

Electrical Engineering

Chair: Professor M. Rudko

Faculty: Professors Y. Chang (on leave Spring), J. Spinelli, C. Traver (on leave Winter, Spring); Associate Professors P. Catravas, S. Cotter (on leave Winter, Spring); Assistant Professors T. Buma and H. Hanson; Senior Lecturer J. Hedrick

Staff: G. Davison (Engineering Assistant), L. Bremigen (Administrative Assistant)

The Electrical Engineering program provides students with a solid basis in electrical engineering and its underlying mathematics and science within the framework of a liberal arts education. We prepare students for immediate professional employment, graduate study, and entry into related professions. We believe that the rigor and depth of an electrical engineering education combined with a broad study of the liberal arts provides an excellent background for students who wish to enter professions such as medicine, law, and business administration as well as engineering itself. Through our required international component, our emphasis on undergraduate research, our flexible curriculum, and the personal attention that we give to each student, we educate well-rounded members of society who are prepared to excel in an increasingly multicultural and technological world.

The Electrical Engineering major is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>. Educational objectives and program outcomes are listed on the department website: ece.union.edu

Requirements for the Major: a total of 40 courses including the following:

Math and Science: (Math 113*, 115, 117, Physics 120, 121) or (IMP 111, 112, 113), Math 130; one science elective numbered 100 or higher (Chemistry 101, Physics 122, or Physics 123 are recommended); one Math or Science elective numbered 100 or higher. *Other calculus sequences are possible depending upon a student's background

Engineering and Computer Science: ESc 100; one from (CSC 103-109); one approved engineering course outside of ECE (a list of approved courses is published on the department website)

Electrical Engineering Core: ECE 118, 225, 240, 241, 248, 343, 350, 351, 363, 366

Electrical Engineering Electives: 3 additional ECE courses numbered 300 or higher. Students may also enroll in graduate engineering courses offered through Union Graduate College. Please see the Union Graduate College catalog for course descriptions and joint degree program options.

Capstone Design: ECE 497 (1/2), 498 (1/2), 499

Electives and General Education: 14 courses should be chosen in consultation with the student's advisor to enhance one or more of the program objectives and meet remaining general education requirements.

Sample schedule starting with Math 113: Students with different math backgrounds will have slightly different math sequences. ECE courses should be taken in the indicated terms to meet program prerequisites.

First Year

Fall: Elective*, ESC-100, MTH-113

Winter: Elective*, MTH-115, PHY-120, CSC-103 to CSC-109**

Spring: Elective*, MTH-117, PHY-121

Second Year

Fall: Elective*, ECE-118, ECE-225

Winter: ECE-240, MTH-130, Engineering Elective

Spring: Electives(2)*, ECE-241, ECE-248

Third Year

Fall: Term abroad option*** or Electives*

Winter: Elective*, ECE-343, ECE-366, Science elective

Spring: Elective*, ECE-350, ECE-497(1/2), Math/Science elective

Fourth Year

Fall: ECE-351, ECE-363, ECE elective 1, ECE-498(1/2)

Winter: ECE elective 2, ECE-499, Elective*

Spring: ECE elective 3, Elective*, Elective*

* Electives should be chosen to enhance one or more of the program objectives and meet remaining general education requirements. Students should work with their academic advisor to develop an appropriate plan of study.

** One course from CSC-103 to CSC-109 should be taken during the first year.

*** The fall term of the third year is the most common term for going on a full term abroad. With appropriate planning, students may go on winter and spring terms abroad as well. Students who do not go on a fall term abroad may take ECE 351 and ECE 363 or electives.

Requirements for the Minor: ECE 118, 225, 240, 248; Electives: one from (ECE 241, 318, 341, 363, 366), and one from (ECE 333, 348, 350, 352, 360).

Requirements for Honors: In addition to meeting all of the general college requirements for honors, candidates for honors in electrical engineering must present their senior project at the Steinmetz Symposium.

Requirements for the Five-Year Combined BS/MS in Electrical Engineering: Union undergraduate students may apply to this program offered in conjunction with Union Graduate College of Union University where both a B.S. and an M.S. degree in electrical engineering are earned in five years. Students are encouraged to apply during sophomore year but no later than the end of the fall term of their senior year. A 3.0 overall GPA is expected for admission. Students enrolled in the program may count up to three Electrical Engineering courses toward both degrees. A petition requesting overlapping degree credit must be approved by the undergraduate and graduate advisors and filed with the graduate office. The Master of Science program is described in the catalog of the Union Graduate College at www.uniongraduatecollege.edu

Electrical and Computer Engineering Course Listings

ECE-011. Practicum: Electrical and Computer Engineering (Fall, Winter, Spring). Hands-on exercises, lectures and guest speakers will demonstrate practical applications of ECE and how these applications are related to the core curriculum. Each offering of the course will have a central theme, such as audio engineering, speech acoustics, energy and the environment, power systems, digital signal processing, global communications, nanotechnology, microscopy (scanning electron microscopy, atomic force microscopy), optics, robotics, etc. This practicum will be of interest to students who would like more information about career paths that are possible with an Electrical and Computer Engineering degree. Students must pass three terms of the practicum in order to receive one course credit. The course is graded pass/fail.

ECE-118. Introduction to Computer and Logic Design (Fall). Cross listed with CSC-118. Fundamental material in the area of digital circuit analysis and synthesis, computer organization, and microprocessor programming. The components of digital computers are studied at the gate level, the machine organization level, and the assembly language programming level. Weekly team-based laboratory exercises and a course portfolio are required.

ECE-222. Introduction to Circuits and Electronics (Winter, Spring). Electrical quantities, circuit principles, analysis and response of basic circuits, semiconductor physics, diodes, transistors, and operational amplifiers. Includes a weekly lab. Not open to Electrical or Computer Engineering majors, or to students who have taken ECE-225. Prerequisites: PHY-121 or IMP-113.

ECE-225. Electric Circuits (Fall). Basic electrical circuit concepts and devices such as Ohm's law, Kirchhoff's laws, Thevenin and Norton equivalents, operational amplifiers, analysis methods, capacitors, inductors, ideal transformers, phasors, AC steady state analysis, complex power, frequency response and filters. Includes a weekly lab. Prerequisite: MTH-102 or MTH-112 or MTH-113 or IMP-112.

ECE-240. Circuits and Systems (Winter). Transient analysis of RLC circuits; modeling of circuits using differential equations; system models and properties; Laplace transforms applied to circuit and system design and analysis; system functions; complex frequency; poles and zeros; stability; frequency response; filter design. Includes a weekly lab. Prerequisite: ECE 225; Corequisite or Prerequisite MTH-130 or MTH-234.

ECE-241. Discrete Systems (Spring). Discrete signals and systems; classification and properties of systems; difference equations; Z-transform; Fourier series, Fourier transforms, the DFT and FFT; filters and filter design; A/D and D/A converters; applications to audio signal processing. Includes a weekly lab. Prerequisite: ECE-240.

ECE-244. Introduction to Bioengineering (Same as MER/BIO 240) (Winter). Students explore the application of engineering principles and analyses to the study of biological systems and seek to understand the potential benefits and constraints of engineered materials and devices in medical and environmental applications. Covers principles of solid mechanics, fluid mechanics, and neural information processing and control. Topics include the mechanics of support and locomotion, circulatory transport, mass transfer in organisms, sensory information processing and biorobotics. One lab per week. Prerequisites: MTH-110 and one major's course in biology, chemistry, or physics; PHY-110 recommended.

ECE-248. Introduction to Semiconductor Devices and Circuits (Spring). Semiconductors: theory of operation of diodes and transistors; circuit models; basic electronic circuits and amplifiers: transfer characteristics and inverters. Includes a weekly lab. Prerequisite: ECE-225.

ECE-281/282/283. ECE Practicum (Fall, Winter, Spring). Under the supervision of an ECE faculty member, students may participate in undergraduate research or a design project. To receive pass/fail credit equivalent to one elective course, a student must receive a passing grade in three terms of the practicum course. Up to two credits may be earned in this way. Pre-requisite: Permission of the faculty supervisor and the department chair is required.

ECE-295H, 296H. Electrical and Computer Engineering Honors Independent Project I & II (Fall, Winter, Spring). Sophomore project in Electrical and Computer Engineering for students participating in a scholars program. Prerequisite: permission of the instructor.

ECE-310. Electronic Devices (not offered 2011-12). Terminal characteristics and theory of electronic devices; band theory, photo and electronic effects, PN junctions; bipolar and field effect transistors, discrete and integrated electronics. Prerequisite: ECE 248.

ECE-312. Application of Integrated Circuits (not offered 2011-12). Electronic processing of signals; properties of linear and hybrid integrated circuits; design of linear, nonlinear and hybrid electronic systems, active filter networks. Design projects required. Prerequisite: ECE-363, ECE-366, or permission of the instructor.

ECE-318. Digital Design (Winter). Cross listed with CSC-318. The design of digital hardware systems at the module level using modern approaches. Datapath and control unit design, hardware description languages, programmable device implementations. Laboratory exercises using electronic design automation tools and a design project are required. Prerequisite: ECE-118.

ECE-325. Acoustics of Speech Communication (not offered 2011-12). Acoustics, circuit theory, and signal processing applied to analysis of speech signals; Physiology of speech production; Articulatory phonetics; Acoustical and articulatory description of phonetic features and of prosodic aspects of speech; Perception of speech; Models of speech production and planning; Some applications to recognition and generation of speech by machine, and to the study of speech disorders. Prerequisite: ECE-241

ECE-329. Neural Networks (not offered 2011-12). Same as CSC-329. Topics include the biological basis of artificial neural networks, neuron models and architectures, backpropagation, associative and competitive learning. Weekly computer laboratories and a final project required. Prerequisite: MTH-130 or MTH-234, CSC-150 for CS students.

ECE-330. Fuzzy Logic (not offered 2011-12). Cross listed with CSC-330. Topics include fuzzy sets and relations, membership functions, defuzzification, classical logic and fuzzy logic, fuzzy rule-based systems, nonlinear simulation, decision making, pattern recognition and control systems. Prerequisite: Calculus and Linear Algebra, CSC-150 for CS students.

ECE-333. Wireless Communication Circuits (not offered 2011-12). Communication circuits, including coupling networks, electrical noise, high-frequency amplifiers, mixers, phase locked loops, high efficiency and broadband amplifiers, modulators and demodulators, pulse modulation techniques. Includes a weekly lab. Design projects required. Prerequisite: ECE-350, ECE-363 or permission of the instructor.

ECE-336. Computer Network Protocols (not offered 2011-12) Same as CSC-236. Design, analysis, and operation of communication protocols for computer networks; TCP/IP, addressing, switching, routing, congestion control, application protocols. Prerequisite: one of CSC-103 to CSC-109, or equivalent programming ability.

ECE-337. Data Communications and Networks (Fall). Same as CSC-237. An introduction to the physical and data link layers of data communication networks, including error detection, and local area networks. Prerequisites: ECE-118 or one of CSC-103 to CSC-109.

ECE-341. Energy Conversion (not offered 2011-12). Theory of electromechanical energy conversion; characteristics of transformers and DC induction; and synchronous machines. Prerequisite: ECE-225.

ECE-342. Power Electronics (not offered 2011-12). Rectifying devices and rectifier circuits: device characteristics, waveforms, harmonic content filtering. Controlled rectifiers (thyristors, triacs): device characteristics, single phase and multiphase systems. Snubber circuits and divide limitations. DC-DC converters: design, application, topologies. Energy storage element selection and design: capacitors and inductors. Prerequisites: ECE-248, ECE-350.

ECE-343. Introduction to Electromagnetic Engineering (Winter). Traveling waves: transmission lines; electrostatics; magnetostatics; applications to engineering problems; solutions by analytical and numerical techniques. Prerequisites: ECE-240, (MTH-117 and PHY-121) or IMP-113.

ECE-347. Image Processing (not offered 2011-12). The course covers the basic operations performed on digital images. These include digitization, image enhancement and restoration, color image processing, and image compression using the discrete cosine transform and wavelets. Prerequisite: ECE-241

ECE-348. Digital Circuits (not offered 2011-12). Special circuitry of digital systems; transistors as switches, logic gate families (RTL, DTL, TTL, ECL, MOS, CMOS, etc.), digital ICs semiconductor memories. Design projects required. Prerequisite: ECE-118, ECE-248, or permission of the instructor.

ECE-350. Communication Systems (Spring). Frequency domain analysis, signal space representations, and their application to wireless communications; quality measures; performance in the presence of noise. Includes a weekly laboratory. Prerequisite: ECE-241

ECE-351. Probability and Digital Communications (Fall). An introduction to probability with an emphasis on applications in digital communications. Digital signaling, coding, probability of error, matched filters, optimum receiver design, source entropy, channel capacity. Prerequisite: ECE-118, ECE-240.

ECE-352. Embedded Microcontroller Systems (Spring). Same as CSC-352. Hardware and architecture with emphasis on 8051 microcontroller; programming in assembly and higher-level languages, microcontroller applications, and inter- facing. Includes an integrated lab. Design projects required. Prerequisites: (ECE-118 and one from CSC-103 to CSC-109) or CSC-270.

ECE-354. VLSI System Design (not offered 2011-12). Same as CSC-354. Design of very large scale integrated systems including structured design, stick diagrams, and delay time estimation. Design from logic to physical levels; CAD tools for layout and simulation. Design projects required. Prerequisites: ECE-118 and CSC-248.

ECE-358. Waves in Communication (not offered 2011-12). This course will cover the basic concepts needed to develop electromagnetic devices in wireless communication. These include transmission line theory and circuits, wave propagation and transmission, elements of guided waves and resonators, and basic antenna concepts. Prerequisite: ECE-343 or equivalent.

ECE-360. Power System Analysis I (not offered 2011-12). Power and energy in AC circuits; single phase, three-phase, and polyphase circuits in balanced and unbalanced regimes; measurement of three-phase power; determination of three-phase sequence; single-line diagrams; per-unit method of representation and computations; transformers and synchronous machines in power systems; parameters of transmission lines. Prerequisite: ECE-225.

ECE-361. Power System Analysis II (not offered 2011-12). Wave-propagation in transmission lines; analysis of power networks, load-flow solutions, and control; three-phase faults and symmetrical components; power system protection; stability of power systems. Prerequisites: ECE-225 or ECE-360.

ECE-363. Analysis and Design of Electronic Circuits (Fall). Multiple-stage amplifiers; Differential amplifiers; Frequency response of amplifiers; Feedback amplifier; Stability of electronic circuits; Analysis and design of operational amplifiers. Includes a weekly lab. Prerequisite: ECE-248.

ECE-366. Control Systems (Winter). Modeling of control systems by block diagrams and flow graphs. Analysis of control systems response, error and stability by Routh's criterion, Root-Locus method, and frequency domain methods (Nyquist, Bode, and Nichols). Laboratory and design project. Prerequisite: ECE-240.

ECE-368. Introduction to Antenna Theory (not offered 2011-12). This course will cover the basic concepts in antenna engineering. These include radiation and radiating systems, fundamental parameters of antennas, wire antennas, antenna arrays, aperture antennas, microstrip antennas, antenna synthesis, integral equation and the method of moments. Prerequisite: ECE-343 or equivalent.

ECE-370. Engineering Acoustics (not offered 2011-12). Course topics will include principles of acoustics, electromagnetics, circuit theory and signal processing applied to the analysis of musical instruments, experimental characterization techniques, digital instruments, MIDI. The symbiosis between music and the hard sciences will be surveyed. Attendance at some out-of-class events is required. Please contact the instructor in advance for a list of dates. Prerequisite: ECE-241; Co-requisite or Prerequisite ECE-343.

ECE-377. Biometrics (not offered 2011-12). Signal processing applied to create technologies which measure and analyze human body characteristics such as voice, face, and fingerprint biometrics which may be used in security and forensic applications. The societal and ethical issues involved will be addressed. Includes a weekly laboratory Prerequisites: ECE-241, CSC-10X.

ECE-463. Fundamentals of Wireless Electronics (not offered 2011-12). Review of phasor analysis; inductance and coupling networks; resonance; complex power and power transfer; transmission line theory and applications; introduction to matching network design. Includes a weekly studio/lab session. Prerequisite: ECE225 or equivalent

ECE-481, 482, 483. Special Topics in Electrical and Computer Engineering. Topics chosen from the current literature according to faculty and student interest. Each of these special topics courses has variable content addressing specific current areas of interest to students. They will be offered whenever the need arises.

ECE-490-496. Independent Study (Fall, Winter, Spring)

ECE-497, 498, 499. Electrical and Computer Engineering Capstone Design Project (Spring 1/2, Fall 1/2, Winter 1). Two course equivalent. Students begin this sequence of courses in the spring of their third year with a seminar component. In the fall and winter terms, students complete the design, implementation, and evaluation of a system under the supervision of one or more faculty members. Topics in the seminar include professional and ethical responsibilities; the historical and societal context of electrical and computer engineering; contemporary issues, and the specification, analysis, design, implementation, and testing phases of a design project. Research papers, project reports, and oral presentations are required.