Department of Electrical and Computer Engineering

The Electrical and Computer Engineering curricula produce well-educated graduates prepared to practice engineering at a professional level in an era of rapid and challenging technological development. The educational objectives of the Electrical Engineering curriculum include providing a foundation in seven fundamental areas of electrical engineering (circuits and systems, electromagnetics, electronics, digital systems, communications and signal processing, control systems, and power engineering), giving our graduates the technical proficiency needed for the professional practice of electrical engineering. The educational objectives of the Computer Engineering curriculum include providing a foundation in both electrical engineering (circuits and systems, electronics, and digital systems) and computer science, giving our graduates the technical proficiency needed for the professional practice of computer engineering, including the design and application of computer components and systems. Both curricula develop within our graduates the ability to communicate their ideas effectively to technical and non-technical audiences, work effectively in multidisciplinary teams, take their places in society as responsible citizens, and instill within them an appreciation of and enthusiasm for lifelong scientific inquiry, learning and creativity.

The goal of the professional portion of each curriculum is to emphasize basic areas of study while providing the flexibility to accommodate a diversity of interests and talents. To this end, each curriculum emphasizes knowledgeable use of digital computer systems, oral and written communication skills, the importance of business, economic, social and global forces on engineering, appreciation of the need to maintain the highest ethical standards, and the maintenance of professional competence through continued self-improvement after graduation. Each curriculum emphasizes engineering design and hands-on laboratory experience, culminating in a capstone design project. The senior year elective structure provides students with the flexibility to pursue a range of career options.

While the Electrical Engineering curriculum provides a foundation in seven fundamental areas, this foundation is very broad. The department offers several specially designed program specializations that provide unique training and course selection to those students who wish to concentrate in a particular area. The current program specializations are power engineering, pulp and paper engineering, and wireless engineering, with descriptions to follow. Students should discuss specialization details with the Electrical and Computer Engineering academic advisor.

Power Engineering Specialization

Pulp and Paper Engineering Specialization

This specialization provides students for careers in the pulp, paper, and bio-resource industries from the electric power perspective. These industries are uniquely capable of sustainable development with a renewable raw material base, recyclable products, and processing technology able to achieve energy self-sufficiency and environmental compatibility. This specialization prepares students for a broad range of career paths in process engineering, product development, biotechnology and sustainable engineering.

Students in this specialization take Pulp and Paper Engineering Technical Electives (9 hours). These courses replace ENGR 2100 and the two ELEC Electives.

Wireless Engineering Specialization

This specialization provides students with the necessary preparation to pursue graduate work in wireless engineering or to transition to a career with emphasis on wireless network systems and/or communication devices.

Students in this specialization take Wireless Engineering Technical Electives (12 hours). These courses replace ENGR 2100, ENGR 2200, and the two ELEC Electives.

Majors

- Computer Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofelectricalandcomputerengineering/computerengineering_major/)
- Electrical Engineering (http://bulletin.auburn.edu/undergraduate/samuelginncollegeofengineering/departmentofelectricalandcomputerengineering/electricalengineering_major/)

Courses

ELEC 2110 ELECTRIC CIRCUIT ANALYSIS (4) LEC. 3. LAB. 3. Pr. (PHYS 1610 or PHYS 1617) and (COMP 1200 or COMP 1220 or COMP 1230 or COMP 1210 or COMP 1217) and (P/C ENGR 1110 or P/C ENGR 1113) and P/C MATH 2650. Basic laws and concepts; resistive circuits; first-order transient circuits; phasors and frequency response of circuits; RMS values and complex power.

ELEC 2120 SIGNALS AND SYSTEMS (4) LEC. 3. LAB. 3. Pr. ELEC 2110 and MATH 2650 and (MATH 2630 or MATH 2633 or MATH 2637). Time-domain and frequency-domain methods for modeling and analyzing continuous and discrete-data signals and systems. Generating and observing signals in the time and frequency domains. MATLAB instruction and programming for signal analysis.

ELEC 2200 DIGITAL LOGIC CIRCUITS (3) LEC. 3. Pr. COMP 1200 or COMP 1220 or COMP 1230 or COMP 1210 or COMP 1217. Electronic devices and digital circuits; binary numbers; Boolean algebra and switching functions; gates and flip-flops; combinational and sequential logic circuits; hierarchical design of digital systems; computer-aided design tools for digital design, simulation, and testing.

ELEC 2210 DIGITAL ELECTRONICS (4) LEC. 3. LAB. 3. Pr. ELEC 2110 and ELEC 2200 and (MATH 2630 or MATH 2633 or MATH 2637) and MATH 2650. History of electronics; semiconductors; biasing and operation of PN junction diodes; field-effect transistors and bipolar junction transistors; logic families and logic technologies; flip-flops and memory circuitry.

ELEC 2220 COMPUTER SYSTEMS (3) LEC. 3. Pr. ELEC 2200. Computer hardware/software organization, processor programming models, assembly language programming, design of memory systems, I/O device interfacing, programming and multiprocessing.

ELEC 3030 RF SYSTEMS LAB (1) LAB. 3. Pr. ELEC 2210. Assembly, testing and analysis of a radio. Integration of basic concepts of electronics, electromagnetics, and signals and systems.

ELEC 3040 ELECTRICAL SYSTEM DESIGN LAB (1) LAB. 3. Pr. ELEC 2220 and (P/C ELEC 3030 and P/C ELEC 3500). Exploration and integration of electrical engineering concepts and professional practice issues through the design of a contemporary engineering system.

ELEC 3050 EMBEDDED SYSTEM DESIGN LAB (1) LAB. 3. Pr. ELEC 2210 and ELEC 2220 and P/C ELEC 2120. Integration of hardware and software in the design of an embedded computing system; development of professional skills.

ELEC 3060 WIRELESS DESIGN LAB (1) LAB. 3. Pr. P/C ELEC 3400. Laboratory experiments geared towards understanding the implementation and testing of components used in wireless communication systems.

ELEC 3310 FUNDAMENTALS OF APPLIED ELECTROMAGNETICS (3) LEC. 3. Pr. (MATH 2660 or MATH 2667) and ELEC 2110 and (MATH 2630 or MATH 2633 or MATH 2637) and MATH 2650. Transmission lines are studied as a bridge to understanding electromagnetic theory. Then, electric and magnetic fields are studied using vector algebra, culminating in Maxwell's equations.

ELEC 3320 ELECTROMAGNETICS FOR WIRELESS COMMUNICATION (3) LEC. 3. Pr. ELEC 3310. Maxwell's equations are used in the study of plane waves, guided waves, fiberoptics, electromagnetic compatibility and interference, antennas and radiation, and satellite communication systems.

ELEC 3400 COMMUNICATION SYSTEMS (3) LEC. 3. Pr. ELEC 3800. Pulse code modulation, line coding, information rate, equalization, amplitude modulation, angle modulation, noise in communication systems.

ELEC 3500 CONTROL SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Analog and discrete transfer function models, system response specifications, control system characteristics, root locus analysis and design, frequency response analysis and design.

ELEC 3600 ELECTRIC POWER ENGINEERING (3) LEC. 3. Pr. ELEC 2110 and (MATH 2630 or MATH 2633 or MATH 2637) and MATH 2650. Introduction to the basic concepts in electric power engineering.

ELEC 3700 ANALOG ELECTRONICS (3) LEC. 3. Pr. ELEC 2210 and ELEC 2120. Amplifier modeling. Design and analysis of single-stage and multistage transistor amplifiers. Biasing for integrated circuit design. Operational amplifier circuits.

ELEC 3800 RANDOM SIGNALS AND SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Introduction to probability, random variables, random processes and basic statistics, analysis of random signals and noise.

ELEC 3810 FUNDAMENTALS OF ELECTRICAL ENGINEERING (3) LEC. 3. Pr. (PHYS 1610 or PHYS 1617) and P/C MATH 2650. Electrical circuit analysis; electronic devices, digital systems, amplifier concepts, power devices and systems. Not open to ECE majors.

ELEC 4010 CAPSTONE DESIGN I (1) LEC. 1. Pr. (ELEC 3800 and P/C ELEC 3030 and P/C ELEC 3040) or (P/C ELEC 3800 and P/C ELEC 3050 and P/C ELEC 4200) or (ELEC 3800 and P/C ELEC 3030 and P/C ELEC 3060). The engineering design process, project management and teamwork, ethical and social impacts of design projects, project documentation and presentation, business considerations, and intellectual property.

ELEC 4020 CAPSTONE DESIGN II (3) LEC. 3. Pr. (ELEC 4010 and ELEC 3030 and ELEC 3040 and ELEC 3320 and ELEC 3600 and ELEC 3700 and P/C ELEC 3400) or (ELEC 4010 and ELEC 3050 and ELEC 3800 and ELEC 4200 and COMP 3270 and P/C ELEC 5200 and P/C ELEC 5220) or (ELEC 4010 and ELEC 3030 and ELEC 3060 and P/C ELEC 4100 and P/C ELEC 5130 and P/C ELEC 5410). A capstone design project which draws on the accumulated curricular experience. Particular project sections may have additional prerequisites. Departmental approval needed.

ELEC 4100 WIRELESS COMMUNICATION SYSTEMS (3) LEC. 3. Pr. ELEC 3400. Introduction to mobile cellular radio and wireless personal communications, mobile radio propagation, modulation techniques, multiple access techniques, wireless systems and standards.

ELEC 4200 DIGITAL SYSTEM DESIGN (3) LEC. 2. LAB. 3. Pr. ELEC 2210 and ELEC 2220. Hierarchical, modular design of digital systems, computer-aided digital system modeling, simulation, analysis, and synthesis; design implementation with programmable logic devices and FPGAs.

ELEC 4980 SPECIAL PROJECTS (1-3) IND. Departmental approval. Supervised study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics.

ELEC 4997 HONORS THESIS (1-6) IND. Pr. Honors College. Departmental approval. Directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

ELEC 5120 TELECOMMUNICATION NETWORKS (3) LEC. 3. Pr. ELEC 3400. Principles and building blocks of telecommunication systems, including switched telephone networks, voice and data networks, transmission technologies, and switching architectures

ELEC 5130 RF DEVICES AND CIRCUITS (3) LEC. 3. Pr. ELEC 3700. Introduction to RF semiconductor devices and circuits targeted for wireless applications.

ELEC 5150 INFORMATION SECURITY (3) LEC. 3. Departmental approval. Emerging protocols, standards and technologies of information security; design of information network security using firewalls, virtual private networks and secured applications.

ELEC 5190 INTRODUCTION TO DIGITAL AND ANALOG IC DESIGN (3) LEC. 3. Pr. ELEC 3700. Digital IC design using Verilog, analog and mixed signal IC design using industry standard tools; emphasis on front-end design skills.

ELEC 5200 COMPUTER ARCHITECTURE AND DESIGN (3) LEC. 3. Pr. ELEC 4200. Structural organization and hardware design of digital computers; register transfers; micro-operations, control units and timing; instruction set design; input/output devices, multiprocessors, automated hardware design aids.

ELEC 5210 HARDWARE SECURITY I (3) LEC. 3. Pr. ELEC 2200. Hardware design of symmetric and asymmetric ciphers, digital signature generation and verification, key management, detection and avoidance of counterfeit ICs, cryptographic primitives, and automated hardware design aids.

ELEC 5220 INFORMATION NETWORKS AND TECHNOLOGY (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Architectures, protocols, standards and technologies of information networks; design and implementation of information networks; applications of information networks for data, audio and video communications.

ELEC 5230 PARALLEL PROCESSING (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Hardware components of multiprocessor systems including processor, inter-connection, memory and control architectures; software elements of parallel processing.

ELEC 5240 NEURAL NETWORKS (3) LEC. 3. Pr. ELEC 2120. Principles, architectures, and technologies of neural networks; design and implementation of neural networks using electronics and optics; applications of neural networks.

ELEC 5250 COMPUTER AIDED DESIGN OF DIGITAL INTEGRATED CIRCUITS (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. Computer-automated design of digital logic circuits using discrete gates, programmable logic devices, and standard cells; hardware description languages, circuit simulation, verification, fault diagnosis and testing, RTL-to-GDSII ASIC flow.

ELEC 5260 EMBEDDED COMPUTING SYSTEMS (3) LEC. 3. Pr. ELEC 2220 or COMP 3350. The design of systems containing embedded computers. Microcontroller technology, assembly language and C programming, input/output interfacing, data acquisition hardware, interrupts, and timing. Real-time operating systems and application programming. Embedded system application examples.

ELEC 5290 HARDWARE SECURITY II (3) LEC. 3. Pr. ELEC 5210. This course will provide an in-depth analysis of various topics, which includes advanced cryptography, hardware Trojans, PUFs, RFID security, side-channel attacks and solutions, and blockchain.

ELEC 5310 DESIGN OF ANTENNAS AND ANTENNA SYSTEMS (3) LEC. 3. Pr. P/C ELEC 3320. Application of electromagnetic and circuit concepts to the design of practical antennas and antenna systems.

ELEC 5320 ELECTROMAGNETIC COMPATIBILITY (3) LEC. 3. Pr. ELEC 3320 and ELEC 3700. Electromagnetic noise coupling, designing for electromagnetic compatibility (EMC), EMC regulation, noise sources, standard techniques for eliminating noise, circuit layout for reduced electromagnetic interference (EMI).

ELEC 5340 MICROWAVE AND RF ENGINEERING (3) LEC. 3. Pr. ELEC 3320 and ELEC 3700. Application of electromagnetic and electronic concepts to the design of practical microwave devices and circuits typically used in wireless communications.

ELEC 5350 RADAR PRINCIPLES (3) LEC. 3. Pr. ELEC 3320 and ELEC 3800. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 5410 DIGITAL SIGNAL PROCESSING (3) LEC. 3. Pr. ELEC 3800. Digital processing of signals, sampling difference equations, discrete-time Fourier transforms, discrete and fast Fourier transforms, digital filter design.

ELEC 5470 FUNDAMENTALS OF VLSI TEST (3) LEC. 3. Test economics, automatic test equipment, fault models, automatic test pattern generation, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability, scan and boundary scan, IDDQ testing.

ELEC 5530 MOBILE ROBOT DESIGN (3) LEC. 3. Pr. ELEC 2210 or ELEC 3810. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization.

ELEC 5600 ELECTRIC VEHICLES (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Electric vehicles, technical aspects, mathematical relationships, and basic design guidelines on electric powertrain, traction inverters, electric machines, motor drives, power converter components, Wide Band Gap power electronics, permanent magnets, battery charging infrastructures, grid interactions, the roles in microgrids and smart grids, and computer simulations.

ELEC 5610 POWER ELECTRONICS (3) LEC. 3. Pr. ELEC 3700 and ELEC 3600. Power electronic circuits, components, and devices.

ELEC 5620 POWER SYSTEM ANALYSIS (3) LEC. 3. Pr. ELEC 3600. Departmental approval. Power system modeling, power flow analysis, analysis of faulted power systems.

ELEC 5630 ELECTRIC MACHINES (3) LEC. 3. Pr. ELEC 3600. Departmental approval. Fundamentals of the electromagnetic-mechanical energy conversion process. Principles of operation, application, and control of ac and dc motors and generators.

ELEC 5640 RENEWABLE ENERGY IN ELECTRICAL POWER SYSTEMS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Conventional power plants, global renewables, energy efficiency, marine hydrokinetic (ocean currents and waves), wind power (aerodynamic, generator, plants, grid integration, finance), photovoltaic (device, inverter, plant levels, finance), hydropower (generator, plant level, pumped storage hydro, advances in hydro),power systems grid integration, system impact studies, control and operation of inverter-based resources, ancillary services provisions, and other important aspects of renewables for bulk power (transmission levels) and for distribution power systems.

ELEC 5650 POWER SYSTEM PROTECTION (3) LEC. 3. Pr. ELEC 3600. Fault analysis using symmetrical components. Power switchgear, including switches, disconnects, fuses, relays and circuit breakers. Fundamentals of electric power system protection, including bus, transformer and line protection.

ELEC 5660 SMART GRIDS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Conventional power systems, renewable energy, inverter base resources, smart grid challenges and opportunities, real-time management, grid edge sensors, communications, advanced system protection, restoration, reactive/voltage control, real power/frequency regulation, monitoring and diagnostics, microgrids concept.

ELEC 5670 ELECTRIC POWER ENGINEERING TOPICS (1-3) LEC. 3. Pr. ELEC 3600. Various topics representing state-of-the-art power technology. Course may be repeated for a maximum of 12 credit hours.

ELEC 5690 MICROGRIDS (3) LEC. 3. Pr. ELEC 3600 or ELEC 3810. Distribution power system modeling, inverter-based resources, control, protection, resilience, and security technologies within distributed energy resources (generation, distribution, energy storage, reactive compensation, renewable energy resources) covering microgrid design, analysis, and operation.

ELEC 5700 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Pr. ELEC 2210. Introduction to semiconductors: crystal structure, energy band theory, equilibrium electron and hole statistics, doping, generation and recombination processes, carrier drift and diffusion, transport equations.

ELEC 5710 SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 2210. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 5720 LASER-MATERIAL INTERACTIONS (3) LEC. 3. Pr. MATH 1620 or Departmental approval. Fundamental principles of lasers, optics, and laser-matter interaction mechanisms in various laser-based manufacturing, materials processing, and diagnostic techniques.

ELEC 5730 MICROELECTRONIC FABRICATION (3) LEC. 2. LAB. 3. Pr. ELEC 2210. Departmental approval. Introduction to monolithic integrated circuit technology. Bipolar and MOS processes and structures. Elements of layout, design, fabrication, and applications. Experiments in microelectronic technologies.

ELEC 5760 SOLID STATE SENSORS (3) LEC. 3. Pr. ELEC 3700. or consent of instructor. Theory, technology and design micro-machined sensors and related sensor technologies; and the application of micro-machined sensors.

ELEC 5770 VLSI DESIGN (3) LEC. 3. Pr. ELEC 2210 and ELEC 2220. Review of MOS transistor fundamentals, CMOS logic circuits; VLSI fabrication and design rules; clocking strategies and sequential design; performance estimation; memories and programmable arrays; standard cell design methodologies; computer aided design (CAD) tools.

ELEC 5780 ANALOG CIRCUIT DESIGN (3) LEC. 3. Pr. ELEC 3700. Departmental approval. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

ELEC 5810 COMPUTED IMAGING SYSTEMS (3) LEC. 3. Pr. ELEC 2120. Introduction to computed imaging systems such as magnetic resonance imaging (MRI) and computed tomography (CT).

ELEC 5820 MEMS TECHNOLOGY (3) LEC. 3. Departmental approval. Introduction to Micro-Electro-Mechanical Systems (MEMS), the study of the materials and microfabrication processes used to fabricate MEMS devices, the principles of operation of MEMS devices, and an introduction to the different application areas of MEMS devices.

ELEC 5970 SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics.

ELEC 6120 TELECOMMUNICATION NETWORKS (3) LEC. 3. Principles and building blocks of telecommunication systems, including switched telephone networks, voice and data networks, transmission technologies, and switching architectures.

ELEC 6130 RF DEVICES AND CIRCUITS (3) LEC. 3. Introduction to RF semiconductor devices and circuits targeted for wireless applications.

ELEC 6150 INFORMATION SECURITY (3) LEC. 3. Departmental approval. Emerging protocols, standards and technologies of information security; design of information network security using firewalls, virtual private networks and secured applications.

ELEC 6190 INTRODUCTION TO DIGITAL AND ANALOG IC DESIGN (3) LEC. 3. Digital IC design using Verilog, analog and mixed signal IC design using industry standard tools; emphasis on on front-end design skills.

ELEC 6200 COMPUTER ARCHITECTURE AND DESIGN (3) LEC. 3. Structural organization and hardware design of digital computers; register transfers; micro-operations, control units and timing; instruction set design; input/output devices, multiprocessors, automated hardware design aids.

ELEC 6210 HARDWARE SECURITY I (3) LEC. 3. This course will provide an in-depth analysis of various topics, which include (i) introduction to cryptography - symmetric and asymmetric ciphers, message authentication codes, and digital signatures, (ii) detection & avoidance of counterfeit ICs, and (iii) security primitives - physically unclonable functions (PUFs) and true random number generators (TRNGs).

ELEC 6220 INFORMATION NETWORKS AND TECHNOLOGY (3) LEC. 3. Architectures, protocols, standards and technologies of information networks; design and implementation of information networks; applications of information networks for data, audio and video communications.

ELEC 6230 PARALLEL PROCESSING (3) LEC. 3. Hardware components of multiprocessor systems including processor, interconnection, memory and control architectures; software elements of parallel processing.

ELEC 6240 NEURAL NETWORKS (3) LEC. 3. Principles, architectures, and technologies of neural networks; design and implementation of neural networks using electronics and optics; applications of neural networks.

ELEC 6250 COMPUTER AIDED DESIGN OF DIGITAL INTEGRATED CIRCUITS (3) DSL/LEC. Computer-automated design of digital logic circuits using discrete gates, programmable logic devices, and standard cells; hardware description languages, circuit simulation, verification, fault diagnosis and testing, RTL-to-GDSII ASIC flow.

ELEC 6260 EMBEDDED COMPUTING SYSTEMS (3) LEC. 3. The design of systems containing embedded computers. Microcontroller technology, assembly language and C programming, input/output interfacing, data acquisition hardware, interrupts, and timing. Real-time operating systems and application programming. Embedded system application examples.

ELEC 6290 HARDWARE SECURITY II (3) LEC. 3. Pr. ELEC 5210 or ELEC 6210. This course will provide an in-depth analysis of various topics, which includes advanced cryptography, hardware Trojans, PUFs, RFID security, side-channel attacks and solutions, and blockchain.

ELEC 6310 DESIGN OF ANTENNAS AND ANTENNA SYSTEMS (3) LEC. 3. Application of electromagnetic and circuit concepts to the design of practical antennas and antenna systems.

ELEC 6320 ELECTROMAGNETIC COMPATIBILITY (3) LEC. 3. Electromagnetic noise coupling, designing for electromagnetic compatibility (EMC), EMC regulation, noise sources, standard techniques for eliminating noise, circuit layout for reduced electromagnetic interference (EMI).

ELEC 6340 MICROWAVE AND RF ENGINEERING (3) LEC. 3. Application of electromagnetic and electronic concepts to the design of practical microwave devices and circuits typically used in wireless communications.

ELEC 6350 RADAR PRINCIPLES (3) LEC. 3. Study of the fundamentals of RADAR and related systems such as SONAR and LIDAR.

ELEC 6410 DIGITAL SIGNAL PROCESSING (3) LEC. 3. Digital processing of signals, sampling difference equations, discrete-time Fourier transforms, discrete and fast Fourier transforms, digital filter design.

ELEC 6470 FUNDAMENTALS OF VLSI TEST (3) LEC. 3. Test economics, automatic test equipment, fault models, automatic test pattern generation, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability, scan and boundary scan, IDDQ testing

ELEC 6530 MOBILE ROBOT DESIGN (3) LEC. 3. Fundamentals of mobile robot design, including motor control, sensor integration, path planning, navigation, and localization. Departmental Approval.

ELEC 6600 ELECTRIC VEHICLES (3) LEC. 3. Electric vehicles, technical aspects, mathematical relationships, and basic design guidelines on electric powertrain, traction inverters, electric machines, motor drives, power converter components, Wide Band Gap power electronics, permanent magnets, battery charging infrastructures, grid interactions, the roles in microgrids and smart grids, and computer simulations.

ELEC 6610 POWER ELECTRONICS (3) LEC. 3. Power electronic circuits, components, and devices. Departmental Approval.

ELEC 6620 POWER SYSTEM ANALYSIS (3) LEC. 3. Departmental approval. Power system modeling, power flow analysis, analysis of faulted power systems.

ELEC 6630 ELECTRIC MACHINES (3) LEC. 3. Departmental approval. Fundamentals of the electromagnetic-mechanical energy conversion process. Principles of operation, application, and control of ac and dc motors and generators.

ELEC 6640 RENEWABLE ENERGY IN ELECTRICAL POWER SYSTEMS (3) LEC. 3. Conventional power plants, global renewables, energy efficiency, marine hydrokinetic (ocean currents and waves), wind power (aerodynamic, generator, plants, grid integration, finance), photovoltaic (device, inverter, plant levels, finance), hydropower (generator, plant level, pumped storage hydro, advances in hydro), power systems grid integration, system impact studies, control and operation of inverter-based resources, ancillary services provisions, and other important aspects of renewables for bulk power (transmission levels) and for distribution power systems.

ELEC 6650 POWER SYSTEM PROTECTION (3) LEC. 3. Fault analysis using symmetrical components. Power switchgear, including switches, disconnects, fuses, relays and circuit breakers. Fundamentals of electric power system protection, including bus, transformer and line protection.

ELEC 6660 SMART GRIDS (3) LEC. 3. Conventional power systems, renewable energy, inverter base resources, smart grid challenges and opportunities, real-time management, grid edge sensors, communications, advanced system protection, restoration, reactive/voltage control, real power/frequency regulation, monitoring and diagnostics, microgrids concept.

ELEC 6670 ELECTRIC POWER ENGINEERING TOPICS (1-3) LEC. 3. Various topics representing state-of-the-art power technology. Course may be repeated for a maximum of 12 credit hours.

ELEC 6690 MICROGRIDS (3) LEC. 3. Distribution power system modeling, inverter-based resources, control, protection, resilience, and security technologies within distributed energy resources (generation, distribution, energy storage, reactive compensation, renewable energy resources) covering microgrid design, analysis, and operation.

ELEC 6700 SEMICONDUCTOR FUNDAMENTALS (3) LEC. 3. Introduction to semiconductors: crystal structure, energy band theory, equilibrium electron and hole statistics, doping, generation and recombination processes, carrier drift and diffusion, transport equations.

ELEC 6710 SEMICONDUCTOR DEVICES (3) LEC. 3. Introduction to semiconductor devices: pn junctions, junction diode based devices, optoelectronic devices, bipolar transistors, field effect transistors.

ELEC 6720 LASER-MATERIAL INTERACTIONS (3) LEC. 3. Departmental approval. Fundamental principles of lasers, optics, and laser-matter interaction mechanisms in various laser-based manufacturing, materials processing, and diagnostic techniques.

ELEC 6730 MICROELECTRONIC FABRICATION (3) LEC. 2. LAB. 3. Departmental approval. Introduction to monolithic integrated circuit technology. Bipolar and MOS processes and structures. Elements of layout, design, fabrication, and applications. Experiments in microelectronic technologies.

ELEC 6750 INTRODUCTION TO PLASMA ENGINEERING (3) LEC. 3. Departmental approval. Electrical breakdown and discharges in gases, basic plasma theories, applications of plasmas, plasma processing for microelectronic fabrication.

ELEC 6760 SOLID STATE SENSORS (3) LEC. 3. Theory, technology and design of micro-machined sensors and related sensor technologies; and the application of micro-machined sensors.

ELEC 6770 VLSI DESIGN (3) LEC. 3. Review of MOS transistor fundamentals, CMOS logic circuits; VLSI fabrication and design rules; clocking strategies and sequential design; performance estimation; memories and programmable arrays; standard cell design methodologies; computer aided design (CAD) tools.

ELEC 6780 ANALOG CIRCUIT DESIGN (3) LEC. 3. Circuit design techniques used for implementing analog integrated circuits in both CMOS and bipolar technologies.

ELEC 6810 COMPUTED IMAGING SYSTEMS (3) LEC. 3. Introduction to computed imaging systems such as magnetic resonance imaging (MRI) and computed tomography (CT).

ELEC 6820 MEMS TECHNOLOGY (3) LEC. 3. Departmental approval. Introduction to Micro-Electro-Mechanical Systems (MEMS), the study of the materials and microfabrication processes used to fabricate MEMS devices, the principles of operation of MEMS devices, and an introduction to the different application areas of MEMS devices.

ELEC 6970 SPECIAL TOPICS (1-5) DSL. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics. Course may be repeated for a maximum of 24 credit hours.

ELEC 7190 ADVANCED RFIC DESIGN FOR WIRELESS COMMUNICATIONS (3) LEC. Pr. ELEC 5190 or ELEC 6190 or ELEC 6196. Wireless standards and multi-standard transceiver architectures, SiGe and CMOS RFIC designs for wireless transceiver building blocks, software defined radios, phase array radars, ultra-high speed data converters, and MIMO wireless transceivers.

ELEC 7250 VLSI TESTING (3) LEC. 3. Pr. ELEC 5770 or ELEC 6770 or ELEC 6776. Exponential nature of the test problem, fault models, test generation algorithms, test generation for sequential circuits, fault simulation, testability measures, fault coverage, yield and defect levels, design-for-testability approaches.

ELEC 7310 ADVANCED ELECTRODYNAMICS I (3) LEC. 3. Departmental approval. Review of basic electromagnetics. Electromagnetic wave propagation in infinite and bounded media. Equivalence Principle, Uniqueness Theorem, Reciprocity, Green's functions and Plane wave functions.

ELEC 7320 ADVANCED ELECTRODYNAMICS II (3) LEC. 3. Pr. ELEC 7310 or ELEC 7316. Cylindrical wave functions. Spherical wave functions. Scattering by cylinders and spheres. Perturbational and variational techniques.

ELEC 7410 STOCHASTIC SIGNAL AND SYSTEM ANALYSIS (3) LEC. 3. Departmental approval. Applications of probability, random variables and stochastic processes in electrical engineering.

ELEC 7440 WIRELESS COMMUNICATION THEORY (3) LEC. 3. Pr. ELEC 3400 or ELEC 7410 or ELEC 7416. The basic of design, analysis and performance limits of wireless communication systems.

ELEC 7450 DIGITAL IMAGE PROCESSING (3) LEC. 3. Departmental approval. Digital image processing principles and applications such as enhancement, restoration and compression.

ELEC 7470 ADVANCED VLSI TEST (3) LEC. 3. Pr. ELEC 5470 or ELEC 6470. Memory/PLA/FPGA testing, delay fault testing, test compression, in-field testing, cell-aware test, adaptive test, system-level test.

ELEC 7500 STATE-VARIABLE ANALYSIS OF SYSTEMS (3) LEC. 3. Departmental approval. Matrices and linear spaces; state variable for linear continuous and discrete systems; applications in analysis and design of control systems.

ELEC 7520 ADVANCED DISCRETE CONTROL (3) LEC. 3. Departmental approval. Discrete state modeling. Pole assignment and estimation. Multi-rate sampled systems. Non-synchronous sampled systems. MIMO.

ELEC 7560 NONLINEAR SYSTEMS AND CONTROL (3) LEC. 3. Pr. ELEC 7500 or ELEC 7506. Departmental approval. Principles of nonlinear system modeling and analysis; nonlinear control systems design; nonlinear system state estimation.

ELEC 7610 POWER SYSTEM DYNAMICS AND STABILITY (3) LEC. 3. Pr. (ELEC 5620 or ELEC 6620 or ELEC 6626) and (ELEC 5650 or ELEC 6650 or ELEC 6656). Departmental approval. Dynamic models of power systems and analysis of power system stability.

ELEC 7620 POWER SYSTEM OPERATION (3) LEC. 3. Pr. ELEC 5620 or ELEC 6620 or ELEC 6626. Departmental approval. Unit commitment, power system security, state estimation, power system control centers and real-time applications.

ELEC 7630 ADVANCED ELECTRIC MACHINES (3) LEC. 3. Pr. ELEC 5630 or ELEC 6630 or ELEC 6636. Departmental approval. Advanced machine modeling, including Kron's generalized machine theory, Park's transformation, and generalized coordinate transformations. Derivation of traditional machine models. Machine non-linearities, including finite element analysis.

ELEC 7640 POWER SYSTEM TRANSIENTS (3) LEC. 3. Pr. ELEC 5620 or ELEC 6620 or ELEC 6626. Departmental approval. Transients in electric power systems, including lightning and switching phenomena. Traveling waves on power transmission lines, BIL, BSL, line insulation. System modeling.

ELEC 7710 THE FIELD-EFFECT TRANSISTOR (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of the modern field-effect transistor: the state-of-the art, the MOS capacitor, the 4-terminal MOSFET, short and narrow-channel effects, reliability, scaling theory, modeling, silicon-on-insulator technology, heterostructure devices.

ELEC 7720 THE BIPOLAR TRANSISTOR (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of the modern bipolar junction transistor; the state-of-the-art, terminal currents, solutions for arbitrary doping profiles, the polysilicon emitter contact, high-injector effects, dynamic operation, device models, heterojunction bipolar transistors.

ELEC 7750 LOW TEMPERATURE ELECTRONICS (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of electronic devices operating at reduced temperatures: the case for cryogenic computers, semiconductor physics at low temperatures, carrier freeze-out, cooled CMOS technology, cooled bipolar technology, superconductors, packaging.

ELEC 7760 SILICON-BASED HETEROSTRUCTURE DEVICES AND CIRCUITS (3) LEC. 3. Pr. ELEC 5700 or ELEC 6700 or ELEC 6706. Departmental approval. Bandgap engineering, strained SiGe and Si, SiGe BiCMOS technology, noise, linearity, circuits applications.

ELEC 7770 ADVANCED VLSI DESIGN (3) LEC. 3. Pr. ELEC 5770 or ELEC 6770 or ELEC 6776. Departmental approval. Review of CMOS logic circuits; impact of fabrication issues on design; high speed switching circuits; high performance memory structures; advanced clocking strategies and clock distribution; performance optimization; deep submicron design issues; ASIC design flow: logic synthesis, placement and routing; design verification; low power design.

ELEC 7780 RF MICROELECTRONICS (3) LEC. 3. Pr. ELEC 5780 or ELEC 6780 or ELEC 6786. Departmental approval. Techniques used in the design of monolithic integrated circuits for RF applications.

ELEC 7830 PHOTOVOLTAICS (3) LEC. 3. Departmental Approval. Theory, technology, design and application of photovoltaic devices and systems.

ELEC 7900 INDEPENDENT STUDY (1-3) IND. Departmental approval. Supervised study in specialized areas of electrical and computer engineering.

ELEC 7950 ELECTRICAL ENGINEERING SEMINAR (1-10) SEM. SU. Course may be repeated for a maximum of 10 credit hours.

ELEC 7970 SPECIAL TOPICS (1-5) DSL. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change of topic. Course may be repeated for a maximum of 24 credit hours.

ELEC 7990 RESEARCH AND THESIS (1-6) MST. Course may be repeated for a maximum of 6 credit hours.

ELEC 8120 PRINCIPLES OF NETWORK PERFORMANCE ANALYSIS (3) LEC. 3. Pr. (ELEC 5120 or ELEC 6120 or ELEC 6126) and (ELEC 7410 or ELEC 7416). Data network performance analysis, queueing systems, admission control, network traffic modeling, network calculus, flow and congestion control, wireless network analysis, and network simulation.

ELEC 8420 DETECTION AND ESTIMATION THEORY (3) LEC. 3. Pr. ELEC 7410 or ELEC 7416. Decision theory concepts. Detection of deterministic and random signals in noise; parameter estimation. Bayesian and maximum likelihood approaches, non-random and random parameter estimation; signal estimation.

ELEC 8560 ADAPTIVE CONTROL (3) LEC. 3. Pr. ELEC 7500 or ELEC 7506. Departmental approval. Theory and application of adaptive control systems. Real-time parameter estimation, self-tuning regulators, model-reference adaptive systems, stability, auto-tuning and gain scheduling controllers.

ELEC 8710 ADVANCED TOPICS IN SEMICONDUCTOR DEVICES (3) LEC. 3. Pr. ELEC 5710 or ELEC 6710 or ELEC 6716. Advanced treatment of selected topics in semiconductor devices. Course may be repeated for a maximum of 6 credit hours.

ELEC 8900 ADVANCED INDEPENDENT STUDY (1-3) IND. Departmental approval. Supervised study in specialized areas of electrical and computer engineering.

ELEC 8970 ADVANCED SPECIAL TOPICS (1-5) LEC. Departmental approval. Study of a specialized area of electrical and computer engineering not covered by regularly offered courses. Course may be repeated with change in topics. Course may be repeated for a maximum of 9 credit hours.

ELEC 8990 RESEARCH AND DISSERTATION (1-10) DSL/DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.