Electrical Engineering

Chair: Professor C. Traver

Faculty: Professors Y. Chang, J. Spinelli; Associate Professors P. Catravas, S. Cotter, H. Hanson; Assistant Professors T. Buma; Senior Lecturer J. Hedrick; Post-doctoral Fellow R. Smith

Staff: G. Davison (Engineering Assistant), L. Galeo (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:

1. Math and Science: (MTH-113*, 115, 117, PHY-120, 121) or (IMP-111, 112, 113) or (IMP-120, 121), MTH-130 or 234; one science elective numbered 100 or higher (CHM-101, PHY-122, or 123 are recommended); one Math or Science elective numbered 100 or higher. *Other calculus sequences are possible depending upon a student’s background

2. Engineering and Computer Science: ESC-100; one from (CSC-103 through109); ECE-101 taken in the first year, or an approved ECE course taken in subsequent years


4. 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.

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

6. Electives: 14 electives should be chosen in consultation with the student’s advisor to meet the Common Curriculum requirements and enhance educational objectives. These elective courses, in addition to the 5 electives in math, science and electrical and computer engineering, can be customized to complete a double-major and one or more minors.

Sample schedule starting with Math 113: Students with different math backgrounds will have slightly different math sequences.

First Year
ESC-100, ECE-101, FPR-100, MTH-113, MTH-115, PHY-120, one of CSC-103 to CSC-109, MTH-117, PHY-121, Electives (1)*

Second Year
ECE-118, ECE-225, ECE-240, SRS-200, MTH-130, Engineering Elective, ECE-241***, ECE-248, Electives (2)*

Third Year**
ECE-351, ECE-363, ECE-343, ECE-366, ECE-350, ECE-497(1/2), Math/Science elective, Science elective, Electives (3)*

Fourth Year
ECE-498(1/2) ECE-499, ECE electives 1, 2, 3, Electives (5)*

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

** 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 go on a fall term abroad may take ECE-351 and ECE-363 during the fall term of their senior year.
Students who would like more information about career paths that are possible with an Electrical and Computer Engineering degree. Students must
nanotechnology, microscopy (scanning electron microscopy, atomic force microscopy), optics, robotics, etc. This practicum will be of interest to
theme, such as audio engineering, speech acoustics, energy and the environment, power systems, digital signal processing, global communications,
demonstrate practical applications of ECE and how these applications are related to the core curriculum. Each offering of the course will have a central
program is described in the catalog of the Union Graduate College at www.uniongraduatecollege.edu

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 Minor: ECE-118, 225, 240, 248, and two ECE electives numbered 100 or higher. Students with interests in a particular area of ECE may select an alternate sequence of six ECE courses numbered above 100, subject to approval from the ECE department chair.

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-101. The Joy of Electronics (Winter, Spring) Introduction to the tools, skills, and principles of electrical and computer engineering. Emphasis is placed on developing an intuitive understanding while learning quantitative methods to design, test, and analyze electronics. Test and measurement tools include oscilloscopes, multimeters, and function generators. Circuit construction techniques include breadboarding and soldering as well as computer software to simulate circuits. Principles such as power, frequency, and modulation are taught through analog and digital electronics projects. Hands-on projects include an audio amplifier, crystal radio receiver, digital clock, and a microcontroller-operated robotic arm. Prerequisites: None.

ECE-118. Introduction to Computer and Logic Design (Fall). Same as 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, or Bioengineering majors, or to students who have taken ECE-225. Prerequisites: PHY-121 or IMP-113.

ECE-225. Electric Circuits (Fall, Winter). 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, Spring). 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 (Fall, 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-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 free elective course, a student must receive a passing grade in

***ECE-241 may also be taken during the fall or spring term of the junior year.
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 2013-14). 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-318. Digital Design** (Winter). Same as 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** (Fall). 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 2013-14). Same as CSC-329. Topics include the biological basic 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-333. Transmission Line Circuits and Applications** (not offered 2013-14). Topics include sinusoidal sources, impedances, admittances, and basic circuit analysis; voltage and current as traveling waves; RLC circuit models and transmission line equations; characteristic impedance and propagation constant; reflection coefficient and power transfer; introduction of using matching circuits to reduce power loss; analysis and design of lumped-parameter (RLC) and distributed-parameter (transmission line) matching circuits; Smith Chart as an analysis/design tool. Includes a weekly studio session. Pre-requisite: ECE-225 or equivalent.

**ECE-336. Computer Network Protocols** (not offered 2013-14) 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 2013-14). Theory of electromechanical energy conversion; characteristics of transformers and DC induction; and synchronous machines. Prerequisite: ECE-225.


**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 2013-14). 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 2013-14). 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 and Robotics** (Spring). Same as CSC-352. Hardware and architecture with emphasis on 8051 microcontroller; programming in assembly and higher-level languages, microcontroller applications, and interfacing. 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 (Spring). Same as CSC-354. Design of very large scale integrated systems including standard CMOS and more advanced and emerging technologies in nanoelectronics. Design from logic to physical levels and manufacturing processes. System-on-chip technologies and applications. Prerequisites: ECE 118 and (225 or 222).

ECE-358. Waves in Communication (Spring). Covers the basic concepts needed to develop electromagnetic devices in communication circuits/systems. Wave propagation and transmission, antenna concepts, design considerations, Friis transmission formula and radar equation, transmission line theory and guided waves. Pre-requisite: Physics 121 or equivalent.

ECE-360. Power System Analysis 1 (Winter). Power and energy in single-phase and polyphase circuits; transformer characteristics; single-line and three-line diagrams; load flow; per-unit analysis; instrument transformers; power system fault duty and x/r; switching and lightning transients; power factor correction; power quality standards. Prerequisite: ECE-225.

ECE-361. Power System Analysis 2 (not offered 2013-14). 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-368. Introduction to Antenna Theory (Fall). 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 2013-14). 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 2013-14). 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-386. Introduction to Biomedical Instrumentation. (Winter). Same as BNG-386. Introduction to the theory and application of instruments in medicine. Measurements of the major systems in the body are covered. A weekly laboratory provides an opportunity to perform measurements and use biomedical instruments. Prerequisite: ECE-240.

ECE-463. Fundamentals of Wireless Electronics (not offered 2013-14). 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: ECE-225 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-487. Medical Imaging Systems (Spring) Same as BNG-487. The basic physics, instrumentation, system design, and image reconstruction algorithms are covered for the following imaging modalities: ultrasound, radiography, x-ray computed tomography (CT), magnetic resonance imaging (MRI), planar scintigraphy, and positron emission tomography (PET). Prerequisites: ECE-241.

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.