ELECTR. AND COMPUTER ENGIN. (ECE)

ECE 2160 Electronics 2E 5 cr
(Lab required) Characteristics of integrated circuits and transistors; design of DC and AC amplifiers in the steady state.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2262.

ECE 2220 Digital Logic Systems 5 cr
(Lab required) Boolean algebra and logic primitives, net-work simplification techniques, physical realizations, number systems and codes; analysis and design of asynchronous and synchronous sequential circuits; applications to computation, measurements, and control.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 1450
Mutually Exclusive: COMP 3090

ECE 2240 Numerical Methods for Electrical Engineers 4 cr
(Lab required) Numerical methods applied to Electrical Engineering problems; mathematical models of physical systems, solutions of linear and non-linear equations, numerical differentiation and integration methods and associated errors, introduction to solution analysis. May not be held with MATH 2120.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2262, COMP 1012, MATH 2132
Equiv To: MATH 2120

ECE 2262 Electric Circuits 4 cr
(Lab required) The application of circuit concepts; network theorems and formal methods, steady state analysis, frequency and transient response, application of the Laplace transform in the analysis of linear time-invariant networks.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: [ENG 1450. Pre- or corequisite: MATH 2132 or [MATH 2100 and MATH 2110].
Equiv To: ECE 2260

ECE 2400 Engineering Algorithms 1 4 cr
(Lab required) An introduction to common engineering algorithmic problem-solving approaches. Students will develop the ability to evaluate, analyze, design, and implement a wide array of generally useful algorithmic paradigms, for example, divide-and-conquer, dynamic programming, and greedy algorithms. May not be held with the former ECE 3790.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: MATH 2132. Pre- or corequisite: COMP 2140 and MATH 2136.
Equiv To: ECE 3790

ECE 3010 Elements of Electric Machines and Digital Systems 4 cr
(Lab required) Introduction to elementary concepts in ac circuits, electric machines, and digital sub-systems. Topics include electrical impedance, capacitors, inductors, electric motors, logic gates, decoders, multiplexing, flip flops, registers, microprocessor structures, I/O and data acquisition. Not available to students in Electrical or Computer Engineering.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ENG 1450, MATH 2132, and a year class designation of Year 3 or Year 4.
Equiv To: ECE 3680

ECE 3400 Engineering Algorithms 2 4 cr
(Lab required) An exploration of common engineering algorithmic problem-solving approaches, focused primarily on numerical analysis problems. Students will develop the ability to evaluate, analyze, design, and implement a wide array of generally useful paradigms, for example solving linear and non-linear equations (linear algebra and root finding), curve fitting, numerical integration and differentiation, solving differential equations, and introduction to optimization and machine learning.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2400 or the former ECE 3790.

ECE 3540 Advanced Circuit Analysis and Design 4 cr
(Lab required) Application of the Laplace Transform in the analysis of linear time-invariant networks, poles, zeros and frequency response; natural frequencies; general network theorems; two ports; energy and passivity; transmission lines; time and frequency domain.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2262 (or ECE 2260) and MATH 3132 (or MATH 3100).

ECE 3580 Foundations of Electromagnetics 4 cr
(Lab required) (Formerly ECE 2130) Fundamental laws of field theory; Maxwell's equations in integral and point form.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2240, PHYS 2152, and MATH 3132 (MATH 3100).
Equiv To: ECE 2130

ECE 3590 Electromagnetic Theory 4 cr
(Lab required) Maxwell's equations; plane electromagnetic waves; transmission line theory; electromagnetic radiation and introduction to antennas.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3580 (or the former ECE 2130.)

ECE 3600 Physical Electronics 4 cr
(Lab required) Basic solid state theory; properties of semi-conductors; principles of metal-semiconductor junctions, p-n junctions and transistors; optoelectronic processes.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: PHYS 2152 or (PHYS 1070) and MATH 3132 or (MATH 3100), and ECE 3670.

ECE 3610 Microprocessing Systems 4 cr
(Lab required) Fundamentals of microprocessors and microcomputers; data flow; machine programming; architectures and instructions sets; stacks, subroutines, I/0, and interrupts; interfacing fundamentals; designing with microprocessors.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2220.
Mutually Exclusive: COMP 2280

ECE 3630 Real-time Embedded Systems 4 cr
(Lab required) Design of embedded systems with real-time requirements. File, memory, I/O, and process management. Real-time operating system considerations, including multitasking, thread communication, and real-time scheduling. Debugging and testing of embedded real-time systems. May not be held with COMP 3430.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 3610 and ECE 3740.
Mutually Exclusive: COMP 3430

ECE 3650 Electric Machines 5 cr
(Lab required) Continuation of ECE 3720 , including steady state and transient performance and introductory power systems theory.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3720

ECE 3670 Electronics 3E 4 cr
(Lab required) Continuation of ECE 2160, including device models, feedback, regulators, frequency effects, oscillators, and bistability and gates.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160.

ECE 3700 Telecommunication Network Engineering 4 cr
(Lab required) This course will introduce modem concepts in telecommunications, including LANs, WANs, telephone networks, wireless and mobile networks, and Internet networks. Focus will be on design engineering, and management of networks, and on network programming for client server architectures.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: COMP 2140.
Mutually Exclusive: COMP 3720, COMP 4300

ECE 3720 Electric Power and Machines 4 cr
(Lab required) Principles and applications of electric power, energy conversion and machines.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2262.

ECE 3730 Principles of Embedded System Design 4 cr
(Lab required) This course will introduce students to the design and implementation of embedded systems. Topics include introduction to UML and data structures, A-to-D, D-to-A, serial bus architectures, embedded computing, bus-based computer systems, program design and analysis, networks, and hardware-software co-design.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2160, ECE 3610 and (COMP 1010 or COMP 1012).

ECE 3740 Systems Engineering Principles 1 4 cr
(Lab required) Complexity and other system measures and analysis, system architectures and architectural elements for embedded systems, hardware and software, incremental design elaboration. Coding, testing, debugging, verification and validation. Project planning, cost analysis and maintenance. Real-time systems, graphical user interfaces and computational models.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: COMP 2140.

ECE 3750 Systems Engineering Principles 2 4 cr
(Lab required) Reliability measures and analysis, software system architectures, system metrics, system verification for embedded systems. Coding practices for large scale embedded system development. Real- time systems, graphical user interfaces, and computational models.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3740.

ECE 3760 Digital Systems Design 1 4 cr
(Lab required) Design methodologies for the development of digital hardware, including system specification, component allocation, functional partitioning, specification refinement, implementation, verification, and testing. Hardware-software co-design.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4240.
Mutually Exclusive: COMP 4550

ECE 3770 Digital Systems Design 2 4 cr
(Lab required) Executable system specification and a methodology for system partitioning and refinement into system-level components. Models and architectures, specification languages, translation to an HDL, system partitioning, design quality estimation, specification refinement into synthesizable models.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4240 and MATH 3120.

ECE 3780 Signal Processing 1 4 cr
(Lab required) Introduction to signals and systems; spectral analysis (Fourier Series) of continuous-time periodic signals; spectral analysis of aperiodic signals (Fourier Transform); the impulse response and convolution operator; frequency analysis of linear time-invariant systems; applications to filtering, communications systems, and biological systems; A/D conversion; sampling. Laboratory periods will be used to give students hands-on experience in programming many of the techniques covered in the theoretical parts of the course.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2262 and (MATH 2136 or MATH 3132).

ECE 4100 Introduction to Microelectronic Fabrication 4 cr
(Lab required) Introduction to the fabrication of integrated circuits (ICs). Emphasis is on silicon based devices. Topics include water preparation, oxidation, thin film deposition, diffusion and ion implantation, lithography, wet and dry etching and metallization. An introduction to MEMS and micromachining technology is given.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160 (B+) or ECE 3670.

ECE 4150 Control Systems 4 cr
(Lab required) Principal methods of analysis and design for feedback control systems.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160 and ECE 3780.

ECE 4160 Control Engineering 4 cr
(Lab required) Design of control systems by frequency domain and root locus method; state equations; introduction to nonlinear analysis.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4150.

ECE 4180 Introduction to Robotics 4 cr
(Lab required) This course provides fundamental concepts of robotics, including robot classification and applications, robot kinematics, sensor and actuators, sensor interfacing, motor control, trajectory planning, and robot programming.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 4150 and (ECE 4240 or ECE 3730).

ECE 4240 Microprocessor Interfacing 4 cr
(Lab required) Interfacing of microcomputers to the external world: interfacing of I/0 devices with minimum hardware and software; data acquisition with and without microprocessors; data communication, transmission and logging with small computers.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 2160 and ECE 3610.
Mutually Exclusive: COMP 4550

ECE 4250 Digital Communications 4 cr
(Lab required) Transmission of digital data; error rates, interference. Information measures, information rate and channel capacity. Coding.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4260 and ECE 3780.

ECE 4260 Communications Systems 4 cr
(Lab required) Development and applications of random processes. Analysis and comparison of modulation schemes: AM, FM, PM, PCM.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 3780 and [STAT 2220 preferred or (STAT 1000 and STAT 2000)].

ECE 4270 Antennas 4 cr
(Lab required) Radiation fundamentals, linear antennas, point source arrays, aperture antennas, antenna impedance, antenna systems.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.

ECE 4280 Engineering Electromagnetics 4 cr
(Lab required) Plane, cylindrical and spherical waves, introduction to scattering and diffraction, waveguides, transmission line applications.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.

ECE 4290 Microwave Engineering 4 cr
(Lab required) Microwave circuit analysis; passive and active devices; communication system power budget and signal-to-noise ratio calculations.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.

ECE 4300 Electrical Energy Systems 1 4 cr
(Lab required) Power system component modelling and computational methods for system problems such as load flow, faults, and stability.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3650.

ECE 4310 Electrical Energy Systems 2 4 cr
(Lab required) Generating stations. Power system stability and optimal operation. EHV-ac and HVDC power transmission. Power system protective relaying and reliability evaluation.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 4150 and ECE 4300.

ECE 4360 High Voltage Engineering 4 cr
(Lab required) The course serves as an introduction to high voltage engineering, including basics of electrical breakdown, high voltage generation, high voltage test systems, measurement and analysis techniques as applied to power system apparatus, such as cables, insulators, transformers, and generators.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3580, ECE 3720.

ECE 4370 Power Electronics 4 cr
(Lab required) Thyristor device theory and operation, controlled rectifiers and line-commuted inverters, and forced commutation as applied to d/c choppers and a/c variable frequency and voltage inverters.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 3720 and ECE 2160.

ECE 4390 Engineering Computations 4E 4 cr
(Lab required) Development and application of numerical methods for the solution of electrical and computer engineering problems. Optimization techniques. Finite difference, finite element and boundary element methods. Solution of large systems of linear and non-linear equations.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: MATH 3132, ECE 2240.

ECE 4420 Digital Control 4 cr
(Lab required) Mathematical modelling of sampling switches. Z-transforms. Response and stability of systems involving sampling. Design of digital compensators.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 4830 and ECE 4150.

ECE 4430 Design of RF Devices and Wireless Systems 4 cr
(Lab required) Techniques for the system level design, simulation, fabrication,and testing of RF devices and microwave circuits, including the basics of radar and RFID technology. May not be held with ECE 4860 when titled " Design of RF Devices and Wireless Systems".
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3590.
Mutually Exclusive: ECE 4860

ECE 4440 Computer Vision 4 cr
(Lab required) Image formation and sensing, image compression, degradation and restoration, geometrical and topological properties, pattern classification, segmentation procedures, line-drawing images, texture analysis, 3-D image processing.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3780.

ECE 4450 Applied Computational Intelligence 4 cr
(Lab required) Computational intelligence and machine learning algorithms and their application in solving complex engineering problems. May not be held with COMP 4360 or ECE 4850 when titled " Applied Computational Intelligence".
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: MATH 3132.
Mutually Exclusive: COMP 4360, ECE 4850

ECE 4520 Simulation and Modelling 4 cr
Monte Carlo Methods, random processes, simulation of complex systems in the design of computer systems. Use of statistical interference and measures of performance in hardware and software systems.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [STAT 2220 preferred or (STAT 1000 and STAT 2000)] and COMP 2140.

ECE 4530 Parallel Processing 4 cr
(Lab required) This course provides an overview of parallel processing (classification of parallel processing architectures and other select topics), parallel programming strategies (embarrassingly parallel partitioning, divide-and-conquer, and other select topics), applied design and implementation of parallel software solutions (including distributed computing, shared memory computing, and GPGPU computing), and evaluation of parallel performance (time and memory complexity, speedup, efficiency, Amdahl's law, Gustafson's law). May not be held with COMP 4510.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: (COMP 2140 and (ECE 2400 or the former ECE 3790)) or (ECE 2240 and ECE 3730).
Mutually Exclusive: COMP 4510

ECE 4540 Wireless Networks 4 cr
(Lab required) Introduction to wireless communications systems, network architectures, protocols and applications. Topics include mobile computing systems, signals propagation, channel modelling, modulation, and networking standards.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3700 and ECE 3780.

ECE 4560 Modern Computing Systems 4 cr
(Lab required) Advanced topics in computer architecture and organization, such as instruction set architecture, performance measures, pipeline processor design, data and instruction cache, data dependencies, branch prediction and penalties, superscalar architecture, multithreading, out-of-order execution, speculative execution, overlapping register windowing, and multiprocessor system design. May not be held with ECE 4850 when titled" Modern Computing Systems".
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3610.
Mutually Exclusive: ECE 4850

ECE 4580 Optoelectronics 4 cr
(Lab required) Basic theory of quantum mechanics; solution of Schrodinger equations; interaction of radiation with matter; masers and lasers; propagation, modulation, excitation and detection in optical waveguides; introduction to fiber and integrated optics.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3600.

ECE 4600 Group Design Project 6 cr
The engineering curriculum must culminate in a significant design experience which is based on the knowledge and skills acquired in earlier course work and which gives students an exposure to the concepts of team work and project management.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: [ENG 2030 or ENG 2040 or the former ENG 2010] and ECE 3780 and [(ECE 3580 (or the former ECE 2130), ECE 3720, ECE 3670 and ECE 3610) or (ECE 3700, ECE 3760 and ECE 3740)].

ECE 4610 Biomedical Instrumentation and Signal Processing 4 cr
(Lab required) Introduction to biological systems and the application of engineering principles to medical problems. Students design systems to acquire and analyze biological signals in the laboratory. Content includes introduction to relevant physiology and anatomy of cells, skeletal muscles, heart and cardiovascular systems, human balance and biomechanics, recording and analyzing biological signals (ECG, EMG,respiratory sounds), design of instrumentation amplifiers for signal conditioning, medical instrumentation safety and health hazards.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisites: ECE 2160 and ECE 3780.

ECE 4740 Digital Systems Implementation 4 cr
(Lab required) Implementation methodologies and technologies for digital systems, including VLSI implementations, PCB implementations, and rapid prototyping (FPGA). Not to be held with ECE 4500.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 4240.

ECE 4830 Signal Processing 2 4 cr
(Lab required) Representation of discrete-time signals and systems in the time and frequency domains; the z-transform; application to various discrete-time linear time-invariant systems; design of digital filters. Laboratory periods will be used to give students hands-on experience in programming many of the techniques covered in the theoretical parts of the course.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: ECE 3780.

ECE 4850 Topics in Electrical and Computer Engineering 1 4 cr
(Lab required) This course will cover contemporary topics in Electrical and Computer Engineering via lectures and laboratory sessions. The specific topics and a detailed course outline will be available at the time or registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.
Mutually Exclusive: ECE 4450, ECE 4560

ECE 4860 Topics in Electrical and Computer Engineering 2 4 cr
(Lab required) This course will cover contemporary topics in Electrical and Computer Engineering via lectures and laboratory sessions. The specific topics and a detailed course outline will be available at the time or registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.
Mutually Exclusive: ECE 4430

ECE 4870 Topics in Electrical and Computer Engineering 3 3 cr
This lecture based course will cover contemporary topics in Electrical and Computer Engineering. The specific topics and a detailed course outline will be available at the time of registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.

ECE 4880 Topics in Electrical and Computer Engineering 4 3 cr
This lecture based course will cover contemporary topics in Electrical and Computer Engineering . The Specific topics and a detailed course outline will be available at the time of registration.
PR/CR: A minimum grade of C is required unless otherwise indicated.
Prerequisite: Permission of the Department.