ECE—ELECTRICAL AND COMPUTER ENGINEERING

COLLEGE OF ENGINEERING

For descriptions of graduate-level courses, please visit www.registrar.neu.edu/cdr.html.

ECE U210 Electrical Engineering 4 SH
Introduces the basic concepts related to circuits and circuit elements; current, voltage, and power; models for resistors, capacitors, and inductors; and circuit analysis using Kirchhoff’s laws. Discusses selected topics that illustrate a variety of applications of electrical engineering, such as AC circuits and electric power, the basics of semiconductor devices with applications to transistor amplifier models, transients in circuits with energy storage, mechanical controls and mechatronics, digital signals, logic circuits, and some basic concepts of computer operations, specifically, number coding, arithmetic operations, and memory circuits. Coreq. ECE U211. Prereq. MTH U242.

ECE U211 Lab for ECE U210 1 SH

ECE U230 Computer Architecture for Computer Scientists 4 SH
Introduces the organization and architecture of computer systems. Uses the MIPS assembly language introduced in the prerequisite course, CS U380, to illustrate the instruction set architecture. Introduces the basics of digital and logic circuits, followed by a description of the structure and function of the data path and control hardware. Illustrates the implementation of the instruction set by single-cycle, multiple-cycle, and a basic pipeline. Covers the architecture of modern high-performance processors inclusive of performance evaluation, arithmetics, hardware and software organization trade-offs, and memory management (caching and virtual memory). Prereq. CS U380; not open to ECE majors.

ECE U300 Introduction to Engineering Co-op Education 1 SH
Provides students preparation for the first co-op experience. Focuses on skills that provide a basis for successful co-op engagement including expectations and requirements, an introduction to professional credentials, résumé construction, self-assessment and goal setting, interviewing, professional and co-op ethics, issues of diversity in the workplace community, academic planning and decision making, and an introduction to career portfolios. Prereq. GE U100.

ECE U322 Digital Logic Design 4 SH
Discusses the implementation of digital systems at the logic gate level. Covers Boolean logic, logic minimization, combinational design, sequential circuits, state machines, data path design, and finite-state machine design. Students use computer-aided logic design tools to design and simulate circuits. Coreq. ECE U323.

ECE U323 Lab for ECE U322 1 SH
Accompanies ECE U322. Introduces aspects of the design of digital hardware including a digital calculator or design of similar complexity. Covers skills including combinational logic, sequential logic, and finite-state machine design. Students use computer-aided logic design tools and field-programmable logic to implement their designs. Coreq. ECE U322.

ECE U324 Computer Architecture and Organization 4 SH
Presents a range of topics that include assembly language programming, number systems, data representations, ALU design, compilation, and the hardware/software interface. Offers students the opportunity to program using assembly language and to use simulators and debugging tools. Covers the architecture of modern high-performance processors including datapath design, caching, memory management, I/O, pipelining, superscalar execution, multimedia extensions, and storage systems. Discusses the metrics and benchmarking techniques used for evaluating power and performance. Prereq. ECE U322 and CS U215.

ECE U326 Optimization Methods 4 SH
Covers the design and implementation of algorithms to solve engineering problems using a high-level programming language. Reviews elementary data structures, such as arrays, stacks, queues, and lists, and introduces more advanced structures, such as trees and graphs and the use of recursion. Covers both the algorithms to manipulate these data structures as well as their use in problem solving. Emphasizes the importance of software engineering principles. Introduces algorithm complexity analysis and its application to developing efficient algorithms. Prereq. CS U215.

ECE U392 Electronic Materials 4 SH
Provides a basic treatment of electronic materials from atomic, molecular, and application viewpoints. Topics include atomic structure and bonding in materials, structure of materials, and crystal defects. These topics lay a foundation for the introduction of thermal and electronic conduction, which is the underlying physics of electronic devices. Finally, the electronic properties of semiconductors, dielectric, magnetic, superconducting, and optical materials are examined. The latter half deals with an introduction to the state of the art in electronic materials, including semiconductor nanoelectronics, magnetic semiconductors and spintronics, molecular electronics, carbon nanotubes, conducting polymers, diamondlike carbon, and other topics representing recent technological breakthroughs in the area of electronic materials.
ECE U400 Linear Circuits 4 SH
Introduces basic device and signal models and circuit laws. Covers independent and dependent sources and resistors, basic circuit analysis with resistive networks, techniques of node-voltage and mesh-current analysis, Thevenin and Norton theorems, and the ideal operational amplifier model. Discusses common signal models, including step functions, exponentials, and sinusoids. Introduces energy storage elements and studies first-order circuits with the solution of related differential equations. Presents the unilateral Laplace transform as a technique for solving differential equations with initial conditions that model linear circuit behavior. Introduces Laplace transform equivalent circuit models and s-domain circuit analysis, including pole/zero plots and network functions. Considers circuits in the sinusoidal steady state using phasor representation. Presents the mutual inductance and the ideal transformer. Concludes with various power calculations in the sinusoidal steady state. Coreq. ECE U401. Prereq. MTH U343 and PHY U155; both courses may be taken concurrently.

ECE U401 Introduction to Electrical and Computer Engineering Lab 1 SH
Provides a hands-on introduction to analog and digital electronic circuits and devices, concepts of frequency and signal-to-noise, and measurement and circuit-debugging techniques. Emphasizes active learning by doing, for example, designing, assembling, and testing a working electronic system. Coreq. ECE U400.

ECE U402 Electronics 4 SH
Introduces methods of design and analysis of modern electronic circuits. Focuses on using large- and small-signal models to understand the behavior of transistors as amplifiers and switches. Briefly introduces operation of the principal semiconductor devices: diodes, field-effect transistors, and bipolar junction transistors. Analog electronics topics extend to the frequency response of transistor amplifiers and the use of cascaded amplifiers to increase gain and bandwidth. Digital electronics topics include NAND and NOR CMOS logic gates, dynamic power dissipation, gate delay, and fan-out. Coreq. ECE U403. Prereq. ECE U210 or ECE U400.

ECE U403 Lab for ECE U402 1 SH
Accompanies ECE U402. Includes experiments on characterization of diodes, BJTs, and MOSFETS and on design of circuits using these components. The circuits include multistage amplifiers and photoswitches. Coreq. ECE U402.

ECE U440 Electromagnetic Fields and Waves 4 SH
Introduces electromagnetics and high-frequency applications. Topics include transmission lines: transmission line model with distributed circuit elements, transmission line equations and solutions, one-dimensional traveling and standing waves, and applications; electromagnetic field theory: Lorentz force equations, Maxwell’s equations, Poynting theorem, and application to the transmission line’s TEM waves. Also studies uniform plane wave propagation along a coordinate axis and along an arbitrary direction; equivalent transmission lines for TEM, TE, and TM waves; reflection and refraction of uniform plane waves by conducting and dielectric surfaces. Discusses applications to wave guides, resonators, and optical fibers and radiation and elementary antennas. Introduces modern techniques (computational methods) and applications (optics, bioelectromagnetics, and electromagnetic effects in high-speed digital circuits). Coreq. ECE U441. Prereq. MTH U341 and PHY U155.

ECE U441 Lab for ECE U440 1 SH
Accompanies ECE U440. Supports class material related to transmission lines, wave-guiding structures, plane-wave reflection and refraction, and antenna radiation. Includes experiments with microwave transmission line measurements and the determination of the properties of dielectric materials, network analyzer analysis of microwave properties of circuit elements and transmission line electrical length, analysis of effective dielectric constant and loss from microstripline resonator transmission, optical measurement of refraction and reflection leading to determination of Brewster angle and optical constants for transparent and absorbing materials, and measurement of radiation patterns from dipole antennas. Coreq. ECE U440.

ECE U464 Linear Systems 4 SH
Develops the basic theory of continuous and discrete systems, with emphasis on linear time-invariant systems. Discusses the representation of signals and systems in both the time and frequency domain. Topics include linearity, time-invariance, causality, stability, convolution, system interconnection, and sinusoidal response. The Fourier and Laplace transforms are developed for the discussion of frequency-domain applications. Sampling and quantization of continuous waveforms (A/D and D/A conversion) are analyzed, leading to the discussion of discrete-time FIR and IIR systems, recursive analysis, and realization. The Z-transform and the discrete-time Fourier transform are developed, and applied to the analysis of discrete-time signals and systems. Prereq. ECE U400 and MTH U343.
ECE U468 Noise and Stochastic Processes 4 SH
Discusses probability, random variables, random processes, and their application to noise in electrical systems. Begins with the basic theory of discrete and continuous probabilities, then develops the concepts of random variables, random vectors, random sequences, and random processes. Continues with a discussion on the physical origins of noise and models of where it is encountered in electronic devices, signal processing, and communications. Defines the concepts of correlation, covariance, and power density spectra and uses them to analyze linear system operations in continuous time. Prereq. MTH U343 and ECE U464.

ECE U500 Professional Issues in Engineering 1 SH
Provides students with an opportunity to reflect on both academic and co-op experiences in the context of planning for the senior year and beyond. Issues include professional and ethical issues, resolving ethical conflicts, awareness of engineers as professionals in a diverse world, strengthening decision-making skills, career portfolios, and lifelong learning needs, goals, and strategies. Students reflect upon issues of diversity from their experience in the University and in their cooperative education placements. Explores the role of different work and learning styles and diverse personal characteristics on the workplace and the classroom. Professional issues include impact of the cultural context, both in the United States and around the world, on the client, government relations, and the workplace. Prereq. Junior or senior standing.

ECE U512 Biomedical Electronics 4 SH
Provides the fundamental background required to interface biological systems with circuits and sensors. Includes signal conditioning electronics, electrodes, and other sensors used to extract information from the organism and safety considerations for medical applications. Combines lectures and labs. Prereq. ECE U210 or ECE U402.

ECE U520 Software Engineering 1 4 SH
Provides an overview of main concepts in software engineering, the software process, methods, techniques, and tools. Topics include requirements analysis and specification; software design, coding, testing, and maintenance; and verification, validation, and documentation. Covers structured analysis and object-oriented design methodologies. Presents overviews of user interface design, prototyping, CASE tools, software metrics, and software development environments. Includes a small software development project. Prereq. CS U215.

ECE U522 Software Engineering 2 4 SH
Continues ECE U520. Provides an overview of principles, methods, and techniques for describing how a software product is implemented so that its requirements are satisfied. Examines the fundamental building blocks and patterns for construction of software systems in the context of a sound design process. Topics include patterns of design, principles of modularity, architectural design, component design, data design, algorithm design, graphical user interfaces, documentation, case studies, and standards. Prereq. ECE U520.

ECE U524 VLSI Design 4 SH
Covers a structured digital CMOS design focusing on designing, verifying, and fabricating CMOS VLSI-integrated circuits and modules. Emphasizes several topics essential to the practice of VLSI design as a system design discipline including systematic design methodology, good understanding of CMOS transistor, physical implementation of combinational and sequential logic network, and physical routing and placement issues. Begins design exercises and tutorials with basic inverters and proceeds to the design, verification, and performance of large, complex digital logic networks. Also covers IC design methodologies and performance, scaling of MOS circuits, design and layout of subsystems such as PLA and memory, and system timing. Requires lab session that includes computer exercises using CAD tools to design VLSI layouts and switch-level plus circuit-level simulations to design and analyze the project. Coreq. ECE U525. Prereq. ECE U322 and ECE U402.

ECE U525 Lab for ECE U524 1 SH
Accompanies ECE U524. Covers topics from the course through various experiments. Coreq. ECE U524.

ECE U526 High-Speed Digital Design 4 SH
Gives the student an overview of the fundamental electrical issues involved in the design of high-performance digital systems and the basic techniques and methods used to deal with these issues. Introduces signaling, timing, synchronization, noise management, and power distribution. Discusses the fundamental problems and engineering solutions to these problems. Addresses, for example, the problem of signaling over transmission lines and incident-wave signaling methods. Includes overview of digital system engineering, including modeling and analysis of wires, digital circuit design, power distribution, noise in digital systems, signaling convention, advanced signaling techniques, timing conventions, synchronization, and timing circuits. Prereq. ECE U322 and ECE U402.
ECE U528 CAD for Design and Test 4 SH
Addresses the principles of the algorithms and approaches for VLSI design and test automation. Briefly covers basic data structures and graph algorithms typically used for computer-aided design (CAD) as well as general-purpose methods for combinatorial optimization, such as backtracking, branch-and-bound, simulated annealing, and genetic algorithms. Design automation topics include physical design automation (partitioning, floor planning, placement, global and detailed routing, cell generation, and layout compaction), and high-level synthesis (scheduling, resource allocation). Testing topics include an overview of fault modeling, automatic test pattern generation, design for testability, and built-in self test (BIST). Course involves some programming assignments (implementation of some of the algorithms covered in class) as well as using state-of-the-art CAD tools in the design flow. Prereq. ECE U322 and ECE U326.

ECE U530 Hardware Description Languages and Synthesis 4 SH
Focuses on modeling of digital systems in a hardware description language. Topics include textual vs. graphical modeling of digital systems, syntax and semantics of the VHDL language, modeling for simulation, and modeling for synthesis. Students use a commercially available CAD tool to simulate and synthesize digital system descriptions. Prereq. ECE U322.

ECE U532 Embedded System Design 4 SH
Concentrates on design methodology, design of components, utilization of packages, use of design tools, and programming of embedded systems. Begins with presentation of register-transfer level design and ends with an implementation of a microcontroller as part of an embedded system. Teaches the Verilog Hardware Description Language and its related tools and uses them as a means of describing hardware at various levels of abstraction for simulation and synthesis. Also uses Field Programmable Gate Arrays and related design tools for simulation and synthesis. Prereq. ECE U322.

ECE U534 Microprocessor-Based Design 4 SH
Focuses on the hardware and software design for devices that interface with embedded processors. Topics include assembly language; addressing modes; embedded processor organization; bus design; electrical characteristics and buffering; address decoding; asynchronous and synchronous bus protocols; troubleshooting embedded systems; I/O port design and interfacing; parallel and serial ports; communication protocols and synchronization to external devices; hardware and software handshake for serial communication protocols; timers; and exception processing and interrupt handlers such as interrupt generation, interfacing, and auto vectoring. Coreq. ECE U535. Prereq. ECE U324.

ECE U535 Lab for ECE U534 1 SH
Accompanies ECE U534. Consists of a comprehensive laboratory performed by a team of students. These laboratory exercises require students to design, construct, and debug hardware and software that runs on an embedded platform. Exercises are centered around a common embedded platform. The final exercise is a project that lets each group integrate hardware and software to realize a complete embedded design. Coreq. ECE U534.

ECE U572 Communications Systems 4 SH
Introduces basic concepts of digital communication over additive white Gaussian noise (AWGN) channels. Reviews frequency domain signal analysis through treatment of noiseless analog communication. Reviews foundations of stochastic processes including stationarity, ergodicity, autocorrelation, power spectrum, and filtering. Provides an introduction to lossless and lossy source coding and introduces Huffman and Lempel-Ziv algorithms. Introduces optimal quantization and PCM and DPCM systems. Examines geometric representation of signals and signal space concepts, principles of optimum receiver design for AWGN channels, correlation and matched filter receivers, and probability of error analysis for binary and M-ary signaling through AWGN channels, and performance of ASK, PSK, FSK, and QAM signaling schemes. If time permits, also covers digital PAM transmission through band-limited AWGN channels, zero ISI condition, system design in the presence of channel distortion, and equalization techniques. Prereq. ECE U468.

ECE U574 Wireless Communication Circuits 4 SH
Explores analog radio electronics through the design and construction of a 7 MHz radio transceiver (the NorCal 40A). Offers an overview of radio designs and components. Describes the phasor analysis of series and parallel resonant circuits. Presents transmission line concepts including phasor analysis for waves, the telegraphist’s equations, dispersion, resonance, quality factor, and lines with loads. Introduces radio filter designs including ladder filters, band-pass filters, as well as filters using crystals and impedance inverters. Introduces working concepts of transformers and speakers. Describes transistor switches and Class B, C, D, E, and F amplifiers. Presents the fundamentals of oscillators and mixers. Also discusses antennas and propagation fundamentals including impedance, Friis’s formula, and reciprocity. Dipole and whip antennae are used as practical examples. Prereq. ECE U402.
ECE U576 Wireless Personal Communications Systems  4 SH
Describes the personal communications network (PCN) and personal communications services (PCS). Examines the first-, second-, and third-generation cellular systems used in the United States, Europe, and Japan. Explores narrow-band channelized and wide-band non-channelized wireless communication systems. Focuses on access technologies, considering capacity, performance, and spectral efficiency. Presents the propagation and multipath characteristics of a radio wave as well as how to calculate propagation losses in urban, suburban, and rural environments. Studies the fundamentals of cellular communications including the relationship between the reuse ratio and cluster size for hexagonal cell geometry. Covers digital modulation techniques, emphasizing modulation schemes used for cellular/wireless communications. Discusses antennas and diversity techniques. Concludes with an overview of the global system for mobile communications (GSM). Prereq. ECE U468.

ECE U580 Classical Control Systems  4 SH
Introduces the analysis and design of classical (single-input, single-output) control systems. Examines control system objectives, modeling and mathematical description, transfer function and state variable representations, feedback control system characteristics, system responses, and stability of feedback systems. Also addresses compensator design based on root-locus and frequency response and introduces concepts important for engineering implementation such as system uncertainty and design robustness. Coreq. ECE U581. Prereq. ECE U402 and ECE U464.

ECE U581 Lab for ECE U580  1 SH
Accompanies ECE U580. Covers the practical aspects of control systems design through lab experiments. Topics vary and include computer simulation, digital computer control, and use of CAD packages such as MATLAB for analysis and design of control systems. Examples emphasize concepts introduced in ECE U580, such as system response to stimuli, stability, and robustness. Coreq. ECE U580.

ECE U600 Electronic Design  4 SH
Covers transistors and op-amp circuits with emphasis on real devices and their performance, analog IC design concepts and building blocks, feedback and stability, oscillators, A/D and D/A converters and mixed-signal circuits, active filters, and other design topics at the discretion of the course instructor. Uses SPICE CAD simulation to support design work. Coreq. ECE U601. Prereq. ECE U402.

ECE U601 Lab for ECE U600  1 SH
Accompanies ECE U600. Consists of laboratory hardware design exercises leading to a design project in which students prototype, test, and verify their designs as well as run computer simulations using SPICE. Coreq. ECE U600.

ECE U604 Semiconductor Device Theory  4 SH
Seeks to develop an understanding of the operation and performance of the basic semiconductor devices and IC components and their application in analog and digital circuit design. Devices treated include p-n junctions, bipolar junction transistors (BJTs), and metal-oxide-semiconductor field effect transistors (MOSFETs). Passive IC elements treated include resistors, capacitors, and inductors. Covers the necessary elements of solid-state theory including crystal structure, quantum theory, and carrier (electron and holes) transport theory. Prereq. ECE U402.

ECE U606 Micro- and Nanofabrication  4 SH
Provides an overview of integrated circuit fabrication from the viewpoint of a process engineer. Students fabricate micro- and nanoscale devices in integrated lab sessions. Focuses on the physics, chemistry, and technology of integrated circuit fabrication in the lecture portion of the course, while students fabricate and test novel devices (an electrohydrodynamic micropump and three-dimensional carbon nanotube interconnects) in integrated lab sessions. Concentrates on silicon IC technology but also includes examples from other materials and device systems including microelectromechanical (MEMS) technologies that are used to build devices such as accelerometers, pressure sensors, and switches for telecommunications and other current examples provided from nanofabrication and nanotechnology. Lab hours are arranged. Prereq. ECE U402.

ECE U608 Nanotechnology in Engineering  4 SH
Explores a wide range of new technologies based on, or influenced by, breakthroughs in nanoscience. Includes such nanotechnologies (the refinement of functional properties of materials, devices, or systems that are in at least one dimension smaller than 100 nm) as spintronics, quantum computing, carbon nanotube electronics, nanoparticle cancer remediation strategies, biomolecular electronics, and nanomachines. A general goal is the engineering of new or enhanced macroscopic properties from nanostructure or nanoscale materials and components. Offers review of the scientific literature, classroom lecture, seminars by international leaders of nanotechnology, and student team projects to enable the student to become well versed in this important burgeoning field. Same as CHE U608. Prereq. Senior standing in engineering, biology, chemistry, or physics, or permission of instructor.
ECE U622 Parallel and Distributed Processing 4 SH  
Covers parallel and distributed processing concepts including concurrency and its management, models of parallel computation, and synchronous and asynchronous parallelism. Topics include simple parallel algorithm formulation, parallelization techniques, interconnection networks, arrays, trees, hypercubes, message routing mechanisms, shared address space and message-passing multiprocessor systems, communication cost and latency-hiding techniques, scalability of parallel systems, and parallel programming concepts and application case studies. Prereq. CS U215.

ECE U626 Image Processing and Pattern Recognition 4 SH  
Provides an introduction to processing and analysis of digital images with the goal of recognition of simple pictorial patterns. Topics include discrete signals and systems in 2-D, digital images and their properties, image digitization, image enhancement, image restoration, image segmentation, feature extraction, object recognition, and pattern classification principles (Bayes rules, class boundaries) and pattern recognition methods. Prereq. ECE U464, ECE U468, and MTH U481.

ECE U628 Computer and Telecommunication Networks 4 SH  
Presents an overview of modern communication networks. The concept of a layered network architecture is used as a framework for understanding the principal functions and services required to achieve reliable end-to-end communications. Topics include service interfaces and peer-to-peer protocols, a comparison of the OSI (open system interconnection) reference model to the TCP/IP (Internet) and IEEE LAN (local area network) architectures, network-layer and transport-layer issues, and important emerging technologies such as Bluetooth and ZigBee. Coreq. ECE U629. Prereq. MTH U481 or ECE U468.

ECE U629 Internetworking Design Lab 1 SH  
Accompanies ECE U628. Presents a detailed examination of the operation of the Internet using a lab-based approach supplemented with readings and brief lectures. Provides in-depth examination of the design and performance of the TCP/IP protocol suite. Emphasizes IP and TCP layer issues primarily, including addressing, routing, congestion-control, reliable vs. best-effort transport, IP address depletion, and mobility. Involves the implementation of a protocol in the lab as students conduct experiments with commercial network equipment and measurement gear and utilize simulation tools. Coreq. ECE U628.

ECE U630 Robotics 4 SH  
Introduces robotics analysis covering basic theory of kinematics, dynamics, and control of robots. Develops students’ design capabilities of microprocessor-based control systems with input from sensory devices and output actuators by having teams of students design and implement a small mobile robot system to complete a specific task, culminating in a competition at the end of the course. Covers actuators, sensors, system modeling, analysis, and motion control of robots. Prereq. ECE U322 and ECE U402.

ECE U638 Special Topics in Computer Engineering 4 SH  
Focuses on advanced topics related to computer engineering technology to be selected by instructor. Prereq. Permission of the department.

ECE U642 Antennas 4 SH  
Introduces the fundamental physical principles for the electromagnetic radiation from antennas and presents the most important mathematical techniques for the analysis of the radiation. Applies these principles and techniques to practical antenna systems. Starts with the fundamental parameters of the antennas. Introduces the vector potentials and the theorems that are needed for the derivation of the radiation integrals from Maxwell’s equations. Covers the application of these theories to practical antennas and antenna systems, including linear wire antennas, loop antennas, linear and two-dimensional planar phased arrays, patch antennas, frequency-independent antennas, and aperture and reflector antennas. Presents impedance matching techniques. Prereq. ECE U440.

ECE U644 Microwave Circuits and Networks 4 SH  
Addresses novel applications of analytical and engineering techniques for RF/microwave circuits and networks. Presents fundamental concepts, essential mathematical formulas and theorems, and engineering applications. Emphasizes transmission lines and smith charts, microstrip lines, S-parameters and network theory, impedance matching and tuning, and novel RF devices such as resonators, power dividers, and filters. Introduces active networks. Provides ample examples to ensure that the participants fully appreciate the power of the materials described in the class. Prereq. ECE U440.

ECE U646 Optics 4 SH  
Presents the basic optical concepts necessary for an understanding of current and future optical communication, remote sensing, and industrial and biomedical systems. Topics include geometrical optics, polarized light, diffraction, and interference. Studies lasers and other light sources, optical fibers, detectors, CCD cameras, modulators, and other components of optical systems. Presents applications to specific systems such as fiber-optic communication, medical imaging systems, fiber-optic sensors, and laser radar. Prereq. ECE U440.
ECE U664 Biomedical Signal Processing and Medical Imaging 4 SH
Introduces biomedical signal processing and biomedical imaging and image processing. Specific topics covered depend on instructor and/or student's areas of interest and are drawn from a variety of application areas. They include the nature and processing of intrinsic signals such as cardiac and neurological bioelectric signals, natural processing of external signals such as auditory and visual processing, and topics related to a variety of medical and biological imaging modalities. Prereq. ECE U464 and ECE U468 or MTH U481; ECE U468 or MTH U481 may be taken concurrently.

ECE U666 Digital Signal Processing 4 SH
Presents the theory and practice of digital signal processing. Topics include review of discrete-time signals, systems, and the Z-transform; sampling and quantization; Fourier transforms (DTFT, DFT, and FFT) with applications to fast convolution; design techniques for FIR and IIR digital filters; realization structures for digital filters and finite precision effects; fundamentals of multirate signal processing and filter-banks; and DSP applications. Coreq. ECE U667. Prereq. ECE U464.

ECE U667 Lab for ECE U666 1 SH
Accompanies ECE U666. Focuses on practical aspects of DSP by programming a digital signal processing chip in a high-level language using an integrated development and debugging environment. Topics include input/output operations via A/D and D/A converters, digital frequency synthesis, computation of discrete-time convolution, and design and implementation of both FIR and IIR filters. Coreq. ECE U666.

ECE U680 Electric Drives 4 SH
Intended for advanced undergraduates and beginning graduate students. Examines all subsystems that comprise an electric drive: electric machines, power electronic converters, mechanical system requirements, feedback controller design, and interactions with utility systems. Draws upon an integrative approach that requires minimal prerequisites: a junior-level course in signals and systems and some knowledge of electromagnetic field theory (possibly from physics classes), and does not require separate courses in electric machines, controls, or power electronics. Prereq. ECE U464.

ECE U682 Power Systems Analysis 4 SH
Intended for advanced undergraduates and beginning graduate students. Fundamentals include phasors, single-phase and balanced three-phase circuits, complex power, and network equations; symmetric components and sequence networks; power transformers, their equivalent circuits, per-unit notation, and the sequence models; transmission line parameters including resistance, inductance, and capacitance for various configurations; steady-state operation of transmission lines including line loadability and reactive compensation techniques; power flow studies including Gauss-Seidel and Newton-Raphson interactive schemes; symmetrical faults including formation of the bus impedance matrix; unsymmetrical faults including line-to-ground, line-to-line, and double line-to-ground faults. Coreq. ECE U683. Prereq. ECE U400 and ECE U440.

ECE U683 Power Systems Lab 1 SH
Accompanies ECE U682. Addresses topics such as transmission line constants, load flow and short-circuit studies, and transient stability. Includes upgrading the design of a small power system. Coreq. ECE U682.

ECE U684 Power Electronics 4 SH
Intended for advanced undergraduate and beginning graduate students. Provides tools and techniques to analyze and design power conversion circuits that contain switches. Emphasizes understanding and modeling of such circuits, and provides a background for engineering evaluation of power converters. Also covers dynamics and control of this class of systems, enabling students to design controllers for a variety of power converters and motion control systems. Addresses a set of analytical and practical problems, with emphasis on a rigorous theoretical treatment of relevant questions. Designed for students with primary interest in power conditioning, control applications, and electronic circuits, but helpful for designers of high-performance computers, robots, and other electronic and electromechanical systems in which the dynamical properties of power supplies become important. Prereq. ECE U402 and ECE U464.

ECE U686 Electrical Machines 4 SH
Intended for advanced undergraduate and beginning graduate students. Reviews phasor diagrams and three-phase circuits; the magnetic aspects including magnetic circuits and permanent magnets; transformers, their equivalent circuits, and performance; principles of electromechanical energy conversion; and elementary concepts of rotating machines including rotating magnetic fields, steady-state theory, and performance of induction machines, synchronous machines, and direct-current machines. Prereq. ECE U400 and ECE U464.
ECE U692 Subsurface Sensing and Imaging 4 SH
Introduces the emerging field of subsurface sensing and imaging (SSI). Topics include the interrelatedness of the three technological levels of sensing, modeling and signal processing, and computational technology, the similarity of SSI across diverse problem domains and size scales, and the variety of information extraction strategies such as localized imaging and the use of multiple views in space, wavelength, and so on. Provides hands-on experience with a particular SSI modality that includes experimental measurement and subsequent processing and visualization of the measured data. Prereq. ECE U400, MTH U343, and ECE U468 or MTH U481.

ECE U694 Numerical Methods and Computer Applications 4 SH
Presents numerical techniques used in solving scientific and engineering problems with the aid of digital computers. Topics include theory of interpolation; the theory of numerical integration and differentiation, numerical solutions of linear as well as nonlinear systems of equations, the theory of least squares; and numerical solution of ordinary and partial differential equations using a programming environment such as MATLAB. Prereq. MTH U343 and GE U111.

ECE U698 Special Topics in Electrical Engineering 4 SH
Covers various topics from term to term, depending on the interests of the department and the students. Prereq. Permission of the department.

ECE U790 Electrical and Computer Engineering Capstone 1 4 SH
Requires students to select a project requiring design and implementation of an electrical, electronic, and/or software system, form a team to carry out the project, and submit and present a detailed proposal for the work. Students must specify the materials needed for their project, provide cost analysis, and make arrangements with their capstone adviser to purchase and/or secure donation of equipment. Requires student to perform a feasibility study by extensive simulation or prototype design of subsystems to facilitate the second phase of the capstone design. Prereq. Junior or senior standing.

ECE U792 Electrical and Computer Engineering Capstone 2 4 SH
Continues ECE U790. Requires students to design and implement the project proposed in that earlier course. Expects students to evaluate progress with interim milestone reports and to present the final design project with written and oral reports. Prereq. ECE U790.

ECE U921 Directed Study 1 SH
ECE U922 Directed Study 2 SH
ECE U923 Directed Study 3 SH
ECE U924 Directed Study 4 SH
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. Prereq. Permission of instructor.

ECE U931 Independent Study 1 SH
ECE U932 Independent Study 2 SH
ECE U933 Independent Study 3 SH
ECE U934 Independent Study 4 SH
Offers theoretical or experimental work under individual faculty supervision. Prereq. Permission of instructor.

ECE U970 Junior/Senior Honors Project 1 4 SH
Focuses on in-depth project in which a student conducts research or produces a product related to the student's major field. Culminating experience in the University Honors Program. Combined with Junior/Senior Project 2 or college-defined equivalent for 8 credit honors project. Prereq. Honors program participation.

ECE U971 Junior/Senior Honors Project 2 4 SH
Focuses on second semester of in-depth project in which a student conducts research or produces a product related to the student's major field. Culminating experience in the University Honors Program. Prereq. ECE U970 and honors program participation.