ECE - ELECTRICAL & COMPUTER ENGINEERING (ECE)

ECE 160 - Engineering Practice 2 Credits

Hours: 0R-4L-2C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: None

An introduction to electrical and computer engineering, systems engineering design, programming, microcontrollers, soldering and circuit building.Students will work individually and on teams to complete projects and create a system for an end of term competition.Students will also learn about technical documentation and communication.Topics include functions, arrays, conditionals, loops, Boolean algebra, wireless communication, resistors, transistors, diodes motors, sensor, analog and digital inputs and outputs.

ECE 180 - Introduction to Signal Processing 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: (MA 112 (may be taken concurrently) or MA 107 (may be taken concurrently)) and (CSSE 120 or CSSE 220 or CSSE 230 or ECE 160 or ENGD 120 or ME 123)
Notes: Prerequisite: MA112 or MA107 (concurrent registration allowed) and either ECE 160 or CSSE 120 or ENGD 120 or ME 123 or prior programming experience

An introduction to discrete-time signal processing applied to audio, images, and video. Topics include phasor representation of sinusoidal signals, complex arithmetic, sampling, signal spectra, linear time-invariant systems, frequency response, convolution, filter implementation, and MATLAB programming. Integral laboratory.

ECE 199 - Professional Experience 1 Credit

Hours: 1R-0L-1C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

The professional experiences course captures the practical work experiences related to the student's academic discipline. Students are required to submit a formal document of their reflections, which communicates how their employment opportunity reinforced and enhanced their academic studies.

ECE 203 - DC Circuits 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: (MA 111 or MA 106 (may be taken concurrently) or MA RA100 or MA 102) and PH 112

A review of the definition of voltage, current, energy and power.An introduction to Ohm's Law, ideal DC independent and dependent voltage and current sources, resistors, inductors, capacitors, and operational amplifiers.Circuit analysis and simplification by using series, parallel, and Wye-Delta reduction, Kirchhoff's laws, mesh and nodal analysis, Thevenin, Norton and Maximum Power Theorems, superposition, and source transformations.An integral laboratory to build electric circuits and measure voltage, current, resistance and power.

ECE 204 - AC Circuits 4 Credits

Hours: 3R-3L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: PH 113 (may be taken concurrently) and (ECE 203 (may be taken concurrently) or ENGD 120 (may be taken concurrently) or BE 131 (may be taken concurrently) or ES 203 (may be taken concurrently) or (ES 213 (may be taken concurrently) and ES 213L (may be taken concurrently)))

ECE 205 - Circuits and Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: (ECE 180 or BE 321) and (HUM H190 or RH EXMPT or ENGL H100 or RH 131 and (MA 222 (may be taken concurrently) or MA 211 (may be taken concurrently)) and (ECE 203 or ENGD 120 or (ES 213 and ES 213L))

Introduction to 1st and 2nd order circuits and review of differential equations. Bode plots. System classification, impulse and step response, convolution. Laplace and inverse Laplace transforms, block and signal flow diagrams. Benefits of feedback. Modeling and simulating electrical systems. Matlab and Simulink. Integral laboratory.

ECE 206 - Elements of Electrical Engineering 4 Credits

Hours: 4R-0L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: MA 221 or MA 211

A course designed for engineers (other than electrical or computer) covering analysis of passive circuits, introduction to op-amps, instrumentation, sinusoidal steady-state, a-c power, and induction motors. EE and CPE majors may not take this course.

ECE 230 - Introduction to Embedded Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: (CSSE 120 or CSSE 221 or CSSE 220EL or CSSE 220) and ECE 160 and ECE 233

Sensors and actuators. Input and output devices. Microcontroller architecture. Standard communications protocols. Interrupt generation and processing. Data representation and storage. Memory management. The C programming language and programming styles. Integral laboratory and a term project.

ECE 233 - Introduction to Digital Systems 4 Credits

Hours: 3R-3L-4C
Term Available: F,W,S
Graduate Studies Eligible: No
Prerequisites: CSSE 120 or CSSE 220 or CSSE 220EL or CSSE 221 or CSSE 230 or CSSE 230EL or ECE 160 or ENGD 120

Number systems, Binary arithmetic, logic gates, forming logic circuits. Boolean algebra, Karnaugh maps. Propagation delay, hazards, common Combinational logic circuits, structures, and design. Contraction, latches, flip-flops, finite state machines, counters, Sequential circuit timing, and designing Sequential circuits. Register design, control and datapath design. Basic computer architecture, including memory. Integral laboratory.

ECE 250 - Electronic Device Modeling 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: (ECE 204 or ECE 205) and (ES 203 or (ES 213 and ES 213L) or ECE 203 or ENGD 120)

Modeling, analysis, and simulation of electronic circuits that contain two-terminal and threeterminal semiconductor devices. Large-signal, biasing, and small-signal analysis models. Introduction to wave shaping circuits, switching circuits, and amplifiers. Integral laboratory.

ECE 300 - Continuous-Time Signals & Systems 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: ECE 205 and MA 381 (may be taken concurrently) and (MA 222 or (MA 211 and MA 212))

Signal modeling. Fourier series and Fourier transforms. Response of systems to periodic and aperiodic signals. Filter characterization and design. Ideal and practical sampling. Use of numerical analysis software. Integral laboratory

ECE 310 - Communication Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: ECE 380

Transmission of information over bandlimited, noisy communication channels. Line codes, probability of error, intersymbol interference. Modulation techniques, synchronization and frequency conversion. Integral laboratory.

ECE 312 - Communication Networks 4 Credits

Hours: 4R-0L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: MA 381 and (CSSE 120 or CSSE 220 or CSSE 221 or CSSE RA120)

Layered architectures. Circuit and packet switching. The ISO Reference Model. Point-to-point protocols, error control, framing. Accessing shared media, local area networks. Virtual circuits, datagrams, routing, congestion control. Queuing theory. Reliable message transport, internetworking.

ECE 320 - Linear Control Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: (ECE 200 or ECE 207) or (ECE 300 and (ECE 230 or ME 430))

Analysis of linear control systems using classical and modern control theories in both continuous and discrete time. Plant representation, closed loop system representation, time response, frequency response, concept of stability. Root locus, Bode, and Nyquist methods. Computer modeling and simulation of feedback systems, implementation of discrete-time algorithims on microcontrollers.

ECE 332 - Computer Architecture II 4 Credits

Hours: 4R-0L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: CS 232 or CSSE 232

Instruction-Level Parallelism. Pipelining. Data Hazards. Exceptions. Branch Prediction. Multilength Instructions. Loop Unrolling. TI C6000 Digital Signal Processor. Cache. Memory. MSP430 Microcontroller. PIC Microcontroller. Intel Itanium. Multiprocessors. Hardware Multithreading. Graphics Processors. Supercomputers.

ECE 340 - Electromagnetic Fields 4 Credits

Hours: 4R-0L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: (ECE 204 and MA 222) or (ECE 204 and MA 211 and MA 212)

Static and dynamic fields. Electric and magnetic properties of materials. Energy, force and power. Resistors, capacitors, and inductors. Application in sensing and actuation. Maxwell's equations. Introduction to electromagnetic waves. Use of vector calculus and numeric approximation. Technical reports and/or term papers.

ECE 341 - Electromagnetic Waves 4 Credits

Hours: 4R-0L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: ECE 340

Wave propagation and reflection. Power and lossy materials. Quasistatic analysis. Steady-state and transient analysis of transmission lines. Application in high-speed systems. Introduction to antennas. Technical reports and/or term papers.

ECE 342 - Introduction to Electromagnetic Compatibility 4 Credits

Hours: 3R-3L-4C
Term Available: F,S
Graduate Studies Eligible: No
Prerequisites: ECE 300

Electromagnetic compatibility (EMC) regulations and measurement. Frequency behavior of passive components. Electromagnetic fields and waves. Transient behavior of transmission lines. Dipole and monopole antennas. Four coupling mechanisms: electrical and magnetic fields, common impedance, and electromagnetic wave. Conducted emissions. Radiated emissions. Electromagnetic shielding and grounding.

ECE 343 - High-Speed Digital Design 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: ECE 300

Signal path modeling through connecting lengths of transmission lines with lumped element models of discontinuities. Circuit parameters from geometries and material properties for resistance, capacitance, inductance and transmission line segments. Lossless and lossy transmission line circuit modeling. High-frequency and high-speed behavior of passive components. Frequency spectrum of digital signals. Digital device driver and receiver modeling. Transmission line impedance discontinuity and termination techniques. Electric and magnetic field coupling mechanisms for capacitive and inductive crosstalk. Ground noise, power plane noise and resonance. Signal and power integrity issues in high-speed digital systems at both the printed-circuit board and chip levels.

ECE 351 - Analog Electronics 4 Credits

Hours: 3R-3L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: ECE 250 and (ECE 205 or ECE 200)

Amplifier design and analysis including discrete and integrated circuit topologies. Cascaded amplifier, input and output stages, frequency response. Linear and non-linear op-amp circuits. Introduction to the non-ideal properties of op-amps. Integral laboratory.

ECE 362 - Principles of Design 3 Credits

Hours: 3R-0L-3C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: ECE 204 and ECE 205 and ECE 230 and ECE 233 and ECE 250 and ECE 300

A formal design course that emphasizes the design process. Project management, project reporting and decision-making are learned by student teams as they carry a project through several stages of a formal design process.

ECE 370 - Electric Machinery 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: (ECE 300 and ECE 340) or ECE 200 (may be taken concurrently) or ECE 204

Analysis of generation systems consisting of: modeling of synchronous and induction generators, examination of fossil, nuclear, hydroelectric, solar, and wind technologies. Analysis of transmission and distribution systems consisting of modeling: power transformers, transmission lines, switchgear, and protection systems. Analysis of customer systems consisting of modeling: induction motors, linear and non-linear loads.

ECE 371 - Conventional & Renewable Energy Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: ECE 204

Conventional and modern sources of energy for power generation in electric power industry with the imposed economic, regulatory, and environmental constraints. Wind, solar-photovoltaic, micro-hydropower, and fuel cell systems. Integral laboratory.

ECE 380 - Discrete-Time Signals and Systems 4 Credits

Hours: 4R-0L-4C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: ECE 300 and MA 381

System properties: linearity and time-invariance. Sampling and reconstruction. Convolution in discrete-time systems. Z-transform, FIR and IIR filters. Discrete-time filter design. Discrete Fourier transform. Random Variables and Random Processes.

ECE 398 - Undergraduate Projects 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: F,W
Graduate Studies Eligible: No
Prerequisites: None

Special design or research projects. Students may take up to four credits in any given term. In contrast to ECE498, no public presentation of work is required. Students cannot use this class to satisfy ECE Area Elective credit.

ECE 412 - Software Defined Radio 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: ECE 380

Essential concepts of wireless communications. Software defined radio (SDR) architecture. Analog and digital modulation formats. Transmitter and receiver system design and implementation methods. Synchronization techniques. Term project.

ECE 414 - Wireless Systems 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 310

Introduction to wireless communications and networks. Wireless channel models, vector space, modulation and demodulation, optimal receiver design, equalization, channel capacity, multipleaccess techniques, spread spectrum, and multiple-antenna systems.Additional recommended prerequisite: MA371 or MA373 with a grade of B or higher.

ECE 415 - Wireless Electronics 4 Credits

Hours: 2R-6L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

Design, fabrication, and testing of a high frequency transmitter-receiver system including but not limited to oscillators, mixers, filters, amplifiers, and matching networks. Integral laboratory.

ECE 416 - Introduction to MEMS: Fabrication & Applications 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: None

Properties of silicon wafers; wafer-level processes, surface and bulk micromachining, thin-film deposition, dry and wet etching, photolithography, process integration, simple actuators. Introduction to microfluidic systems. MEMS applications: capacitive accelerometer, cantilever and pressure sensor. Cross-listed with CHE 405, NE 410, and ME 416.

ECE 418 - Fiber Optic Systems 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 310

Analysis and design of common photonic systems such as fiber optic communication links, optical sensing systems, and optical networks. Topics include basic architectures, component overview, system design, and expected degradations along with mitigation techniques. An oral presentation of a technical paper is required.

ECE 420 - Discrete-Time Control Systems 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: ECE 320 or ME 406

Sampled systems and z-transforms. Transfer function and state-variable models of systems. Discrete-time control of systems including state variable feedback and observer construction.

ECE 425 - Introduction to Mobile Robotics 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: CSSE 120 and (ECE 320 or ME 406 or BE 350 or CHE 440)

This course will introduce the basic principles of mobile robotics history, theory, hardware and control. Topics will include robot components, effectors and actuators, locomotion, sensors, feedback control, control architectures, representation, localization and navigation. This is a project-oriented course and the student will have hands-on experience with a real mobile robot. The student will be required to complete several laboratory assignments and a multidisciplinary team design project.

ECE 430 - Microcontroller Based Systems 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 130

Microcontroller register set, addressing modes and instruction set. Microcontroller peripheral support modules. Assembly language and C programming. Fundamental data structures. Interrupts. Real time programming. Data communications. Microcontroller interface to displays, digital and analog devices, sensors, and actuators. Embedded system design, implementation and applications. Integrated development environment. Formal final report and oral presentation. Integral laboratory. Credit cannot be obtained for both ECE 331 and ECE 430.

ECE 433 - Advanced Digital System Design with Verilog 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: ECE 233

Concepts and designs of combinational and sequential digital systems; Modern design methodology; ASM and ASMD charts for behavioral modeling; Synthesizable Verilog descriptions and synthesis techniques; Design verification and functional simulations; FPGA implementations of digital systems; Timing analysis and constraints; Storage devices; Implementation options; I/O clocking techniques; Synchronous and asynchronous designs; Complex digital systems; IP core applications. Integrated Development Environment. Integral laboratory.

ECE 434 - Embedded Linux 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: CSSE 332 or ECE 230

Brief introduction to Linux on an embedded processor. Software development in various languages (C, shell scripts, Python, JavaScript, etc.). Hardware interfacing. Kernel development. Software tools (IDE, gcc, make, node.js, etc.)

ECE 436 - Internet of Things 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 230 or CSSE 132 and ECE 312 or CSSE 432

ECE 452 - Power Electronics 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 250

Analysis and design of networks that use electronic devices as power switches. Silicon-controlled rectifiers, power transistors, and power MOSFETS are used to form phase-controlled rectifiers, AC voltage controllers, choppers, and inverters. Integral laboratory.

ECE 454 - System Level Analog Electronics 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: ECE 351

Analysis and design of Op-Amp circuits: wave shaping circuits, Schmitt triggers, power amplifiers, high power buffers, controlled current sources, peak detectors, sample and hold circuits. Precision Op-Amp Circuits. Non-ideal properties of Op-Amps. Integral laboratory.

ECE 460 - Engineering Design I 3 Credits

Hours: 1R-6L-3C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: ECE 362 (may be taken concurrently) and (ECE 380 (may be taken concurrently) and ECE 310 (may be taken concurrently) and ECE 351 (may be taken concurrently) and (ECE 370 (may be taken concurrently) or ECE 371 (may be taken concurrently)) and ECE 340 (may be taken concurrently) and ECE 341 (may be taken concurrently) and ECE 320 (may be taken concurrently) and ECE 230 (may be taken concurrently)) or (ECE 343 (may be taken concurrently) and CSSE 332 (may be taken concurrently) and CSSE 230 (may be taken concurrently) and ECE 250 (may be taken concurrently) and (ECE 380 (may be taken concurrently) or ECE 320 (may be taken concurrently)) and ECE 362 (may be taken concurrently) and ECE 312 (may be taken concurrently) and ECE 332 (may be taken concurrently) and ECE 230 (may be taken concurrently))

A continuation of a sequence of formal design courses that emphasizes completion of a client-driven project using a formal design process. Student teams carry a project from inception to completion to satisfy the need of a client. Integral laboratory.

ECE 461 - Engineering Design II 4 Credits

Hours: (0 - 4)R-(0 - 6)L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: ECE 460

Continuation of the design project from ECE460. Integral laboratory.

ECE 461C - Engineering Design II (CPE) 4 Credits

Hours: 4R-0L-4C
Graduate Studies Eligible: No
Prerequisites: CSSE 332 and ECE 331 and ECE 332 and ECE 333 and ECE 342 and ECE 351 and ECE 380 and ECE 460

ECE 461E - Engineering Design II (EE) 4 Credits

Hours: 4R-0L-4C
Graduate Studies Eligible: No
Prerequisites: ECE 310 and ECE 320 and ECE 333 and ECE 341 and ECE 351 and (ECE 370 or ECE 371) and ECE 380 and ECE 460

ECE 462 - Engineering Design III 2 Credits

Hours: 1R-3L-2C
Term Available: W,S
Graduate Studies Eligible: No
Prerequisites: ECE 461 or ECE 461C or ECE 461E

Completion of the design project from ECE 460 and ECE 461. Integral laboratory.

ECE 466 - Consulting Engineering Seminar 2 Credits

Hours: 2R-0L-2C
Graduate Studies Eligible: No
Prerequisites: None

Discussion problems in the field of consulting engineering; seminars presented by practicing consulting engineers. Cross-listed with BE 400, ME 420, CHE 420, and CE 420.

ECE 470 - Power Systems Analysis I 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 370

Per-unit concepts. Modeling and analysis of synchronous machines. Configuration of transmission and distribution lines. Modeling of power system components. Formulation of power flow equations. Computer solutions of the load-flow problem. Fault-level evaluation by symmetrical components. Principles of grounding. Integral laboratory.

ECE 471 - Power Systems Analysis II 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 370

Design and analysis techniques for low and medium voltage power distribution systems. Harmonics, transients, system coordination, reliability and economics. A design project is carried throughout the course.

ECE 472 - Power Systems II 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 470

Power system protection and stability. Design and application of relaying schemes for protection of transformers, buses, distribution lines, transmission lines, generators, motors, capacitors, and reactors. Power system stability and generator rotor dynamics phenomenon with use of the equal-area criterion. Integral laboratory.

ECE 473 - Control of Power Systems 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

Principles of interconnected operation of power systems. Optimum scheduling of generation using economic dispatch and unit commitment. Primary and secondary load-frequency control. Voltage and reactive-power flow control. Principles of state estimation. Integral laboratory.

ECE 480 - Introduction to Image Processing 4 Credits

Hours: 4R-0L-4C
Term Available: W,S
Graduate Studies Eligible: Yes
Prerequisites: MA 222

This course explores fundamental image processing techniques including intensity transformations, spatial and frequency-domain filtering, restoration, reconstruction, geometric transformations, segmentation, and morphological processing. Through the projects, students build practical engineering and computer science expertise, focusing on real world implementation and application while discussing foundational mathematical concepts.#Cross-listed with OE437.

ECE 481 - Electronic Music Synthesis 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 280 or ECE 380

Analog synthesis techniques. Instrument control using MIDI. FM, additive and subtractive synthesis. Physical modeling and sound spatialization. Course project.

ECE 483 - DSP System Design 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 380 and MA 381

Study of finite word length effects in DSP systems. Cascaded filter structures. Coefficient quantization, roundoff noise, scaling for overflow prevention. Discrete-time noise, filtering noise, power spectral density. Polyphase filtering, interpolation and decimation. Implementation and system design and test issues for a SSB communication system. Integral laboratory based on a fixed point programming project.

ECE 484 - Introduction to Radar & Electronic Warfare 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: PH 113 and (MA 381 or MA 223)

Introduction to radar systems and electronic warfare (EW) techniques. Basic concepts in the field of electromagnetic energy propagation, antennas, and data acquisition systems. The students will gain knowledge on the different types of radar systems, perform analysis on RF signals, and simulate electronic warfare systems and operation. This class helps provide a foundation to work professionally in the areas of radar and other sensor applications.

ECE 497 - Special Topics in Electrical Engineering 1-10 Credits

Hours: (0 - 10)R-(0 - 10)L-(1 - 10)C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

Topics of current interest to undergraduate students.

ECE 498 - Undergraduate Projects 1-4 Credits

Hours: (1 - 2)R-(2 - 6)L-(1 - 4)C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

Special design or research projects. Students may take up to four credits in any given term. Level and rigor of work should be consistent with other 400-level ECE elective courses. Work must be presented publicly at the end of term. Up to four credits of ECE498 can count towards ECE Area Elective credit. Students not wishing to give a public presentation of their work should take ECE398.

ECE 510 - Error Correcting Codes 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: ECE 310

Coding for reliable digital communication. Topics to be chosen from: Hamming and BCH codes, Reed-Solomon codes, convolutional codes, Viterbi decoding, turbo codes, and recent developments, depending on interests of class and instructor. Mathematical background will be developed as needed.

ECE 511 - Data Communications 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: ECE 310 and (MA 381 or MA 223)

Design of digital communication systems. Autocorrelation function and power spectrum, vector space models of signals and noise, optimal receiver structures and performance, bandlimited channels and equalization, convolutional coding.

ECE 512 - Probability, Random Processes, and Estimation 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: MA 381 and ECE 380

Review of probability and random variables, random vectors, topics in estimation and detection theory, linear and nonlinear estimation, orthogonality principle, hypothesis testing, random processes, stationarity, correlation functions, and spectra. Additional topics chosen from Wiener and Kalman filtering, and Markov chains.

ECE 513 - Information Theory and Coding 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: MA 381 and (ECE 320 or ECE 380)

Information measures. Source coding theorem and lossless compression limit. Data compression techniques. Uniquely decodable codes and their properties. Reliable communication over noisy channels. Channel coding theorem and channel capacity. Error-control coding techniques. Linear codes and their properties. Near-capacity codes.

ECE 516 - Introduction to MEMS: Fabrication & Applications 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: None

Properties of silicon wafers; wafer-level processes, surface and bulk micromachining, thin-film deposition, dry and wet etching, photolithography, process integration, simple actuators. Introduction to microfluidic systems. MEMS applications: capacitive accelerometer, cantilever and pressure sensor. Cross-listed with BE 516, CHE 505, NE 510, and ME 516.

ECE 530 - Advanced Microcomputers 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 230 or ECE 331

32-bit microcontroller architecture. Software development in both assembly language and C language. Hardware interfacing. Use of a real-time-operating system (RTOS). System-on-a-chip (SOC) hardware/software design using a field programmable gate array (FPGA) chip containing an embedded microcontroller cores. Software debugging tools. Integral laboratory.

ECE 531 - Digital Test & Product Engineering 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 230 and ECE 250 and (ECE 233 or ECE 333)

Industrial testing techniques for microcontrollers and other digital integrated circuits. Includes common digital system fault modeling, test generation, and design for testability in addition to memory testing strategies. Integral labs using an industrial grade automatic test environment (ATE).

ECE 532 - Advanced Topics in Computer Architecture 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 332

Superscalar processors. Out-of-Order Execution. Register Renaming. Dynamic Random Access Memory (DRAM). Prefetching. Trace Cache. Victim Cache. 3D DRAM. Multithreading.Multicore. Cache Coherence. Transactional Memory. Performance Modeling. Power Modeling. Intel Pentium Pro Architecture. Transmeta Crusoe Architecture. Code Morphing. ARMv7 Architecture. Nvidia G80 Architecture.

ECE 534 - Advanced Signal & Power Integrity 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 341 or ECE 342 or ECE 343

Signal and power integrity modeling and measurement in high-speed digital systems at IC, PCB, and chassis levels. High-frequency behavior of passive components and packages. Behavior and SPICE models of drivers and receivers. Lossy transmission lines and discontinuity characterization. Mixedmode s-parameters and other network parameters. Frequency and time-domain modeling of capacitive and inductive crosstalk. Differential signaling techniques; timing conventions. Synchronization. Signal equalization. Power plane noise and resonance. High-speed PCB design guidelines. Measurement techniques including time-domain reflectometry, vector network analyzer and impedance analyzer. PCB simulation. Full-wave simulations.

ECE 540 - Antenna Engineering 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 341

Electromagnetic radiation, antenna terminology and characteristics, dipole antennas, arrays, aperture antennas, measurements, computer-aided analysis, design projects and reports.

ECE 541 - Microwave/Millimeter-Wave Engineering 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 341

Wave-guiding structures, microwave network analysis, scattering parameters, Z, Y and ABCD parameters, passive devices and components, design, fabrication, simulation and measurement of microwave devices and components, matching strategies, multi-conductor transmission lines and crosstalk.

ECE 542 - Advanced Eletromagnetics 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 341

Maxwell's equations, EM field theorems, potential functions, power and energy, material properties, wave propagation, reflection and transmission, radiation, scattering, Green's functions, metamaterials and metamaterial-inspired structures, modeling & simulation, measurement technique.

ECE 543 - Electromagnetic Metamaterials 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 341

Electromagnetic fundamentals, control of permittivity and permeability, dispersion, causality, double-negative materials, epsilon near-zero materials, transmission line-based metamaterials, composite right/left handed wave-guiding structures, even/odd mode analysis,differential signaling, electromagnetic bandgap structures, phase control, dual band devices, enhanced bandwidth devices, zeroth-order resonators, full wave simulation, device fabrication and laboratory measurement.

ECE 551 - Digital Integrated Circuit Design 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 250 and ECE 233

Design, performance analysis, and physical layout of CMOS logic. Custom and standard cell methodologies. Use of commercial CAD tools. Design issues such as interconnect, timing, and testing methods. Integral laboratory and project.

ECE 552 - Analog Integrated Circuit Design 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 351 and ECE 380

Design, performance analysis, and physical layout of analog integrated circuits. Focus on operational amplifier design and op-amp circuits. Introduction to mixed-signal circuit design such as switch-capacitors, A/D, or D/A systems. Integral laboratory and design project.

ECE 553 - Radio-Frequency Integrated Circuit Design 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 310 and ECE 351

Design, analysis, and physical layout of high-frequency analog integrated-circuits for modern RF transceivers. Circuit design for each primary transceiver component. General issues such as impedance matching and design of inductors on integrated circuits. Integral laboratory and design project.

ECE 554 - Instrumentation 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 351

Transducers and their applications. Analog signal processing techniques using operational amplifiers. A/D and D/A converters. Protection from electric shock. Measurement of biological potential waveforms (ECG, EMG, EEG, ENG, EOG, ERG). Ultrasound techniques and instrumentation. X-ray CAT techniques. No laboratory, but many in-class demonstrations and emphasis on circuit simulation.

ECE 556 - Power Electronics: DC Power Supplies 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 351

Analysis and design of AC-DC and DC-DC converters. Linear, basic switching, charge-pump, and fly-back topologies. Introduction to devices used in a power switching supplies. Thermal management. Integral laboratory.

ECE 557 - Analog Test & Product Engineering 4 Credits

Hours: 3R-3L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: ECE 300 and ECE 351

Fundamental skills necessary to be an industrial integrated circuit test engineer or product engineer. Includes the economics associated with testing, impact of fabrication variation on devices, instrumentation associated with industrial testing, turning a data sheet into a test plan, industrial testing techniques for analog circuits, trade-offs between test time and test accuracy, statistical analysis of the data and statistical process control, the use of device interface boards necessary to control device loading for different tests. Integral labs with an industrial grade automatic tester (ATE).

ECE 558 - Mixed-Signal Test & Product Engineering 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 300 and ECE 233 and ECE 351

Industrial testing techniques for AC and DC tests of mixed-signal integrated circuits using an automatic test environment (ATE). Includes the structure and operation of comparators and standard data converters (DACs, ADCs), common data converter datasheet specifications, impact of data converter design on testing strategies, and statistical analysis of accuracy-time trade-offs. Integral labs using an industrial grade ATE.

ECE 580 - Digital Signal Processing 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: ECE 380 and MA 381

Digital filters. Fundamental concepts of digital signal processing. Analysis of discrete-time systems. Sampling and reconstruction. Theory and application of z-transforms. Design of recursive and nonrecursive digital filters. Window functions. Discrete Fourier transforms and FFT algorithm.

ECE 582 - Advanced Image Processing 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: CSSE 120 or ME 123

Introduction to image segmentation and recognition. Use of neural networks, fuzzy logic and morphological methods for feature extraction.Advanced segmentation, detection, recognition and interpretation. Relevant laboratory experiments and required project.Cross-listed with OE 537.

ECE 584 - Medical Imaging Systems 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 300 or BE 321 or OE 392

Engineering principles of major imaging techniques/modalities for biomedical applications and health care including diagnostic x-ray, computed tomography, nuclear techniques, ultrasound, and magnetic resonance imaging. Topics include general characteristics of medical images; physical principles, signal processing to generate an image, and instrumentation of imaging modalities. Clinical applications of these technologies are also discussed. Cross-listed with BE541 and OE584.

ECE 596 - Independent Study in Electrical Engineering 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: None

Thesis topic selected in consultation with adviser. Graduate students only.

ECE 597 - Special Topics in Electrical Engineering 1-6 Credits

Hours: 0R-0L-(1 - 6)C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: ECE 332

Special topics of current interest to graduate students and senior undergraduates.

ECE 598 - Thesis Research 1-12 Credits

Hours: 0R-0L-(1 - 12)C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: None

Thesis topic selected in consultation with adviser. Graduate students only.

ECE 699 - Professional Experience 1 Credit

Hours: 1R-0L-1C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

The professional experiences course captures the practical work experiences related to the student's academic discipline. Students are required to submit a formal document of their reflections, which communicates how their employment opportunity reinforced and enhanced their academic studies. The work experiences should be informative or integral to the advancement or completion of the student's program requirements.