IN RENEWABLE ENERGY. (3)**

In 6 lecture modules and 4 observational visits to laboratories on UK campus, this course covers: effects of small size (1 nm to 100 nm) on the electro-optical properties of materials; fundamental principles of quantum mechanics; applying quantum mechanics to understand the changes in material properties like color, luminescence and electrical conductance at nanoscale; operating principles, basic theory and design issues in solar cells; nanotechnology applications for enhancing the performance of renewable energy generation and storage systems, especially solar cells and batteries. Prereq: Proficiency in mathematics, physics and chemistry at the high school graduate level.

### **EE 211 CIRCUITS I. (4)**

Fundamental laws, principles and analysis techniques for DC and AC linear circuits whose elements consist of passive and active components used in modern engineering practice including the determination of steady state and transient responses. In addition to the required text book, additional materials including a portable Oscillator & Signal Generator, a digital Multimeter, an electronics-part kit, and a simulation software are required for at-home laboratory assignments. Prereq: MA 114, prereq or concurrent; PHY 232, 242.

### **EE 221 CIRCUITS II. (3)**

Analysis and design methods for analog linear circuits whose elements consist of passive and active components used in modern engineering practice, including transfer functions, network parameters, and a design project involving modern design practices. Prereq: EE 211. Concur: MA 214.

### **EE 222 ELECTRICAL ENGINEERING LABORATORY I. (2)**

Laboratory exercises in the use of measuring instruments. Experiments in R-L-C circuit analysis. Lecture, one hour; laboratory, three hours. Prereq or concur: EE 221.

### **EE 223 AC CIRCUITS. (4)**

Analysis and design methods for analog linear circuits whose elements consist of passive and active components used in modern engineering practice, including transfer functions, network parameters, and a design project and laboratory experiments involving modern design practices. Prereq: EE 211. Concurrent: MA 214.

### **EE 280 DESIGN OF LOGIC CIRCUITS. (3)**

Boolean algebra; combinational logic circuits; synchronous sequential circuits; asynchronous sequential circuits; design problems using standard integrated circuits. Prereq: CS 115 or EGR 102.

### **EE 281 LOGICAL DESIGN LABORATORY. (2)**

A laboratory involving the design and implementation of logic circuits. Combinational and sequential (both synchronous) design examples using small and medium scale integrated circuits. Lecture, one hour; laboratory, one three-hour session. Prereq: EE 280.

### **EE 282 DIGITAL LOGIC DESIGN. (4)**

Boolean algebra; number systems; combinational logic circuits; synchronous sequential circuits; asynchronous sequential circuits; design problems using digital logic. Laboratory experiments reinforce the course content. Lecture, three hours; laboratory, one three-hour session. Prereq: EGR 102 or equivalent programming course. (Same as CPE 282.)

### **EE 287 INTRODUCTION TO EMBEDDED SYSTEMS. (4)**

Introduction to Embedded Systems teaches students how to use microcontrollers to interact with the physical world. Lectures will cover the theory behind microcontroller architecture, programming, and interfacing and lab projects will back up that theory with hands-on design experiments using microcontrollers. Topics include assembly language and high-level language programming, address decoding, hardware interrupts, parallel and serial interfacing, analog I/O, and basic real-time processing. Prereq: EE/CPE 282 and prereq or concur: CS 215 or consent of instructor. (Same as CPE 287.)

### **EE 305 ELECTRICAL CIRCUITS AND ELECTRONICS. (3)**

A service course covering electrical engineering principles for engineering or science students with majors outside of electrical engineering. Topics include: AC and DC circuits analysis. Prereq: MA 114, PHY 232.

### **EE 360 INTRODUCTION TO SEMICONDUCTOR DEVICES. (3)**

Electronic properties of solid-state materials and calculation of charge carriers in semiconductors; structure and physical model of p-n junctions and various diode devices, bipolar transistors, field effect transistors; semiconductor fabrication technologies and microelectronics manufacturing issues. Prereq: PHY 232 and CHE 105.

### **EE 380 COMPUTER ORGANIZATION. (3)**

Hardware and software organization of a typical computer; machine language and assembler language programming, interfacing peripheral devices, and input-output programming; real-time computer applications, laboratory included. Prereq: Engineering standing, CS 215 and EE/CPE 282 or EE 280. (Same as CPE/CS 380.)

### **EE 383 INTRODUCTION TO EMBEDDED SYSTEMS. (3)**

A course in the hardware and software of microprocessors. Assembly language programming, address decoding, hardware interrupts, parallel and serial interfacing with various special purpose integrated circuits. Each student is expected to do homework assignments using microprocessor hardware. Prereq: EE 280 and EE/CS 380. (Same as CS 383.)

### **EE 391 UNDERGRADUATE RESEARCH EXPERIENCE. (1)**

Research project or activity led by an engineering faculty member, designed to provide students research experience. Completion of this course requires that the student submit a report overviewing activities of the student and summarizing the experience. Course may be repeated to a maximum of three credit hours. Prereq: Submission of approved learning plan and approval of department.

### **EE 395 INDEPENDENT WORK IN ELECTRICAL ENGINEERING. (1-6)**

Special research and problems for individual students who are capable of pursuing independent investigations. May be repeated to a maximum of six credits. Prereq: Consent of instructor.

### **EE 396 COMMUNITY OR CAMPUS EXPERIENTIAL LEARNING. (1)**

This course credit recognizes extensive involvement by a student in a campus organization or community organization. This involvement may be leadership or responsibility for significant substantial portions of a project or event. Enrollment in this course requires a Learning Plan developed by the student and a faculty advisor (such as the organization faculty advisor, for campus organizations). The Learning Plan must be approved by the Director of Undergraduate Studies. The plan should include a list of learning objectives, and a list of readings or other curricular materials that will be read related to the experience. Successful completion of the course requires that the student submit a report, covering an overview of activities and responsibilities of the student during the experience, and a reflective statement on lessons learned during the experience. These lessons learned may be in regards to leadership, team interactions, project management, or technical aspects of a project. The report must be approved by the designated advisor and the DUS, or his/her delegate. Course may be taken on a pass-fail basis only and may be repeated to a maximum of three credit hours. Prereq: Submission of acceptable learning plan and approval of department.

### **EE 402G ELECTRONIC INSTRUMENTATION AND MEASUREMENTS. (3)**

Elementary treatment of electronic circuits emphasizing laboratory work. Topics include AC circuits, filters, theory and operation of transistors and other semiconductor devices and a simple treatment of operational amplifiers. Lecture, two hours per week; laboratory, three hours per week. Prereq: PHY 242 or EE 305 or consent of instructor. (Same as PHY 402G.)

### **EE 415G ELECTROMECHANICS. (3)**

Study of electric machines and electromechanical systems. Prereq: Engineering standing, EE 221 with a C or better, and PHY 232.

### **EE 416G ENERGY CONVERSION LABORATORY. (2)**

Laboratory practice and experimental studies related to EE 415G. Lecture one hour; laboratory, three hours. Prereq or concur: EE 415G.

### **EE 421G SIGNALS AND SYSTEMS. (3)**

An introduction to continuous and discrete signal and system models and analyses. Topics include discrete and continuous convolution, Fourier transforms, and Laplace transforms and Z-transforms with application examples including AM modulation and the sampling theorem. Prereq: Engineering standing, MA 214 and a C or better in EE 221.

**EE 422G SIGNALS AND SYSTEMS LABORATORY. (2)**

Lectures and laboratory exercises on signal and systems modeling. Topics include noise models and analysis, filter design, modulation techniques, sampling, discrete Fourier Transforms, State Variable Models, and feedback design with an emphasis on using computer software for analysis and simulation. Prereq: EE 421G, MA 320.

**EE 461G INTRODUCTION TO ELECTRONICS. (3)**

Analysis and design of electronic circuitry incorporating nonlinear electronic elements such as transistors, FET's, and vacuum tubes. Applications to amplifiers. Prereq: Engineering standing and a grade of C or better in EE 221.

**EE 462G ELECTRONIC CIRCUITS LABORATORY. (2)**

Experimental exercises in the design and analysis of useful electronic circuits incorporating semiconductor devices: transistors, tunnel and Zener diodes; also, vacuum tubes, integrated circuits and operational amplifiers. Lecture, one hour; laboratory, three hours. Prereq: EE 222 and EE 461G.

**EE 468G INTRODUCTION TO ENGINEERING ELECTROMAGNETICS. (4)**

Applications of electromagnetic theory; electrostatic and magnetostatic fields; Maxwell's field equations; plane waves; transmission lines and waveguides; antennas and radiation. Prereq: Engineering standing and MA 213; prereq or concur: EE 221.

**EE 480 ADVANCED COMPUTER ARCHITECTURE. (3)**

This course focuses on advanced computer architectures and low-level system software. Topics include RISC architectures, vector and multiprocessor architectures, multiprocessor memory architectures, and multiprocessor interconnection networks. Peripheral devices such as disk arrays, NICs, and video/audio devices are covered. Topics also include device drivers, interrupt processing, advanced assembly language programming techniques, assemblers, linkers, and loaders. Prereq: CPE/CS/EE 380. (Same as CPE 480 and CS 480G.)

**EE 490 ECE CAPSTONE DESIGN I. (3)**

The first semester of a two-semester design sequence for senior students in electrical engineering with an emphasis on the engineering process. Topics important in product design and manufacturing are included, including considerations of economics, safety, and communication. Students are expected to formally propose a design project that includes a problem definition that incorporates engineering standards and realistic constraints. Students work in teams to develop and complete the designs. Lecture, two hours; laboratory, three hours per week. Prereq: Engineering standing and completion of all other required 400-level EE/CPE courses, excluding EE/CPE 491. (Same as CPE 490.) This course is a Graduation Composition and Communication Requirement (GCCR) course in certain programs, and hence is not likely to be eligible for automatic transfer credit to UK.

**EE 491 ECE CAPSTONE DESIGN II. (3)**

The second semester of a two-semester design sequence for senior students in electrical engineering with an emphasis on the engineering process. Students work in teams to develop and complete the designs. Topics to include engineering ethics, design, documentation, and communication. Prereq: EE/CPE 490 completed in the previous semester and Engineering standing. (Same as CPE 491.)

**EE 503 POWER ELECTRONICS. (3)**

Study of solid-state power electronic devices and their applications. Examination of control philosophies, steady-state models, and numerical simulation of characterizing differential equations. Current topics of interest from the literature. Prereq: EE 415G and EE 461 or consent of instructor.

**EE 511 INTRODUCTION TO COMMUNICATION SYSTEMS. (3)**

An introduction to the basic signal processing operations in communications systems. Topics include frequency and time domain signal and system representation, random signals, modulation, sampling, pulse modulation, information theory. Prereq: EE 421G, MA 320, and engineering standing.

**EE 512 DIGITAL COMMUNICATION SYSTEMS. (3)**

A treatment of the basic signaling concepts involved in the communication of digital information. Topics include transmission requirements and distortion of digital signals; discrete amplitude, frequency, and phase modulation; error control coding. Prereq: EE 421G, EE 422G, engineering standing or consent of instructor.

### **EE 513 AUDIO SIGNALS AND SYSTEMS.**

**(3)**

An introduction to digital signal processing and classification methods for audio signals. Topics include signal analysis and system design using correlation functions, power spectra, difference equations, and transfer functions; implementations of filters, classifiers, and audio effects; characteristics and modeling of common audio signals such as speech, music, and noise. Prereq: EE 422G, engineering standing.

### **EE 517 ADVANCED ELECTROMECHANICS.**

**(3)**

Dynamics of electromechanical systems and rotating electrical machines. Applications of electro-magnetic theory to electrical machines. Certain special topics of current interest. Prereq: EE 415G, EE 421G, and engineering standing.

### **EE 518 ELECTRIC DRIVES.**

**(3)**

Introduction to common power electronic converters used in electric motor drives. Steady-state analysis methods for electric machines fed by power conditioning converters. Performance prediction of electric machines by electromagnetic field theory and by coupled oil models. Prereq: EE 415G, EE 421G, and engineering standing.

### **EE 521 INTRODUCTION TO WIRELESS COMMUNICATIONS.**

**(3)**

Study of analog RF electronics for wireless communications through a combination of course and laboratory work. Topics covered in the course include: modulation/demodulation, filters, RF transformers, mixers, transistor switches and amplifiers, class A, B, AB, C, D, E, and F amplifiers, quartz crystals, transmission lines, impedance inverters, acoustics, oscillators, audio circuitry, noise and inter-modulation, and antennas. Prereq: Engineering standing.

### **EE 522 ANTENNA DESIGN.**

**(3)**

Principles of radiation, potential solution to Maxwell's equations for current in empty space, electrically small antennas, antenna arrays, wire antenna principles, introduction to numerical methods, aperture antennas, frequency scaling antennas, receiving properties of antennas, antenna measurement techniques. Prereq: EE 468G and engineering standing.

### **EE 523 MICROWAVE CIRCUIT DESIGN.**

**(3)**

Physical and mathematical descriptions of wave propagation in guided structures; microstrip lines; microwave integrated circuits; passive components; two-terminal devices; four-terminal devices; S-parameter concept; equivalent circuit concept; solid state microwave amplifiers and oscillators. Prereq: EE 468G and engineering standing.

### **EE 524 SOLID STATE PHYSICS.**

**(3)**

Introductory solid state physics with emphasis on the properties of electrons in crystals; crystal structure, crystal diffraction, reciprocal lattice, lattice vibrations and phonons, free electron theory, energy bands in solids, semiconductors. Prereq: PHY 520, or consent of instructor. Engineering standing required for EE 524. (Same as PHY 524.)

### **EE 525 NUMERICAL METHODS AND ELECTROMAGNETICS.**

**(3)**

This course covers the basics of numerical methods and programming with applications in electromagnetics. Examples range from statics to radiation/scattering problems involving numerical solutions to integro-differential and finite difference equations. Prereq: EE 468G and engineering standing, or consent of instructor.

### **EE 526 LEAN OPERATIONS MANAGEMENT.**

**(3)**

This course will cover topics in basic lean system operations as well as the management system to support the attainment of highest customer satisfaction with respect to Safety, Quality, Cost, Productivity, Delivery and Human Resource Development. Working in teams, students apply fundamental lean tools and concepts to develop a lean operations environment capable of driving continuous improvement in a simulated factory. As the operational environment evolves, key management principles and tools are explored using the teachings of Taiichi Ohno and others considered to be the pillars of the Toyota Production System. All students must have a webcam and microphone or headset to participate in on-line team and class meetings. Prereq: Enrollment restricted to junior-level or above students. Prior enrollment in the Lean Student certificate course or MFS 503 is required or with the consent of the instructor. (Same as ME 526/MFS 526.)

### **EE 527 ELECTROMAGNETIC COMPATIBILITY.**

**(3)**

Design of electronic systems to minimize 1) emission of electromagnetic signals that cause interference in other electronic systems, 2) the susceptibility of that system to electromagnetic signal from other electronic systems, and 3) the susceptibility of that system to its own, internally generated signals. A set of brief laboratory experiments demonstrate the design principles and provide familiarity with modern test equipment. Prereq: EE 468G and engineering standing.

### **EE 528 AUTOMOTIVE BODY WELDING. (3)**

The objective of this course is to introduce students to automotive Body Production Engineering (BPE). The course will introduce students to the joining methods to produce subassemblies and the main body assembly. The course will cover joining methods, joining theory, quality assessment, and design of experiment to prove welding joints. Prereq: Engineering Standing and enrollment in the Production Engineering Certificate.

### **EE 531 ALTERNATIVE AND RENEWABLE ENERGY SYSTEMS. (3)**

Study of non-traditional, electric generating systems, and the use of renewable energy sources. Energy sources include solar, wind, hydro, and biomass/biogas. Generating technologies include both inverter based equipment and rotating machinery. Prereq: EE 415G, Engineering Standing or consent of instructor.

### **EE 532 SMART GRID: AUTOMATION AND CONTROL OF POWER SYSTEMS. (3)**

This course covers introduction to smart grid, key technologies in transmission and distribution systems that enable smart grid, power market structure, and real time pricing. Prereq: Engineering standing, or consent of instructor.

### **EE 533 ADVANCED POWER SYSTEM PROTECTION. (3)**

This course teaches philosophies for protecting power systems, covers micro-processor based relays, and provides projects on relay setting and relay testing. Prereq: Engineering standing, or consent of instructor.

### **EE 535 POWER SYSTEMS: GENERATION, OPERATION, AND CONTROL. (3)**

This course covers essential aspects of the energy management system of power systems. Will cover topics: power system economics, state estimation, power system stability, power quality, and fault location. Prereq: EE 537 or concurrent, and Engineering Standing.

### **EE 536 POWER SYSTEM FAULT ANALYSIS AND PROTECTION. (3)**

This course teaches computer based methods for performing fault analysis of power systems, and principles for protecting power systems. Prereq: EE 537, or concurrent, and Engineering Standing.

### **EE 537 ELECTRIC POWER SYSTEMS I. (3)**

A study of power flow, elements of power factor correction, the one-line diagram, the per-unit system, transformer modeling, generator modeling, transmission line modeling, transmission line performance calculations from equivalent circuits, and general methods for network calculations. Prereq: Engineering standing, or consent of instructor.

### **EE 538 ELECTRIC POWER SYSTEMS II. (3)**

Introduction to modern power system practices, basic transient and steady-state stability analysis with emphasis on digital techniques. Prereq: Engineering standing and consent of instructor.

### **EE 539 POWER DISTRIBUTION SYSTEMS. (3)**

Study of electric utility distribution power systems. Topics include configurations, equipment, customer class data, load flow, phase balancing, capacitor placement, system protection, power quality, and distributed generation. Prereq: EE 537, engineering standing or consent of instructor.

### **EE 543 SOLAR CELL DEVICES AND SYSTEMS FOR ELECTRICAL ENERGY GENERATION. (3)**

Physics of photovoltaic (PV) devices, emerging technologies, design of PV cells and systems, electronic components for signal conditioning, integration, installation, performance evaluation and economic issues related to PV systems. Prereq: EE 211 or EE 305 and Engineering Standing, or consent of instructor. (Same as BAE 543/EGR 543.)

### **EE 546 ELECTRIC POWER SYSTEM FUNDAMENTALS. (3)**

Introduction to power transmission basics, power system components, power flow, fault analysis and protection, control, stability, and economic operation of the power grid. This course will also introduce modern trends such as distributed generation, communications, and cybersecurity. Prereq: Graduate or engineering standing and EE 221, EE 305, or equivalent. (Same as EGR 546.)

### **EE 555 INTRODUCTION TO MICRO-/NANO-ELECTROMECHANICAL SYSTEMS. (3)**

This course provides an overview of micromachined structures with an emphasis on operational theory and fabrication technology. Prereq: Engineering standing or consent of instructor. (Same as ME/MSE 555.)

## EE

## Electrical Engineering

### EE 560 SEMICONDUCTOR DEVICE DESIGN. (3)

Theory, development and discussion of equivalent circuit models of transistor devices, negative resistance, semiconductor devices and praetersonic devices based on electronic processes in solid state elements. High and low frequency, as well as the Ebers-Moll and charge control switching models and their application in computerized electronic circuit analysis will be developed. Prereq: EE 461G or equivalent, and engineering standing.

### EE 562 ANALOG ELECTRONIC CIRCUITS. (3)

Feedback amplifiers, tuned and untuned amplifiers, oscillators, AM and FM transmitters. Prereq: EE 360, EE 461G and engineering standing.

### EE 566 ENGINEERING OPTICS. (3)

Fundamentals of geometrical and physical optics; applications as related to problems in engineering design and research, details of some optical measurement techniques; introduction to lasers; techniques for determining optical properties. Prereq: Engineering standing. (Same as ME 560.)

### EE 567 INTRODUCTION TO LASERS AND MASERS. (3)

Basic principles of laser action; atomic transitions; population inversion; two and three level systems; optical resonators; pumping methods; applications. Prereq: EE 360, EE 468G, or PHY 417G, or consent of instructor. (Same as PHY 567.)

### EE 568 FIBER OPTICS. (3)

The course presents theory and practice related to (a) fiber optic cable and their fabrication, (b) fiber optic transmitters and detectors, (c) fiber optic communication systems and (d) fiber optic remote sensors. Prereq: EE 468G. (Same as MSE 568.)

### EE 569 ELECTRONIC PACKAGING SYSTEMS AND MANUFACTURING PROCESSES. (3)

Study of packaging systems which interconnect, support, power, cool, protect, and maintain electronic components. The course will address systems at the chip, board, and product levels. Topics include design, properties, materials, manufacture, and performance of various packaging systems. Laboratory will provide familiarity with design software and production equipment and processes. Prereq: EE 211 or EE 305, EE 360 or MSE 402G, or consent of instructor. (Same as MSE 569.)

### EE 570 FUNDAMENTALS OF NANOELECTRONIC DEVICES AND MATERIALS. (3)

Energy bonds in crystals; heterostructures; quantum wells and low dimensional systems; the two-dimensional electron gas and MODFET; transmission in nanostructures; current topics in nanoscale devices. Prereq: EE 360 and engineering standing, or consent of instructor. (Same as ME/MSE 570.)

### EE 571 FEEDBACK CONTROL DESIGN. (3)

System representation via transfer function and state variables, root locus analysis; Bode plots; compensation by root-locus and frequency response methods; state variable feedback; sensitivity analysis; tracking via output feedback; digital control systems. Prereq: EE 421G, EE 422G, engineering standing, and consent of instructor.

### EE 572 DIGITAL CONTROL OF DYNAMIC SYSTEMS. (3)

Zero and first order hold, theory of analog to digital and digital to analog conversion. Z-transform analysis, discrete state variable analysis, discrete estimation techniques, error analysis of discrete systems. Prereq: EE 422G, engineering standing.

### EE 575 INDUSTRIAL CONTROL. (3)

Control technologies for industrial and process control systems, including sensors, actuators, PLCs, and hydraulic and pneumatic control elements. Prereq: Engineering standing or graduate standing.

### EE 576 CYBERSECURITY. (3)

This course focuses on technologies in protecting infrastructure, networks, programs and data from unintended or unauthorized access, change or destruction. It provides a survey of latest developments in cyber-security through study of theoretical foundation and hands-on practical implementation. Topics include basic security technology, cryptography, security management, risk assessment, operations and physical security, software and network security, as well as ethical and legal issues. Prereq: CS 270 and EE 380 or consent of instructor.

### **EE 579 NEURAL ENGINEERING: MERGING ENGINEERING WITH NEUROSCIENCE. (3)**

A multidisciplinary approach combining engineering principles for systems analysis and control, knowledge of biological control mechanisms, and computational properties of biological neural networks in the development of engineering neural networks for control applications. Topics include: equivalent circuit models for biological neurons and networks, non-linear differential equation representations, biological control strategies for rhythmic movements, design and development of controller for robot function, proposal development and presentation. Prereq: EE 422G and Engineering Standing or consent of instructor. (Same as BME 579.)

### **EE 580 EMBEDDED SYSTEM DESIGN. (3)**

Embedded System Design covers the design and implementation of hardware and software for embedded computer systems. Topics include architectural support for embedded systems, power management, analog and digital I/O, real-time processing design constraints and the design of embedded systems using a real-time operating systems. Prereq: EE/CPE 287, EE/CPE 380, and engineering standing or consent of instructor. (Same as CPE 580.)

### **EE 582 HARDWARE DESCRIPTION LANGUAGES AND PROGRAMMABLE LOGIC. (3)**

A study of hardware description languages including netlists, VHDL and Verilog; their use in digital design methodologies including modeling techniques, design verification, simulation, synthesis, and implementation in programmable and fabricated logic media. Programmable logic topics include CPLD and FPGA architectures, programming technologies and techniques. Prereq: EE/CS 380 and engineering standing.

### **#EE 583 INDUSTRIAL ENERGY UTILIZATION AND ASSESSMENT. (3)**

This course considers energy use in industrial settings – including energy flows and energy transformations. Students will learn methodologies for assessing, analyzing, and reducing energy use and cost in industrial facilities and auxiliary equipment. The content presented in this course is intended to be consistent with the US Department of Energy Industrial Assessment Center program methods. Students will learn how to perform energy assessments in real engineering settings. Prereq: Engineering standing or consent of instructor. (Same as BAE 583/EGR 583/ME 583/MFS 583.)

### **EE 584 INTRODUCTION OF VLSI DESIGN AND TESTING. (3)**

Introduction to the design and layout of Very Large Scale Integrated (VLSI) Circuits for complex digital systems; fundamentals of the VLSI fabrication process; and introduction to VLSI testing and structured design for testability techniques. Prereq: Engineering standing or consent of instructor. (Same as CPE 584.)

### **EE 585 FAULT TOLERANT COMPUTING. (3)**

Students in this course study the theory and practice of fault-tolerant and dependable computing systems. The course will introduce sources of faults, error and failures in computer controlled systems and approaches to design masking and recovery techniques at the hardware, software, and systems level. Prereq: EE/CPE 380 and engineering standing or consent of the instructor. (Same as CPE 585.)

### **EE 586 COMMUNICATION AND SWITCHING NETWORKS. (3)**

Fundamentals of modern communication networking and telecommunications, data transmission, multiplexing, circuit switching networks, network topology routing and control, computer communication, packet switching networks, congestion control, frame relay, ATM switching networks, traffic and congestion control. Prereq: EE/CPE 282 and engineering standing. (Same as CPE 586.)

### **EE 587 ADVANCED EMBEDDED SYSTEMS. (3)**

An advanced course in the design of embedded systems using state-of-the art microcontroller hardware and software development tools. Topics include architecture support for real-time operating systems, language support for embedded and real-time processing, embedded and wireless networking. Prereq: EE/CPE 580 and engineering standing or consent of instructor. (Same as CPE/CS 587.)

### **EE 588 REAL-TIME COMPUTER SYSTEMS. (3)**

This course covers features typically found in real-time and embedded systems. Topics include real-time operating systems, scheduling synchronization, and architectural features of single and multiple processor real-time and embedded systems. Prereq: EE/CPE 580 and engineering standing or consent of instructor. (Same as CPE 588.)

### **EE 589 ADVANCED VLSI. (3)**

An advanced class in topics related to Very Large Scale Integration. Example topics are advanced simulation, yield impact, memory design, statistical analysis and data reduction. Prereq: EE 584, engineering standing.

### EE 595 INDEPENDENT PROBLEMS. (1-3)

For electrical engineers. A problem, approved by the chairperson of the department, provides an objective for study and research. May be repeated to a maximum of six credits. Prereq: 2.5 standing and engineering standing.

### EE 598 SPEC. TOPICS MULTI-INST (Subtitle required). (3)

This course covers advanced topics on various aspects of electrical engineering, and is a template for courses to be shared among multi-institutions via distance learning technologies.

### EE 599 TOPICS IN ELECTRICAL ENGINEERING (Subtitle required). (3)

A detailed investigation of a topic of current significance in electrical engineering such as biomedical instrumentation, digital filter design, active networks, advanced electrical devices, digital communications, display of electronics. May be repeated, but only three credits can be earned under the same title. Only nine credit hours may count toward degree requirements. A particular topic may be offered at most twice under the EE 599 number. Prereq: Equivalent of two 400-level courses in electrical engineering, consent of instructor and engineering standing.

**PREREQUISITE FOR GRADUATE WORK:** Students desiring to take any of the following courses should have a thorough working knowledge of chemistry, physics and mathematics. For major work, a candidate must hold a bachelor's degree in electrical engineering or its equivalent.

### EE 601 ELECTROMAGNETIC ENERGY CONVERSION I. (3)

Generalized electric machine theory; parameter determination. Energy conversion in continuous media including magnetohydrodynamics. Prereq: Consent of instructor.

### EE 603 POWER ELECTRONICS. (3)

Study of solid-state power electronic devices and their applications. Examination of control philosophies, steady-state models, and numerical simulation of characterizing differential equations. Current topics of interest from the literature. This course may not be used to satisfy degree requirements if credit is earned in EE 503. Prereq: EE 517 and EE 571 or consent of instructor.

### EE 604 SWITCH MODE CONVERTERS. (3)

Study of analysis techniques for switching mode converters and associated control practices. Boost, buck, buck-boost, flyback, and Cuk topologies in both continuous and discontinuous conduction modes are presented. Numerical solution, state-space averaging, and linearization techniques are applied to predict performance and formulate transfer characteristics. Prereq: EE 517 or consent of instructor.

### EE 605 MODELING, SIMULATION AND CONTROL FOR MANUFACTURING. (3)

The purpose of this course is to examine methods and systems from the perspectives of modeling, simulation, and control of manufacturing facilities. The emphasis will be primarily on techniques that can be used to model and evaluate performance of systems. Students are encouraged to think critically about available technologies, identify relative strengths and weaknesses, and analyze the technologies toward developing improved solutions to factory control and information management problems. Prereq: Graduate Standing. (Same as ME/MFS 605.)

### EE 606 GLOBAL ISSUES IN MANUFACTURING. (3)

The need to increase quality, productivity, efficiency and sustainability in manufacturing operations spanning the product, process and systems (manufacturing systems as well as supply chain) domains is essential for companies to be successful. The increased globalization of markets and manufacturing operations, declining natural resources and negative consequences of some manufacturing practices as well as increased legislation in many regions has led to many new challenges that companies must overcome to be successful in competitive markets. This seminar course will introduce students to a variety of global issues in manufacturing through presentations by leading national and international experts in these domains. The seminars will cover a broad range of manufacturing related topics relevant to many disciplines including manufacturing, mechanical and electrical engineering. The course can also help graduate students identify topical issues that need further investigation and could become potential research topics. (Same as ME/MFS 606.)

### EE 611 DETERMINISTIC SYSTEMS. (3)

Concepts of linear systems, singularity functions, convolution and superposition integrals, state-variable method for linear systems, relation between transfer function and state-variable equations, fundamental matrix, state-transition matrix, unit-impulse response matrix, and transmission matrix. Prereq: EE 421G.



- EE 613 OPTIMAL CONTROL THEORY. (3)**  
State-space modeling of control systems; variational techniques; system optimization by maximum principle, dynamic programming; Hamilton-Jacobi equations design of linear optimal systems; computational methods for solving boundary value problems. Prereq: EE 611.
- EE 614 ADAPTIVE CONTROL. (3)**  
Real-time parameter estimation; deterministic self-tuning regulators; stochastic and predictive self-tuning regulators; model-reference systems; auto-tuning; gain scheduling; practical issues; design and simulation projects. Prereq: EE 611.
- EE 619 PROBLEMS SEMINAR IN OPERATIONS RESEARCH. (3)**  
In this course, the student is exposed to the art of applying the tools of operations research to real world problems. The seminar is generally conducted by a group of faculty members from the various disciplines to which operations research is applicable. Prereq: MA 617 and STA 525 or consent of instructor.
- EE 621 ELECTROMAGNETIC FIELDS. (3)**  
Development of electromagnetic field theory from the basic postulates of Maxwell's equations in differential and integral forms, solution to static, quasistatic, and wave-propagation problems. Radiation from dipole antenna elements. Prereq: EE 468G.
- EE 622 ADVANCED ELECTRODYNAMICS. (3)**  
Solution methods for applied electrodynamics problems; uniqueness, equivalence, duality, reciprocity; linear space methods; wave solutions in separable coordinate systems; classical problems in cartesian, cylindrical, and spherical coordinates. Prereq: EE 468G.
- EE 624 COMPUTATIONAL ELECTROMAGNETICS: THE FINITE-DIFFERENCE TIME-DOMAIN. (3)**  
A course on the application of the finite-difference time-domain (FDTD) technique for the full-wave simulation of time-dependent electromagnetic waves in complex media. Representative topics in the course include: The Yee-algorithm, numerical dispersion and stability, physical source models, absorbing boundaries and perfectly matched layered media, near-field to far-field transformations, modeling of microwave circuits and antennas, parameter extraction, lumped load models, non-uniform and non-orthogonal grid methods, and current topics in FDTD. Prereq: EE 621 or consent of instructor.
- EE 625 COMPUTATIONAL ELECTROMAGNETICS. (3)**  
This advanced course in computational electromagnetics primarily covers moment method and finite element method solutions to scattering problems. Representative topics of the course include surface and volume equivalence principles, scattering by material cylinders, scattering by periodic structures and absorbing boundary condition models. Prereq: EE 525, EE 621, or consent of instructor.
- EE 630 DIGITAL SIGNAL PROCESSING. (3)**  
An introductory treatment of the basic concepts of signal processing via time and frequency domain (Z-transform) methods and a survey of procedures for designing, implementing and using digital signal processors. Prereq: EE 512 or consent of instructor.
- EE 635 IMAGE PROCESSING. (3)**  
The course outlines applications of image processing and addresses basic operations involved. Topics covered include image perception, transforms, compression, enhancement, restoration, segmentation, and matching. Prereq: Graduate standing and consent of instructor. (Same as CS 635.)
- EE 639 ADVANCED TOPICS IN SIGNAL PROCESSING AND COMMUNICATIONS. (3)**  
Advanced topics in signal processing and communications research and design topics of current interests, such as optical processing, pattern recognition, satellite systems, and digital communication networks. A review and extension of current literature and selected papers and reports. May be repeated to a maximum of nine credits. Prereq: Advanced graduate standing.
- EE 640 STOCHASTIC SYSTEMS. (3)**  
Random variables, stochastic processes, stationary processes, correlation and power spectrum, mean-square estimation, filter design, decision theory, Markoff processes, simulation. Prereq: EE 421G.
- EE 641 ADVANCED POWER SYSTEMS. (3)**  
This course covers advanced topics on electric power systems including power system analysis, operation, monitoring, protection, optimization and control. Prereq: Graduate student, AND EE 415 or equivalent or consent of instructor.

### **#EE 643 INTEGRATION OF DISTRIBUTED ENERGY RESOURCES. (3)**

This course covers characteristics of distributed energy resources, and the challenges and methods for integrating them into the power grid. Prereq: Graduate student, AND EE 415 or equivalent or consent of instructor.

### **EE 645 ADVANCED CONTROL SYSTEM ANALYSIS. (3)**

Conceptual development and study of complex systems; their synthesis and design; analysis and optimization of system parameters. Input-output relationships; formulation of mathematical models, parameters and constraints on physical systems. Prereq: ME 440 or instructor consent. (Same as ME 645.)

### **EE 661 SOLID-STATE ELECTRONICS. (3)**

A study of semiconductor fundamentals including crystal structure, basic quantum mechanics, energy-band theory, carrier distributions, carrier transport, and recombination-generation. Analysis of semiconductor devices including PN junction diodes, bipolar-junction transistors, metal-semiconductor diodes, and metal-oxide semiconductor field effect transistors. Prereq: EE 360 and EE 461G or consent of instructor.

### **EE 663 OPTOELECTRONIC DEVICES. (3)**

Theory and applications of photodetectors, solar cells, semiconductor lasers, light emitting diodes and display devices, nanocrystalline structures and organic semiconductors applications in optoelectronic devices. Prereq: EE 360 or MSE 402G, consent of instructor and/or graduate standing. (Same as MSE 663.)

### **EE 664 MULTIDISCIPLINARY SENSORS LABORATORY. (3)**

A multidisciplinary laboratory course with laboratory experiences in areas related to sensors and sensing architectures, typically including chemistry, chemical and materials engineering, and electrical engineering. Lecture, 1 hour; laboratory, 2 hours. Prereq: One year of college chemistry, calculus and physics. GS 660 or by consent of instructor. (Same as CHE/CME/MSE 664.)

### **EE 672 NONLINEAR SYSTEMS AND CONTROL. (3)**

This course presents methods for analyzing and controlling nonlinear dynamic systems. The major topics are: 1) fundamental properties of nonlinear ordinary differential equations such as existence and uniqueness; 2) Lyapunov stability theory; and 3) nonlinear feedback control techniques such as backstepping, feedback linearization, and Lyapunov-based design. (Same as ME 672.)

### **EE 684 INTRODUCTION TO COMPUTER AIDED DESIGN OF VLSI CIRCUITS. (3)**

Computer aided design of Very Large Scale Integration (VLSI) circuits. Topics include: VLSI technologies, CMOS circuit characteristics, computer aids in the design of VLSI circuits, use of various CAD tools for layout, circuit design, logic design, and functional design, and the use of VLSI circuits in the system design. A design project is required. Prereq: EE 581 and EE 461G or consent of instructor.

### **EE 685 DIGITAL COMPUTER STRUCTURE. (3)**

Study of fundamental concepts in digital computer system structure and design. Topics include: computer system modeling based on instruction set processor (ISP) and processor-memory-switch (PMS) models, design and algorithms for ALU, processor, control unit and memory system. Special topics include floating-point arithmetic, cache design, pipeline design technologies, and parallel computer architectures. Prereq: EE 380 and EE 581 or consent of instructor.

### **EE 686 ADVANCED COMPUTER ARCHITECTURE DESIGN. (3)**

A study of current diverse advanced architectures such as microprogrammed, parallel, array and vector, networked, and distributed architectures; applications and example systems employing these architectures; matching applications to architectures; consideration of architectures of the future. Prereq: EE 685.

### **EE 698 SPEC. TOPICS MULTI-INST (Subtitle required). (3)**

This course covers advanced topics on various aspects of electrical engineering, and is a template for courses to be shared among multi-institutions via distance learning technologies.

### **EE 699 TOPICS IN ELECTRICAL ENGINEERING (Subtitle required). (3)**

A detailed study of a topic of current interest in electrical engineering. May be repeated to a maximum of six credits, but only three credits may be earned under the same subtitle. A particular topic may be offered at most twice under the EE 699 number. Prereq: Consent of instructor.

## EE

## Electrical Engineering

- EE 748 MASTER'S THESIS RESEARCH. (0)**  
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.
- EE 749 DISSERTATION RESEARCH. (0)**  
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.
- EE 767 DISSERTATION RESIDENCY CREDIT. (2)**  
Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.
- EE 768 RESIDENCE CREDIT FOR THE MASTER'S DEGREE. (1-6)**  
May be repeated to a maximum of 12 hours.
- EE 769 RESIDENCE CREDIT FOR THE DOCTOR'S DEGREE. (0-12)**  
May be repeated indefinitely.
- EE 780 ADVANCED PRACTICE IN ELECTRICAL AND COMPUTER ENGINEERING. (1-3)**  
Apply advanced training in electrical/computer engineering to solve complex practical problems through analysis, design, implementation, experiments, and/or developments subject to approval of the course instructor. This course may be repeated for a maximum of six credit hours in combination with EE 783. Prereq: 18 hours of graduate courses.
- EE 783 SPECIAL PROBLEMS IN ELECTRICAL ENGINEERING. (1-3)**  
Open to graduate students only. Individual work on an assignment approved by the chairperson of the department. May be repeated to a maximum of nine credits.
- EE 784 RESEARCH PROJECT IN ELECTRICAL ENGINEERING. (3)**  
Individual study related to a special research project supervised by the student's advisor. A final written report on the project is required. This course is open only to and required by students pursuing the MSEE degree with a non-thesis option (Plan B). The course cannot satisfy part of the required 30 hours of course work for Plan B. Prereq: Approval of student's MSEE advisor.
- EE 790 RESEARCH IN ELECTRICAL ENGINEERING. (1-9)**  
Research in any field of electrical and/or computer engineering subject to approval of the Director of Graduate Studies. This course can be taken prior to the qualifying examination, but will not count for pre-qualifying examination residency credit. This course may be repeated to a maximum of 18 credit hours. Prereq: Consent of DGS.