Electrical and Computer Engineering (ECE)

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For major requirements, see the School of Engineering section of this *Catalog*.

1101. Electrical and Computer Engineering Tools

~~(101)~~ One credit. Not open for credit to students who have passed ECE 3101.

An introduction to the modern computer tools used for circuit analysis, signal and system analysis, control, and data acquisition.

1110. Microcontroller Applications in Engineering

~~(110)~~ Three credits.

Introduction to microcontroller-based design. Assembly language programming. Design projects for microcontroller applications in engineering.

2000. Electrical and Computer Engineering Principles

~~(220)~~ (Formerly offered as ECE 3002.) Three credits. Prerequisite: PHYS 1502Q, which may be taken concurrently. Recommended preparation: MATH 2410Q. This course and ECE 2608 or ECE 2001W may not both be taken for credit. Intended for non-ECE majors.

Basic concepts of circuit analysis as applied to electronic circuits and electromechanical devices, including measuring instruments.

2001. Electrical Circuits

Four credits. Three 1-hour lectures and one 2-hour laboratory. Prerequisite: MATH 2410Q and either PHYS 1502Q or 1230 or 1530, both of which may be taken concurrently. This course and either ECE 2608 or 2609W may not both be taken for credit.

Analysis of electrical networks incorporating passive and active elements. Basic laws and techniques of analysis. Transient and forced response of linear circuits. AC steady state power and three-phase circuits. Periodic excitation and frequency response. Computer analysis tools. Design projects are implemented and tested in the laboratory. Laboratory reports are required for each project.

2001W. Electrical Circuits

~~(210W)~~ Prerequisite: MATH 2410Q and either PHYS 1502Q or PHYS 1230 or PHYS 1530, both of which may be taken concurrently; ENGL 1010 or 1011 or 2011. This course and either ECE 2608 or 2609W may not both be taken for credit.

3001. Electromagnetic Fields and Waves

~~(205)~~ Three credits. Prerequisite: MATH 2110 and 2410 and either PHYS 1502 or 1230 or 1530; open only to students in the School of Engineering.

Application of electric and magnetic field theory to engineering problems involving conductors, dielectrics, semiconductors, magnetic materials, the motion of charged particles, and wave propagation. Relationship between fields and circuit parameters in the context of transmission lines and radiation.

3101. Signals and Systems

~~(202)~~ (Also offered as ENGR 3101.) Three credits. Three class periods and one discussion period. Prerequisite: ECE 2000 or 2001W; open only to students in the School of Engineering.

Representation of signals in the time and frequency domains. Fourier series. Fourier and Laplace transform methods for analysis of linear systems. Introduction to state space models. Introduction to sampling and discrete systems analysis via z transforms.

3111. Systems Analysis and Design

~~(232)~~ Four credits. Two 75-minute lectures and one discussion period. Prerequisite: ECE 3101 and prerequisite or corequisite: MATH 2210Q; open only to students in the School of Engineering.

Modeling, analysis and design of control systems using frequency and time-domain methods. Differential equation, Transfer function, signal flow graph and state variable representations of continuous and discrete-time systems.

Linearization of nonlinear systems. Transient and frequency response of second order systems. Stability of linear systems with feedback; Routh Hurwitz, Root locus, Bode and Nyquist methods. Controllability and observability. Computational methods for analysis of linear systems. Team-based design projects involving modeling, classical compensator design and state variable feedback design.

3201. Electronic Circuit Design and Analysis

~~(212)~~ Four credits. Three 1-hour lectures and one 2-hour laboratory. Prerequisite: ECE 2001W; open only to students in the School of Engineering. This course and either ECE 3608 or 3609 may not both be taken for credit.

Physical electronics underlying the operation of electronic devices. Diodes, diode models, and diode circuits. Transistors, transistor models, and transistor circuits. DC, small signal, and frequency analysis of transistor amplifiers. Compound transistor configurations. Computer analysis tools. Design projects are implemented and tested in the laboratory. Laboratory reports with revisions are required for each project.

3211. Power Electronics

~~(214)~~ ~~Three~~ Four credits. Two ~~1-hour~~75-minute lectures and one 2-hour laboratory. Prerequisite: ECE 3201; open only to students in the School of Engineering. This course and ECE 3610W may not both be taken for credit.

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Power converters for power processing, regulation, and control as applied to computer and telecommunication systems, transportation systems, industrial drives, and renewable power conversion systems. Power semiconductor device characteristics, transformers, and dc/dc converters including design projects.

3212. Electric Machines and Drives

~~Three~~ Four credits. Prerequisite: ~~ECE 3001 and~~ ECE 3201. Two 75-minutes lectures and one 2-hour laboratory.

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Fundamental operation, equivalent circuit models, physical structure, and control of electric machinery; basic power electronic drives, three-phase systems, magnetic circuit equivalents, basic electro-mechanics, transformers, basic rotating machines; different electric machines including switched reluctance machines, stepper motors, three-phase synchronous machines, induction or asynchronous machines, and DC machines; Basic electronic drives for each machine type along with open-loop control strategies. Weekly laboratory experiments accompany the lectures to demonstrate most of these concepts.

3221. Digital Integrated Circuits

~~(215)~~ Three credits. Prerequisite: ECE 3201 and CSE 2300W; open only to students in the School of Engineering. This course and ECE 3222 may not both be taken for credit.

Switching, timing, wave shaping, and logic circuits to generate waveforms and functions used in pulse systems, instrumentation and computers. Emphasis is on integrated circuits.

3222. Digital Integrated Circuit Design and Analysis

~~(213)~~ Four credits. Prerequisite: ECE 3201; open only to students in the School of Engineering. Three 1-hour lectures and one 2-hour laboratory. This course and ECE 3221 may not both be taken for credit.

Fabrication, testing, and yield of digital integrated circuits. Design and analysis of bipolar and MOS digital integrated circuits. Bistable circuits and digital memories. System implementation with digital integrated circuits. Layout of digital integrated circuits. Integrated circuit packages. Computer analysis tools. Design and laboratory evaluation of digital electronic circuits.

3223. Optical Engineering

~~(223)~~ Three credits. Prerequisite: ECE 3001 or PHYS 3201; open only to students in the School of Engineering. Not open to students who have passed ECE 4231.

Principles and techniques of optical engineering, including geometrical optics, optical fibers and systems, sources and detectors, measurements, imaging, lenses, wave optics, polarization, interference, diffraction, optical Fourier transforms, holography, interferometry, integrated optics, frequency conversion, interaction of light and matter.

3225. Optical Engineering Laboratory

~~(225)~~ Three credits. One 3-hour laboratory period. ~~Prerequisite~~Corequisite: ECE 3223 ~~or 4231~~; open only to students in the School of Engineering. Not open to students who have passed ECE 4232.

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Hands-on design and measurement of optical systems and components. Lens systems and imaging, fiber-optic communications and fiber-optic sensors, diffraction and Fourier Optics, interferometry, etc. Structured experiments and design projects centered on available equipment.

3231. Introduction to Modern Power Systems

Three credits. Lecture. Prerequisite: ECE 2001W; open only to students in the School of Engineering.

Fundamentals of power system planning, operation, and management. Power generation, transmission and distribution. Sustainable energy sources such as photovoltaics, solar-thermal power, wind farms, and their grid integration. Modern power system monitoring/control, fault analysis, and transient stability analysis using computer tools. Use of power system simulation tool e.g. PSS/E for power system planning.

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3243. Introduction to Nanotechnology

Three credits. Lecture. Prerequisite: open only to students in the School of Engineering

Basic concepts of nanoscience; new physical properties at these scales (~1-100 nm); different approaches to fabricate, image, characterize and manipulate nanostructures and nanodevices; current and potential applications in areas as diverse as electronics, health and energy; societal impacts of nanotechnology.

3401. Digital Systems Design

~~(252)~~ (Also offered as CSE 3302.) Three credits. Prerequisite: CSE 2300W; open only to students in the School of Engineering.

Design and evaluation of control and data structures for digital systems. Hardware design languages are used to describe and design alternative register transfer level architectures and control units with a micro-programming emphasis. Consideration of computer architecture, memories, digital interfacing timing and synchronization, and microprocessor systems.

3411. Microprocessor Applications Laboratory

~~(266)~~ Three credits. One class period and one 4-hour laboratory. Prerequisite: Open only to students in the School of Engineering

Design of software and interface hardware to use a microcomputer as an on-line, real-time element in data acquisition, filtering and control systems. Use of clocks, DAC's, ADC's, speech synthesis modules, and movement generators. Design project. Written and oral presentations of laboratory results.

3421. Very Large Scale Integrated Circuit (VLSI) Design and Simulation

~~(249)~~ Four credits. Two-hour lecture and three-hour laboratory period. Prerequisite: ECE 3221: open only to students in the School of Engineering.

Design of MOS transistors, including short channel effects in sub-micron devices; scaling laws; design rules. Layout of NMOS and CMOS logic gates; power-delay calculations. Design of static and/or dynamic memories. Laboratory emphasizes schematic capture, simulation, timing analysis and testing; layout of custom IC's; use of VHDL.

3431. Numerical Methods in Scientific Computation

~~(257)~~ (Also offered as CSE 3802.) Three credits. Prerequisite: CSE 1100 or 1010 and MATH 2110Q and 2410Q and prerequisite or corequisite: MATH 2210Q; open only to students in the School of Engineering.

Introduction to the numerical algorithms fundamental to scientific computation. Equation solving, function approximation, integration, difference and differential equations, special computer techniques. Emphasis is placed on efficient use of computers to optimize speed and accuracy in numerical computations. Extensive digital computer usage for algorithm verification.

4079. Independent Design Laboratory

~~(265)~~ Three credits. Prerequisite: Instructor consent; open only to students in the School of Engineering. May be taken twice for credit.

Experimental design project undertaken by the student by special arrangement with a faculty member of the Department of Electrical and Computer Engineering.

4095. Special Topics in Electrical and Computer Engineering

~~(295)~~ Credits by arrangement. Prerequisite: Consent of instructor; open only to students in the School of Engineering. With a change in content, this course may be repeated for credit.

Classroom and/or laboratory course in special topics as announced in advance for each semester.

4099. Independent Study in Electrical and Computer Engineering

~~(299)~~ Credits by arrangement, not to exceed four in any semester. Prerequisite: Consent of instructor; open only to students in the School of Engineering. With a change in content, this course may be repeated for credit.

Individual exploration of special topics as arranged by the student with course instructor.

4099W. Independent Study in Electrical and Computer Engineering

Prerequisite: ENGL 1010 or 1011 or 2011; consent of instructor; open only to students in the School of Engineering.

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4111. Communication Systems

~~(241)~~ Three credits. Prerequisite: ECE 3101 or BME 3400 and STAT 3345Q or MATH 3160; open only to students in the School of Engineering.

Communication of information over noisy channels. Fourier transform review, spectral analysis, and sampling. Amplitude, phase, and frequency modulation of a sinusoidal carrier. Time and frequency division multiplexing. Random processes and analysis of communication of systems in noise. Elements of digital communication systems.

4112. Digital Communications and Networks

~~(242)~~ Three credits. Prerequisite: ECE 3101 and STAT 3345Q or MATH 3160; open only to students in the School of Engineering.

Fundamentals of digital communication systems. Encoding of analog signals for digital transmission. Basic information theory. Source encoding techniques. Baseband data transmission. Digital carrier modulation schemes. Multiplexing techniques. Basic error control coding. Random processes and analysis of communication of systems in noise.

4121. Digital Control Systems

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~~(234)~~ Three credits. Prerequisite: ECE 3111; open only to students in the School of Engineering.

Analysis and design of control systems incorporating a digital computer as the controlling element. Building blocks of digital control. Measures of control system performance. Frequency domain and state variable methods of control design. Optimal control methods. State variable estimation. Implementation issues. Use of computer-aided software tools for simulation and design.

4122. Systems Laboratory

~~(267)~~ Three credits. One 4-hour laboratory period. Prerequisite: ECE 3111; open only to students in the School of Engineering.

Real-time digital control and signal processing of cyber-physical systems. Typical topics include control of inverted pendulum and magnetic levitation systems, velocity and position control of motors, robot path planning and control. Written and oral presentations of laboratory results.

4131. Introduction to Digital Signal Processing

~~(247)~~ Three credits. Prerequisite: ECE 3101; open only to students in the School of Engineering.

Discrete-time signals and systems. The z-transform. Digital filters; stability, frequency response, canonic realizations and state equations. Fourier methods for discrete signal representation; Fourier transform of sequences, the discrete Fourier transform, and the FFT. Design of linear digital filters in time and frequency domains. Spectrum analysis and filtering via the FFT.

4132. Information Processing Systems Laboratory

~~(292)~~ Three credits. Prerequisite or corequisite: ECE 4131, and either ECE 4111 or 4112 or instructor consent~~.~~; open only to students in the School of Engineering

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Laboratory experiments in signal processing, real-time digital filters, image processing, imaging systems, data acquisition using detectors, pattern recognition, communication receivers, and system performance evaluation. Emphasis is on real-time information processing systems with interface between sensors and computer/processors. Applications of analog and digital techniques to design, implementation and testing of real-time information processing systems.

4141. Introduction to RF/Microwave Wireless Systems

~~(227)~~ Three credits. Prerequisite: ECE 3001; open only to students in the School of Engineering.

An introduction to the general hardware components, system parameters, and architectures of radio-frequency (RF) and microwave wireless systems. Practical examples will be drawn from communication as well as radar/sensor systems.

4201. Electronic Circuits and Applications

~~(240)~~ Three credits. Prerequisite: ECE 3201; and either ECE 4211 or ECE 4225, which may be taken concurrently; open only to students in the School of Engineering. Recommended preparation: ECE 3111.

Analysis and design of linear amplifiers. The effects of feedback in tuned, video, and operational amplifiers. Noise, stability, and frequency compensation. Applications encompass active filters, oscillators, phase lock loops and nonlinear operations such as multiplication, modulation, sampling, and analog-to-digital conversion.

4211. Semiconductor Devices and Nanostructures

~~(245)~~ Three credits. Prerequisite: ECE 3201; open only to students in the School of Engineering.

Principles and applications of contemporary solid state devices such as light-emitting diodes, injection lasers, solar cells, p-n-p-n diodes, SCRs and Triacs, transistors, MESFETs and MODFETs, and fundamentals of integrated circuits. Impact of nanostructures on devices.

4223. Nanophotonics

Three credits. One 3-hour lecture. Prerequisite: ECE 3223; open only to students in the School of Engineering.

Principles and applications of nanophotonics with focus on optical metamaterials, plasmonics, and photonic bandgap crystals. Topics covered include electric plasma, magnetic plasma, optical magnetism, negative index metamaterials, localized and non-localized surface plasmon polaritons, photonic bandgap structures, superlens, optical cloaking.

4225. Fundamentals of Electron Device Design and Characterization

Three credits. Prerequisite: ECE 3201; open only to students in the School of Engineering.

Design of micro/nano electronic devices using state-of-the-art computer simulation tools, experimental electrical characterization of semiconductor devices and introduction to modern electronic devices such as high-performance MOSFETs, TFTs, solar cells, non-volatile memories, CCDs, and thermoelectric power generators.

4242. Micro/Opto-electronic Devices and Circuits Fabrication Laboratory

~~(268)~~ Three credits. One class period, and one 4-hour laboratory period. Prerequisite: 4211 or 4225; open only to students in the School of Engineering.

Semiconductor wafer preparation and characterization including: determination of carrier concentration, mobility, and lifetime; oxidation, diffusion, metallization, mask layouts, and photolithographic techniques as employed in the realization of discrete devices (e.g., bipolar and MOS transistors, solar cells) and integrated circuits; design of basic IC components such as transistors, resistors, and capacitors; monolithic fabrication of simple digital/analog circuits. Design project. Written and oral presentations of laboratory results. A fee of $75 is charged for this course.

4243. Nanoscience and Nanotechnology I

(Also offered as ENGR 4243.) Three credits. Prerequisite: ECE 4211 or PHYS 2300 or 3401 or MSE 4001, and CHEM 1127 or equivalent; open only to students in the School of Engineering.

Fundamentals of electron and hole confinement in quantum well, wire, and dot heterostructures, confinement of photons in photonic band gap structures, density of states in quantum wires; transport in quantum wires and dots, and single wells (SWNT) and multi-wall carbon nanotubes; operation of nano field-effect transistors; absorption and emission in quantum wires and dot structures; fabrication methodology to grow and assemble quantum wires and dots including self-assembly techniques for light-emitting diodes, transistors, lasers, and nanoelectromechanical (NEM) structures.

4244. Nanotechnology II

~~(251)~~ (Also offered as ENGR 4244.) Three credits. One-hour lecture and four-hour laboratory. Prerequisites: Senior standing and ECE 4211 or ECE/ENGR 4243; open only to students in the School of Engineering.

Growth and characterization of carbon nanotubes using vapor phase nucleation; growth of CdSe quantum dots using liquid phase precipitation and vapor phase MOCVD reactor; characterization using AFM and TEM and dynamic scattering techniques; device processing highlighting nanolithography (E-Beam), and ~~self-~~ self-assembly techniques; project work involving fabrication of devices such as LEDs, carbon nanotube based FETs, and sensors using self-assembled quantum dots hosted in inorganic or organic/polymer layers. A fee of $75 is charged for this course.

4261. Introduction to Memory Device Technologies

Three credits. Prerequisite: ECE 3201 or 3421 or 4225. This course and ECE 5261 may not both be taken for credit.

Current and future digital solid-state memory device technologies including DRAM, SRAM, flash memory, ferroelectric memory, magnetoresistive memory, phase-change memory and resistive memories, with an emphasis on the underlying physical mechanisms.

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4401. Digital Design Laboratory

~~(280)~~ (Also offered as CSE 3350.) (Formerly offered as EE 280.) Three credits. Four hours of laboratory. Prerequisite: Open only to students in the School of Engineering. Prerequisite or corequisite: CSE 3302/ECE 3401.

Digital designing with PLA and FPGA, A/D and D/A conversion, floating point processing, ALU design, synchronous and asynchronous controllers, control path; bus master; bus slave; memory interface; I/O interface; logic circuits analysis, testing, and trouble shooting; PCB; design and manufacturing.

4402. Digital Hardware Laboratory

~~(281)~~ (Also offered as CSE 4901.) Three credits. One 4-hour laboratory period. Prerequisite: CSE 4302; ECE 3401 or CSE 3302; open only to students in the School of Engineering.

Advanced combinational and sequential circuit design and implementation using random logic and microprocessor based system. Hardware and software interface to the basic system. Serial communication, user program loading and execution. Microcontrollers – familiarization and inclusion in design.

4451. Introduction to Hardware Security and Trust

Three credits. One 3-hour lecture. Prerequisite: ECE 3401; open only to students in the School of Engineering.

Fundamentals of hardware security and trust for integrated circuits. Cryptographic hardware, invasive and non-invasive attacks, side-channel attacks, physically unclonable functions, watermarking of Intellectual Property (IP) blocks, FPGA security, counterfeit detection, hardware Trojan detection and prevention in IP cores and integrated circuits.

4901. Electrical and Computer Engineering Design I

~~(290)~~ (Also offered as CSE 4950.) Two credits. Prerequisite: ECE 3101, 3201; senior standing; open only to students in the School of Engineering.

Discussion of the design process; project statement, specification, project planning, scheduling and division of responsibility, ethics in engineering design, safety, environmental considerations, economic constraints, liability, manufacturing, and marketing. Projects are carried out using a team-based approach. Selection and analysis of a design project to be undertaken in CSE 4951/ECE 4902 is carried out. Written progress reports, a proposal, an interim project report, a final report, and oral presentations are required.

4902. Electrical and Computer Engineering Design II

~~(291)~~ (Also offered as CSE 4951.) Three credits. Prerequisite: ECE 4901; open only to students in the School of Engineering. Hours to be arranged.

Design of a device, circuit, system, process, or algorithm. Team solution to an engineering design problem as formulated in CSE 4950/ECE 4901, from first concepts through evaluation and documentation. Written progress reports, a final report, and oral presentations are required.