ELECTRICAL AND COMPUTER ENGINEERING (EGRE)

EGRE 101. Introduction to Engineering. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Course open to first-year students majoring in electrical or computer engineering. Introduction to engineering through instruction on basic concepts of engineering. Topics will include an introduction to basic circuit components and circuit analysis, digital logic design and programming. General topics important to all engineers will also be covered, such as mathematics, improving written and oral communication skills, teamwork, ethics and life-long learning. The laboratory introduces fundamental testing, measurement, troubleshooting methodology and proper laboratory notebook maintenance. Engineering design and analysis is also emphasized through a team-based design that involves designing, building and programming a robot.

EGRE 206. Electric Circuits. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: MATH 200; and one of EGRE 101 or EGRB 102 or both EGMN 103 and EGMN 190, as applicable per department, all with minimum grades of C. Corequisite: MATH 201. An introduction to electrical circuit theory and its application to practical direct and alternating current circuits. Topics include Kirchhoff's Laws (review from departmental prerequisites, as applicable), fundamental principles of network theorems, transient and steady-state response of RC, RL and RLC circuits by classical methods, time-domain and frequency-domain relationships, phasor analysis and power. Laboratory work, practical applications and integral laboratory demonstrations emphasize and illustrate the fundamentals presented in this course.

EGRE 207. Electric Circuits II. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: EGRE 206, with a minimum grade of C. An introduction to higher level electric circuit theory, including the study of basic active components, such as diodes and operational amplifiers. Emphasis will be placed on design rather than analysis. The laboratory exercises will serve to train students in the art of designing a circuit to perform specific tasks and to conform to specific design parameters.

EGRE 245. Engineering Programming. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: MATH 151 with a minimum grade of C. Enrollment restricted to electrical and computer engineering majors. Students are expected to have fundamental computer skills. Introduction to the concepts and practice of structured programming using C. Problem-solving, top-down design of algorithms, basic C syntax, control structures, functions, arrays, files and strings.

EGRE 246. Advanced Engineering Programming. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 245 with a minimum grade of C. Enrollment restricted to electrical and computer engineering majors. Advanced programming for engineering applications in C and C++. Topics include objects, classes and inheritance; linked lists; recursion; basic searching and sorting techniques; and program design for control and monitoring type applications.

EGRE 254. Digital Logic Design. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 101 and EGRE 245 or equivalents, both with a minimum grade of C. An introduction to digital logic design with an emphasis on practical design techniques and circuit implementations. Topics include number representation in digital computers, Boolean algebra, theory of logic functions, mapping techniques and function minimization, design of combinational, clocked sequential and interactive digital circuits such as comparators, counters, pattern detectors, adders and subtractors. An introduction on designing digital circuits using schematic capture, logic simulation and hardware description languages is included. Students will use the above basic skills in the laboratory to design and fabricate digital logic circuits using discrete logic and field programmable gate arrays.

EGRE 303. Electronic Devices. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: EGRE 306 and MATH 301, both with a minimum grade of C. An introduction to solid state electronic devices covering the fundamentals of atomic structure, band theory, charge transport in solids and terminal electrical characteristics of semiconductor devices including p-n junction and Schottky diodes, bipolar junction and insulated gate field-effect transistors.

EGRE 306. Introduction to Microelectronics. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 207 and MATH 301, both with a minimum grade of C. This course covers the analysis, modeling and design of electrical circuits which contain electronic devices. Students will learn to design analog circuits to specifications through laboratory problems, a design project and circuit simulation.

EGRE 307. Integrated Circuits. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 306 and EGRE 337, both with a minimum grade of C. Corequisite: EGRE 336. Analysis, modeling, design and measurement of advanced MOSFET and bipolar analog integrated circuits. Topics include active filters, differential amplifiers, frequency response and feedback topologies. Operational amplifier circuit topologies are used as a means of studying input, gain, level shift and output stages. Circuit design techniques are explored for mixed signal analog-digital circuits. This course provides the opportunity for a group design project of an integrated circuit chip, using advanced software tools for simulation and physical layout.

EGRE 309. Introduction to Electromagnetic Fields. 3 Hours.
Semester course; 2 lecture and 3 laboratory hours. 3 credits. Prerequisites: EGRE 207, MATH 301, MATH 307 and PHYS 208, all with a minimum grade of C. This course provides an introduction to the concept of electromagnetic fields. Topics include electrostatics, magnetostatics, scalar and vector potentials, and work and energy in fields, as well as the analysis and understanding of the phenomena associated with static electric and magnetic fields. Laboratory exercises will serve to reinforce students' understanding of fields and train them in methods to measure, quantify and analyze electromagnetic phenomena.

EGRE 310. Electromagnetic Fields and Waves. 3 Hours.
Semester course; 2 lecture and 3 laboratory hours. 3 credits. Prerequisite: EGRE 309 with a minimum grade of C. This course covers the fundamentals of time-varying electromagnetic fields. Topics include electromagnetic induction, Maxwell's equations, wave propagation, guided waves, transmission lines and antennas. Laboratory exercises will serve to reinforce students' understanding of time-varying fields and waves and train them in methods to measure, quantify and analyze dynamic electromagnetic phenomena.

EGRE 334. Introduction to Microfabrication. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: CHEM 101, MATH 201 and PHYS 208, all with a minimum grade of C. This course gives an overview of microscale device fabrication and testing for a general audience. A wide variety of new terms, equipment and processes are presented. Fundamentals of photolithography, mask making, diffusion, oxidation, ion implantation, film deposition and etching are covered. Laboratory work consists of safety training, hands-on fabrication experience and testing. A laboratory chip test is fabricated from start to finish and then tested. The test chip includes basic integrated circuit elements as well as solar cells.

EGRE 335. Signals and Systems I. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 206 and 245 and MATH 301, all with a minimum grade of C. Presents the concept of linear continuous-time and discrete-time signals and systems, their classification, and analysis and design using mathematical models. Topics to be covered: the concepts of linear systems and classification of these systems, continuous-time linear systems and differential and difference equations, convolution, frequency domain analysis of systems, Fourier series and Fourier transforms and their application, and continuous-time to discrete-time conversion.

EGRE 336. Introduction to Communication Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 337 with a minimum grade of C. Introduction to the theory and application of analog and digital communications including signal analysis, baseband transmission, amplitude and angle modulation, digital modulation, baseband digital communication, and design considerations.

EGRE 337. Signals and Systems II. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 335 with a minimum grade of C. This class presents the Laplace and Z transforms and their application to electrical circuits and discrete-time systems, an introduction to probability, random variables and random processes with applications in electrical engineering.

EGRE 364. Microcomputer Systems. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 246 and 254, both with a minimum grade of C. Basic computer organization, microprocessor instruction sets and architectures, assembly language programming and the function of computer memory and I/O subsystems will be discussed. The laboratory is designed to reinforce the lectures by providing the opportunity to study the workings of a simple computer system in detail using simulation models and real hardware. Students will write and execute assembly language programs and make use of commercial design automation tools.

EGRE 365. Digital Systems. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 246 and 254, both with a minimum grade of C. Corequisite: EGRE 364. Focuses on the design of modern digital systems. Topics covered include: introduction to modeling, simulation, synthesis and FPGA design techniques using VHDL; microprocessor peripherals and interfacing; embedded system hardware and software design issues.

EGRE 402. Senior Design Studio I (Laboratory/Project Time). 2 Hours.
Semester course; 6 laboratory hours. 2 credits. Prerequisites: EGRE 207, 246, 254 and 335; and completion of three from: EGRE 306, 309, 337 and 364. All prerequisite courses must be completed with a minimum grade of C. Corequisite: any electrical engineering technical elective. Enrollment restricted to students with senior standing in electrical engineering and participation in a senior design (capstone) project. A minimum of six laboratory hours per week dedicated to the execution phase of the senior design (capstone) project, which should meet appropriate engineering standards and multiple realistic constraints. Tasks include team meetings, brainstorming, sponsor advising, designing, fabrications, assembling, reviewing, studying, researching, testing and validating projects.

EGRE 403. Senior Design Studio II (Laboratory/Project Time). 2 Hours.
Semester course; 6 laboratory hours. 2 credits. Prerequisite: EGRE 402 with a minimum grade of C. A minimum of six laboratory hours per week dedicated to the execution phase of the senior design (capstone) project, which should meet appropriate engineering standards and multiple realistic constraints. Tasks include team meetings, brainstorming, sponsor advising, designing, fabrications, assembling, reviewing, studying, researching, testing and validating projects.

EGRE 404. Senior Design Studio I (Laboratory/Project Time). 2 Hours.
Semester course; 6 laboratory hours. 2 credits. Prerequisites: for electrical engineering majors: EGRE 207, 246, 254 and 335; and completion of three from: EGRE 306, 309, 310, 337 and 364, or completion of EGRE 364, 365 and CMSC 355; for computer engineering majors: EGRE 207, 335, 364, 365 and CMSC 355. Corequisite: any electrical or computer engineering technical elective. All prerequisite courses must be completed with a minimum grade of C. Enrollment is restricted to students with senior standing in electrical engineering or computer engineering and participation in a senior design (capstone) project. A minimum of six laboratory hours per week dedicated to the execution phase of the senior design (capstone) project, which should meet appropriate engineering standards and multiple realistic constraints. Tasks include team meetings, brainstorming, sponsor advising, designing, fabrications, assembling, reviewing, studying, researching, testing and validating projects.

EGRE 405. Senior Design Studio II (Laboratory/Project Time). 2 Hours.
Semester course; 6 laboratory hours. 2 credits. Prerequisite: EGRE 404 with a minimum grade of C. Enrollment is restricted to students with senior standing in electrical engineering or computer engineering and participation in a senior design (capstone) project. A minimum of six laboratory hours per week dedicated to the execution phase of the senior design (capstone) project, which should meet appropriate engineering standards and multiple realistic constraints. Tasks include team meetings, brainstorming, sponsor advising, designing, fabrications, assembling, reviewing, studying, researching, testing and validating projects.

EGRE 406. Senior Design Studio I - VIP (Laboratory/Project Time). 2 Hours.
Semester course; 6 laboratory hours. 2 credits. Prerequisites: for electrical engineering majors: EGRE 207, 246, 254, 335, and 3 credits of ENGR 497 during the two semesters prior to enrollment; and completion of three from: EGRE 306, 309, 310, 337 and 364, or completion of EGRE 364, 365 and CMSC 355; for computer engineering majors: EGRE 207, 335, 364, 365, CMSC 335, and 3 credits of ENGR 497 during the two semesters prior to enrollment. Corequisite: any electrical or computer engineering technical elective. All prerequisite courses must be completed with a minimum grade of C. Enrollment is restricted to students with senior standing in electrical engineering or computer engineering, and participation in a senior design (capstone) project associated with their vertically integrated project team. A minimum of six laboratory hours per week dedicated to the execution phase of the senior design (capstone) project, which should meet appropriate engineering standards and multiple realistic constraints. Tasks include team meetings, brainstorming, sponsor advising, designing, fabrications, assembling, reviewing, studying, researching, testing and validating projects.

EGRE 407. Senior Design Studio II - VIP (Laboratory/Project Time). 2 Hours.
Semester course; 6 laboratory hours. 2 credits. Prerequisite: EGRE 406 with a minimum grade of C. Enrollment is restricted to students with senior standing in electrical engineering or computer engineering and participation in a senior design (capstone) project associated with their vertically integrated project team. A minimum of six laboratory hours per week dedicated to the execution phase of the senior design (capstone) project, which should meet appropriate engineering standards and multiple realistic constraints. Tasks include team meetings, brainstorming, sponsor advising, designing, fabrications, assembling, reviewing, studying, researching, testing and validating projects.

EGRE 426. Computer Organization and Design. 3 Hours.
Semester course; 2 lecture and 3 laboratory hours. 3 credits. Prerequisite: EGRE 364 or CMSC 311 with a minimum grade of C. This course presents the foundation for computer design at the register transfer level. Starting from an instruction set architecture, students will learn the process used to design a data path and control unit to implement that instruction set. In addition, the topics of computer components and structures, data paths and control unit organizations, I/O and memory systems, interrupt systems, pipelining, and multiprocessing will be discussed. In addition to reinforcing the lecture material, the laboratory exercises will teach students the art of modeling and designing computer system components using a hardware description language.

EGRE 427. Advanced Digital Design. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: EGRE 365 and 426, both with a minimum grade of C. This course provides students with practical foundations for the design, implementation and testing of digital systems. It expands on the digital and computer system theory presented in prerequisite courses. Topics covered include: microcontrollers and embedded processors, application specific IC (ASIC) architectures and implementing digital systems with ACISs, logic families and high-speed interfacing, logic synthesis, design methodologies, hardware/software codesign, production testing and design for testability, and construction, testing and debugging of digital system prototypes. In the laboratory, the students will design, construct, test and debug a multidisciplinary, computer-based hardware/software system to meet appropriate engineering standards and multiple realistic constraints.

EGRE 428. Introduction to Integrated Systems Design. 2 Hours.
Semester course; 1 lecture and 3 laboratory hours. 2 credits. Prerequisites: EGRE 364 and EGRE 365, both with a minimum grade of C. This course provides an introduction to senior capstone design for computer engineers. Topics include hardware/software project design methodologies, integrated hardware and software design tools, life cycle costs analysis and requirements and specification analysis. Students are also introduced to concepts and design tools for FPGA and system-on-a-chip devices. Lectures are intended to support tasks required to execute a successful senior capstone experience. These tasks include, but are not limited to, project configuration management, customer interaction skills, requirements elicitation, simulation, procurement, design, testing and validation.

EGRE 429. Advanced Digital Systems Design. 2 Hours.
Semester course; 1 lecture and 3 laboratory hours. 2 credits. Prerequisite: EGRE 428 with a minimum grade of C. This course provides students with theoretical and practical foundations for advanced embedded systems design and cyber physical system applications. It extends the concepts introduced in EGRE 428. Special emphasis is placed on the design of advanced embedded computing platforms for cyber physical system applications. Topics covered include: introduction to cyber physical systems; cyber physical systems theory; FPGA and system-on-a-chip design environments; designing, developing and implementing cyber physical systems using FPGA and system-on-a-chip technology; real-time computing and operating systems; real-time sensor networks; engineering design standards; and verification and validation of complex designs. In the laboratory the students will use state-of-the-art system development tools to design, construct, test and verify a system-on-a-chip-based system to meet appropriate engineering standards and multiple realistic system constraints.

EGRE 435. Microscale and Nanoscale Fabrication. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: EGRE 306 and EGRE 334, both with a minimum grade of C. This course presents the design tools and techniques for designing a fabrication process as well as a device design and layout for advanced microscale and nanoscale devices. A number of different types of device technologies are covered, incorporating electronic, micromechanical and microfluidic devices and sensors. In the laboratory section of the course, students work in design teams to develop a complete fabrication process and design layout for a microscale device to meet appropriate engineering standards and multiple realistic constraints. Computer simulations and computer-aided design tools are used in the final design. The laboratory section of this course accomplishes the design phase of the senior design capstone project, which is presented at the end of semester and fabricated in the subsequent course, EGRE 436.

EGRE 436. Advanced Microscale and Nanoscale Fabrication. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 435 with a minimum grade of C. This course presents a detailed analysis of the physics and modeling of the fundamental processes used in semiconductor processing. Emphasis is placed on the non-ideal effects that cause realistic processes to deviate from first order models, including second order effects such as interactions on the atomic level and the influence of crystal defects. Processes covered in detail include oxidation, diffusion, ion implementation, thin film deposition and plasma etching techniques.

EGRE 444. Communication Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 336 with a minimum grade of C. Design and analysis of analog and digital communication systems, pulse modulation, information and digital transmission, digital modulation, information theory and coding will be treated. Emphasis is placed on the student gaining an appreciation for and an understanding of the role of optimization and trade-offs by considering bandwidth requirements, signal-to-noise ratio limitations, complexity and cost of analog and digital communication systems.

EGRE 454. Automatic Controls. 4 Hours.
Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: EGRE 337, EGMN 305 or EGMN 315 with a minimum grade of C. For computer engineering or electrical engineering majors, the prerequisite is EGRE 337 with a minimum grade of C.This course covers the design and analysis of linear feedback systems. Emphasis is placed upon the student gaining mathematical modeling experience and performing sensitivity and stability analysis. The use of compensators to meet systems design specifications will be treated. Topics include: an overview and brief history of feedback control, dynamic models, dynamic response, basic properties of feedback, root-locus, frequency response and state space design methods. The laboratory will consist of modeling and control demonstrations and experiments of single-input/single-output and multivariable systems, analysis and simulation using MATLAB/ Simulink and other control system analysis/design/implementation software.

EGRE 455. Control Systems Design. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 454 with a minimum grade of C. This course covers the use of state space methods to model analog and digital linear and nonlinear systems. Emphasis is placed on the student gaining mathematical modeling experience, performing sensitivity and stability analysis and designing compensators to meet systems specifications. Topics treated will include a review of root locus and frequency design methods, linear algebraic equations, state variable equations, state space design and digital control systems (principles and case studies). The students will use complex dynamic systems for analysis and design.

EGRE 471. Power System Analysis. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 309 with a minimum grade of C. Provides a comprehensive overview of electrical power system operation and design. Students develop models and tools for investigating system behavior and have opportunities for using those tools in design processes. At the completion of the course students will be able to develop appropriate models for an interconnected power system, perform power flow analysis, economic dispatch, power system protection and controls. Students will also be able to write a basic power flow computer program.

EGRE 491. Special Topics. 1-5 Hours.
Semester course; variable hours. 1-5 credits. May be repeated with different topics for a total of 21 credits. Advanced study of a selected topic in electrical or computer engineering. See the Schedule of Classes for specific topics to be offered each semester and prerequisites.

EGRE 492. Independent Study in Electrical and Computer Engineering. 1-5 Hours.
Semester course; variable hours. 1-5 credits. May be repeated with different content for a total of 9 credits. Prerequisite: permission of the instructor. Students must submit a written proposal to be approved by the supervising instructor prior to registration. Investigation of specialized electrical or computer engineering problems through literature search, mathematical analysis, computer simulation and/or laboratory experimentation. Written and oral progress reports as well as a final report and presentation are required.

EGRE 521. Advanced Semiconductor Devices. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: EGRE 303, PHYS 420 and 440, or equivalents or permission of instructor. Studies the fundamentals of semiconductor heterojunctions, metal-semiconductor contacts, metal-oxide-semiconductor structures, defects, interface states, scaled MOS transistors and heterojunction bipolar transistors.

EGRE 525. Fundamentals of Photonics Engineering. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: EGRE 303, 309 and 310 or equivalents. An introduction to the interaction of electromagnetic lightwaves with solid-state materials. Based on the quantum mechanics of photon emission and absorption, the generation and detection of coherent light by semiconductor lasers and photodetectors are investigated. Optical waveguides also are studies for use in sensors employing interferometric and evanescent-field principles. Examples of integrated photonic sensors are presented for mechanical, chemical and biological systems.

EGRE 526. Computer Networks and Communications. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: CMSC 312. Theoretical and applied analysis of basic data communication systems; design of networks in the framework of the OSI reference model; Local and Wide Area Networks; performance analysis of networks; error control and security. Students will work in teams to design and implement a small computer network. Crosslisted as: CMSC 506.

EGRE 531. Multicore and Multithreaded Programming. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 364 or CMSC 311 or permission of instructor. Introducing multicore architectures, multithreaded programming models, OpenMP, Pthreads, thread synchronization, performance evaluation and optimization, load balancing and software tools for multicore/multithread programming.

EGRE 532. GPU Computing. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: CMSC 502, EGRE 531 or permission of instructor. The primary objective of this course is to provide students with knowledge and hands-on experience in developing application software for graphics processing units. The course concentrates on parallel programming basics, GPU hardware architecture and software, GPU programming techniques, GPU performance analysis and optimization, and application development for GPUs.

EGRE 535. Digital Signal Processing. 3 Hours.
Semester course; 2 lecture and 3 laboratory hours. 3 credits. Prerequisites: EGRE 337 or consent of instructor. The course focuses on digital signal processing theory and algorithms, including sampling theorems, transform analysis and filter design techniques. Discrete-time signals and systems, and filter design techniques are treated. Several applications of DSP in telecommunications, image and video processing, and speech and audio processing are studied.

EGRE 540. RF Communications and Antennas. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 309 or equivalent or permission of instructor. Basics of electromagnetics and passive RF components such as filters, isolators, tuners, phase shifters, resonators and tees are discussed, along with design and characterization of wire and planar antennas.

EGRE 541. Medical Devices. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Enrollment requires permission of instructor. An introduction to engineering applications in medicine and design principles for next-generation medical devices. Topics include early cancer detection using microwaves, wireless data telemetry using implantable or body-centric systems, implantable sensors, biodegradable sensors, hyperthermia/ablation for cancer treatment, magnetic resonance imaging, and deep brain and nerve stimulation.

EGRE 553. Industrial Automation. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: EGRE 246 and EGRE 254, or permission of the instructor. Enrollment restricted to students with senior or graduate standing in the School of Engineering. This course provides an introduction to the systems, techniques and languages used in the control of manufacturing and process industries. Major topics include programmable logic controller operation and programming, supervisory control and data acquisition systems, and human machine interfaces. Other topics include an introduction to feedback control systems, analog-to-digital and digital-to-analog conversion, sensors and transducers, and actuators and motors.

EGRE 554. Advanced Industrial Automation. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 553. This course provides additional instruction on topics related to systems, techniques and languages used in the control of manufacturing and process industries. Major topics include advanced PLC programming and operation, motion control, and HMI programming. Other topics include feedback control systems, industrial networking and system simulation.

EGRE 555. Dynamics and Multivariable Control I. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: MATH 301 and 310 or the equivalent. Systems of differential equations with controls, linear control systems, controllability, observability, introduction to feedback control and stabilization. Crosslisted as: MATH 555.

EGRE 573. Sustainable and Efficient Power Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 471. The course covers distributed power generation system and renewable energy technologies. It introduces models and tools for investigating electric power generation and efficiency analysis, the wind and solar power, energy storage, renewable integration, and environmental impacts. At the completion of the course students will be able to apply appropriate models and complete a feasibility study of practical renewable energy systems.

EGRE 591. Special Topics in Electrical and Computer Engineering. 1-4 Hours.
Semester course; variable hours. 1-4 credits. Prerequisite: senior or graduate standing in the School of Engineering or permission of the instructor. Lectures, tutorial studies, library assignments in selected areas of advanced study or specialized laboratory procedures not available in other courses or as part of research training.

EGRE 610. Research Practices in Electrical and Computer Engineering. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Enrollment is restricted to graduate students in engineering and physical sciences. The course is an interactive course designed to introduce graduate students to the research practices in physical science and engineering, with emphasis on electrical and computer engineering, as well as mentorship and teaching. It is intended to teach students how to write competitive research grant proposals for federal, state and private funding agencies. It also improves writing skills for research papers and teaches research ethics. The focus areas include defining a valid research problem, effective survey and critique of research literature, assessment of relevance and credibility, scientific integrity, engineering and scientific ethics, scientific recordkeeping and data management, collaborative research, authorship and peer review, research compliance, intellectual property, conflicts of interest, and environmental and global issues. Finally, the students are trained to become better teachers and mentors.

EGRE 620. Electron Theory of Solids. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: PHYS 420 and 440 or permission of instructor. The study of electronic structures, band structure calculations, optical absorption and emission, lasing in semiconductors, electron-photon interactions, heterostructures and nanostructures. Quantum theory of electron-photon interaction, absorption and emission, semiconductor lasers, linear response transport, Landauer Buttiker formulas, mesoscopic devices and phenomena, resonant tunneling, single electronics, non-equilibrium Green's function formalism, second quantization, coupled mode theory, electrons in a magnetic field, and integer quantum Hall effect.

EGRE 621. Spintronics. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 620 or equivalent, or with permission of instructor. Basic concept of spin, spin interactions, spin transport, spin-based classical devices, single spintronics and spin-based quantum computing.

EGRE 622. MEMS Design and Fabrication. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: EGRE 303 and EGRE 334 or permission of instructor. The course provides the background required to conduct research in microelectromechanical systems. The course provides an overview as well as detailed coverage of material properties, specialized fabrication techniques and the fundamental principles of the major classes of MEMS devices. This will include mechanical sensors and actuators, surface acoustic wave devices, optical sensors, modulators and switches, bioMEMS, chemical and biochemical sensors, and microfluidic devices.

EGRE 624. Nonlinear Optical Materials and Devices. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 525 or equivalent or permission of instructor. This course describes the principles of nonlinear optics and discusses the operation of photonic devices and systems that utilize various second- and third-order nonlinear optical effects. The topics include electromagnetic wave propagation in anisotropic media, nonlinear optical susceptibility tensor, linear and quadratic electro-optic effects, second harmonic, sum- and difference-frequency generation, phase-matching, parametric amplification, optical switching, multi-photon absorption, and self-focusing and self-phase modulation.

EGRE 625. Clean Room Lab Practicum. 1 Hour.
Semester course; 3 laboratory hours. 1 credit. Prerequisite: EGRE 334 or permission of instructor. The course develops the detailed knowledge and skills required to design and fabricate advanced microscale and nanoscale devices for doctoral thesis work in a micro- and nano-fabrication facility cleanrooms. The course focuses on fabricating a nanostructured device and involves photolithography, wet and dry etching, oxidations, diffusions and thin film depositions. Students will complete the processing of the device and perform characterization experiments. Design skills will also be developed, including design and layout using software tools and fabrication of custom photomasks. Students will document all aspects of the laboratory work.

EGRE 626. Advanced Characterization of Electronic Materials and Devices. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 303 or permission of instructor. This course discusses crystal symmetry in relation with physical properties of crystalline solids, with special emphasis on semiconductor materials forming the basis of modern electronic and optoelectronic devices, point and extended defects and their effects on electronic and optical properties of semiconductor materials and device performance, and defect formation during processing. The course also covers in depth structural, electrical and optical techniques used to reveal various structural defects: the theory and practice of X-ray, neutron and electron diffraction methods, transmission and scanning electron microscopy, scanning probe microscopy, Hall effect, deep-level transient spectroscopy, photo- and cathodoluminescence, and time-resolved spectroscopy, with particular focus on their applications to real semiconductor materials and device structures.

EGRE 627. Nanophotonics. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 525 or equivalent or permission of instructor. Advances in nanotechnology and fabrication have allowed scientists to control light like never before, bringing topics of science fiction such as cloaking, unlimited resolution imaging, nanometer-thick optics and breakthrough treatments for disease into the realm of reality. This course explores what is possible when students can confine light at the nanoscale and engineer materials at will, covering topics such as light guiding by metals (plasmonics), optical lattices (photonic crystals), arbitrary materials (meta-materials/surfaces), nanoscale lasers (spasers) and stopping light (static optics). Students are exposed to the newest advances in the field through discussion, projects and presentations.

EGRE 631. Real-time and Embedded Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 426 or equivalent or permission of instructor. Presents advanced material in the area of the design, implementation and testing of embedded computer systems intended to operate as part of a larger system. Topics to be discussed include design challenges of embedded computing, real-time scheduling theory, worst-case execution time analysis, embedded architectures, embedded software design and performance optimizations. Hands-on labs and a research project on advanced topics in this field will be included in this course.

EGRE 632. Dependable Embedded Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 364 or permission of instructor. This course explores the rich set of issues that must be considered when dealing with dependable embedded systems in smart energy delivery, transportation, interconnected health and medical devices and smart buildings, which have one or more of the following attributes: need for safety, continuous reliable operation, resilient to disruptions, secure against cyber-attacks, operate in real-time, maintainable and designed correctly. Among the topics covered are fault-tolerant computing, reliability and safety engineering, understanding the origins of failures and errors, design criteria, software reliability, formal verification of designs, cyber security, review of standards in safety critical systems and social/legal concerns.

EGRE 635. Advanced Computer Architecture. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 426 or with permission of instructor. This course will focus on the design and analysis of high performance computer architectures. Topics investigated include pipeline design, superscalar computers, multiprocessors, memory systems, peripherals, interfacing techniques, networks, performance and software issues. Crosslisted as: CMSC 605.

EGRE 636. Introduction to Cyber-Physical Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: EGRE 335 and EGRE 365 or equivalents or permission of instructor. This course introduces students to the research, design and analysis of cyber-physical systems -- the tight integration of computing, control and communication. The main focus is on understanding existing and emerging models of CPSs, as well as physical processes in terms of differential equations and computational models for discrete time systems, such as extended finite-state machines and hybrid automata. State-charts are introduced and combined with the physical models for analysis of embedded systems. Linear temporal logic is introduced and applied to specify the desired system behavior. Tools for analytical study and verification of the satisfaction of linear temporal logic formulae are presented and discussed in numerous applications. Dependability attributes such as safety, reliability and cyber-security are discussed in the context of high integrity CPSs.

EGRE 640. Semiconductor Optoelectronics. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 309 or equivalent or permission of instructor. Discussions of optical processes in semiconductors and semiconductor heterostructures in terms of radiative and nonradiative processes, as well as absorption. Also covers in depth the theory and practice of light-emitting diodes, including those intended for solid-state lighting, lasers and detectors.

EGRE 644. Wireless Communications. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 444 or permission of instructor. The main objective of this course is to introduce the fundamental principles of wireless communications. The focus will be on the physical layer and wireless transceiver design issues. Students are expected to gain a thorough understanding of wireless channel modeling, the concept of channel fading, the means to mitigate the effect of fading through diversity techniques. Some practical wireless communication techniques will also be introduced such as space-time coding, multiple input multiple output communications and orthogonal frequency-division multiplexing.

EGRE 651. Intelligent Linear Systems. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 337 or permission of instructor. This course covers selected topics on intelligent systems and fundamental principles of system analysis. Emphasis is placed on the student gaining mathematical modeling experience, performing computer simulations and designing systems architecture. Topics include intelligent agents, autonomous control, linear algebraic equations for state variable equations, complex dynamic systems, controllability and observability, linear discriminant functions in algorithm-independent optimization, multilayer neural networks, unsupervised learning and clustering, mobile robot localization and kinematics, and perception for planning and navigation.

EGRE 656. Estimation and Optimal Filtering. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisites: MATH 310, EGRE 337 and EGRE 555/MATH 555. This course will expose students to the fundamental issues in parameter estimation and recursive state estimation for dynamic systems. Topics covered will include maximum likelihood estimation, maximum a posteriori estimation, least squares estimation, minimum mean square error estimation, Cramer-Rao lower bound, discrete-time Kalman filter for linear dynamic systems, extended Kalman filter for nonlinear problems and system models for the Kalman filter.

EGRE 671. Power System Operations and Controls. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: EGRE 471 or equivalent. This course covers the fundamental concepts of economic operation and controls of power systems, including real and reactive power balance, optimized generation dispatch, steady state and dynamic analysis, real-time monitoring and controls, and contingency analysis. Upon completion of this course, students will be able to develop equivalent circuits and compute programs for power flow analysis, define and analyze automatic generation control scheme on a power system, develop generation dispatching schemes, define and analyze state estimation of a power system using analysis programs, and perform contingency studies of the grid.

EGRE 691. Special Topics in Electrical and Computer Engineering. 1-3 Hours.
Semester course; 1-3 lecture hours. 1-3 credits. Prerequisites: at least one graduate-level engineering course and permission of instructor. An advanced study of selected topic(s) in electrical and computer engineering. See the Schedule of Classes for specific topics to be offered each semester.

EGRE 692. Independent Study. 1-3 Hours.
Semester course; 1-3 lecture and 1-3 laboratory hours. 1-3 credits. Prerequisites: graduate standing and permission of instructor. The student must identify an electrical and computer engineering faculty member willing to supervise the course and submit a proposal for approval to the electrical and computer engineering graduate committee. Investigation of specialized electrical and computer engineering problems through literature search, mathematical analysis, computer simulations and/or experimentation. Written and oral reports, final report and examination are required.

EGRE 697. Directed Research in Electrical and Computer Engineering. 1-15 Hours.
Semester course; variable hours. 1-15 credits. Prerequisite: graduate standing or permission of instructor. Research directed toward completion of the requirements for the electrical and computer engineering track in the M.S. or Ph.D. in Engineering performed under the direction of an electrical and computer engineering faculty member and advisory committee. Graded as S/U/F.