ELECTRICAL AND COMPUTER ENGINEERING

William Sanders
155 Everitt Laboratory, 1406 West Green, Urbana
PH: (217) 333-2300
http://ece.illinois.edu

Head of the Department: William Sanders
Department office: 2120 ECE Building, 306 N. Wright Street, Urbana
Phone: (217) 333-2300
Department web site: http://ece.illinois.edu

For the Degree of Bachelor of Science in Computer Engineering

Computer Engineering at Illinois focuses on the development of vital computing technologies, ranging from chips to computers to networks to programming tools to key algorithms for building exciting applications. Fundamentally, Computer Engineering addresses the problem of building scalable, trustworthy computing systems, and the faculty’s interests span a broad spectrum of issues pertinent to this theme. Computer engineering has taken the lead in revolutionizing many science and engineering disciplines with parallel computing, from chips to clouds to planet-scale critical infrastructures, and has defined new standards of security, privacy, and dependability for systems ranging from small circuits to the electric power grids of many nations. Students need a broad and sound set of mathematical and computing skills, and are well-served by a flexible curriculum that enables them to pursue topics of interest among the many subdisciplines in computing.

The computer engineering core curriculum focuses on fundamental computer engineering knowledge: circuits, systems, electromagnetics, computer systems, electronics for information processing and communication, and computer science. The rich set of ECE elective courses permits students to concentrate in any sub-discipline of computer engineering including: hardware systems; cyberphysical systems; foundations and theory; software and languages; algorithms and mathematical tools; trust, reliability, security; networking, mobile and distributed computing; big data analytics and systems; artificial intelligence, robotics, cybernetics.

For the Degree of Bachelor of Science in Electrical Engineering

Electrical engineering is a multifaceted discipline that over the last century has produced an astounding progression of technological innovations that have shaped virtually every aspect of modern life. Electrical engineers need a broad and solid foundation in mathematics and physics to support their education in the engineering principles of analysis, synthesis, design, implementation, and testing of the devices and systems that provide the bedrock of modern energy, communication, sensing, computing, medical, security, and defense infrastructures. Within each subdiscipline one can find application domains that strongly rely on hands-on experimental work or that are based on theoretical, mathematical and computational approaches. The multidisciplinary nature of the electrical engineering education addresses the growing demand for the innovation and design of sensing, communication, computing, and decision-making systems of increasing complexity in consumer, defense, and medical applications.

The curriculum starts with a core of fundamental courses on circuits, electromagnetics, solid-state electronics, and computer systems, leading to a comprehensive array of specialized courses and laboratories in all of the important areas of modern electrical engineering. These range from power and energy systems to electronic, opto-electronic, and photonic devices; integrated circuits; telecommunications and remote sensing; control systems; robotics; signal processing; and bio-medical instrumentation and sensing.

- Major in Computer Engineering (http://catalog.illinois.edu/undergraduate/engineer/departments/electrical-computer-engin/electrical-engineering-major)
- Major in Electrical Engineering (http://catalog.illinois.edu/undergraduate/engineer/departments/electrical-computer-engin/electrical-engineering-major)

ECE Class Schedule (https://courses.illinois.edu/schedule/DEFAULT/DEFAULT/ECE)

Courses

**ECE 101 Exploring Digital Info Technol** credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/101)
Principles and processes for the development of information technologies: digital music, digital images, digital logic, data compression, error correction, information security, and communication networks. Laboratory for design of hardware and software, and experiments in audio and image processing. Intended for students outside the College of Engineering. Credit is not given to Computer or Electrical Engineering majors.
This course satisfies the General Education Criteria for: Nat Sci Tech - Phys Sciences

**Quantitative Reasoning II**

**ECE 110 Introduction to Electronics** credit: 1 to 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/110)
Introduction to selected fundamental concepts and principles in electrical engineering. Emphasis on measurement, modeling, and analysis of circuits and electronics while introducing numerous applications. Includes sub-discipline topics of electrical and computer engineering, for example, electromagnetics, control, signal processing, microelectronics, communications, and scientific computing basics. Lab work incorporates sensors and motors into an autonomous moving vehicle, designed and constructed to perform tasks jointly determined by the instructors and students.

**ECE 120 Introduction to Computing** credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/120)
Introduction to digital logic, computer systems, and computer languages. Topics include representation of information, combinational and sequential logic analysis and design, finite state machines, the von Neumann model, basic computer organization, and machine language programming. Laboratory assignments provide hands-on experience with design, simulation, implementation, and programming of digital systems. Prerequisite: Restricted to Computer Engineering or Electrical Engineering majors or transfer students with ECE Department consent.

**ECE 198 Special Topics** credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/198)
Lectures and discussions relating to new areas of interest. May be repeated in the same or separate terms for unlimited hours if topics vary. See class schedule for topics and prerequisites.

Information listed in this catalog is current as of 01/2020
ECE 199 Undergraduate Open Seminar credit: 1 to 5 Hours. (https://courses.illinois.edu/schedule/terms/ECE/199)
Approved for both letter and S/U grading. May be repeated.

ECE 200 Seminar credit: 0 Hours. (https://courses.illinois.edu/schedule/terms/ECE/200)
Discussions of educational programs, career opportunities, and other topics in electrical and computer engineering. Approved for Letter and S/U grading. May be repeated. For Computer Engineering and Electrical Engineering majors only.

ECE 205 Electrical and Electronic Circuits credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/205)
ECE 205 is an introductory course on circuit analysis and electronics for non-majors in engineering. The course includes bi-weekly electronics lab experiments designed to provide students with hands-on experience. Basic principles of circuit analysis and DC circuits; time-domain analysis of 1st and 2nd order linear circuits; complex numbers, phasors, AC steady-state analysis; frequency response; op-amp, diode, and BJT circuits; logic gates and digital logic circuits. Credit is not given to Computer or Electrical Engineering majors. Credit is not given to Computer or Electrical Engineering majors.
Prerequisite: ECE 205.

ECE 206 Electrical and Electronic Circuits Lab credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ECE/206)
Laboratory experiments in digital logic and controllers; transistor amplifier and switching circuits; DC motor control and voltage regulators; sensors and motion control with feedback; wireless communication. Credit is not given to Computer or Electrical Engineering majors.
Prerequisite: ECE 205.

ECE 210 Analog Signal Processing credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/210)
Analog signal processing, with an emphasis on underlying concepts from circuit and system analysis: linear systems; review of elementary circuit analysis; differential equation models of linear circuits and systems; Laplace transform; convolution; stability; phasors; frequency response; Fourier transform; Fourier transform; active filters; AM radio. Credit is not given to both ECE 210 and ECE 211. Prerequisite: ECE 110 and PHYS 212; credit or concurrent registration in MATH 285 or MATH 286.

ECE 211 Analog Circuits & Systems credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ECE/211)
Concepts from circuit and system analysis: linear systems; review of elementary circuit analysis; op amps; transient analysis; differential equation models of linear circuits and systems; Laplace transform. Credit is not given to both ECE 211 and ECE 210. Prerequisite: ECE 110 and PHYS 212; credit or concurrent registration in MATH 285 or MATH 286.

ECE 220 Computer Systems & Programming credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/220)
Advanced use of LC-3 assembly language for I/O and function calling convention. C programming, covering basic programming concepts, functions, arrays, pointers, I/O, recursion, simple data structures, linked lists, dynamic memory management, and basic algorithms. Information hiding and object-oriented design as commonly implemented in modern software and computer systems programming.
Prerequisite: ECE 120
Restricted to Computer Engineering or Electrical Engineering majors or transfer students with ECE Department consent.

ECE 297 Individual Study credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ECE/297)
Individual projects. Approved written application to department as specified by department or instructors is required. Approved for both letter and S/U grading. May be repeated in separate terms to a maximum of 2 hours. Prerequisite: Consent of instructor.

ECE 298 Special Topics credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/298)
Lectures and discussions relating to new areas of interest. May be repeated in the same or separate terms for unlimited hours if topics vary. See class schedule for topics and prerequisites.

ECE 304 Photonic Devices credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/304)
Introduction to active and passive photonic devices and applications; optical processes in semiconductor and dielectric materials including electrical junctions, light emission and absorption, and waveguide confinement; photonic components such as light emitting diodes, lasers, photodetectors, solar cells, liquid crystals, and optical fiber; optical information distribution networks and display applications. Prerequisite: PHYS 214.

ECE 307 Techniques for Engng Decisions credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/307)
Modeling of decisions in engineering work and the analysis of models to develop a systematic approach to making decisions. Fundamental concepts in linear and dynamic programming; probability theory; and statistics. Resource allocation; logistics; scheduling; sequential decision making; siting of facilities; investment decisions; application of financial derivatives; other problems for decision making under uncertainty. Case studies from actual industrial applications illustrate real-world decisions.
Prerequisite: ECE 210; credit or concurrent registration in ECE 313.

ECE 310 Digital Signal Processing credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/310)
Introduction to discrete-time systems and discrete-time signal processing with an emphasis on causal systems; discrete-time linear systems, difference equations, z-transforms, discrete convolution, stability, discrete-time Fourier transforms, analog-to-digital and digital-to-analog conversion, digital filter design, discrete Fourier transforms, fast Fourier transforms, spectral analysis, and applications of digital signal processing.
Prerequisite: ECE 210.

ECE 311 Digital Signal Processing Lab credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ECE/311)
Companion laboratory for ECE 310. Prerequisite: Credit or concurrent registration in ECE 310.

ECE 313 Probability with Engrg Applic credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/313)
Probability theory with applications to engineering problems such as the reliability of circuits and systems to statistical methods for hypothesis testing, decision making under uncertainty, and parameter estimation. Same as MATH 362. Credit is not given for both ECE 313 and MATH 461.
Prerequisite: MATH 286 or MATH 415.

ECE 314 Probability in Engineering Lab credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ECE/314)
Designed to be taken concurrently with ECE 313, Probability in Engineering Systems, to strengthen the students’ understanding of the concepts in ECE 313 and their applications, through computer simulation and computation using the Python programming language. Topics include sequential hypothesis testing, parameter estimation, confidence intervals, Bloom filters, min hashing, load balancing, inference for Markov chains, PageRank algorithm, vector Gaussian distribution, contagion in networks, principle component method and linear regression for data analysis, investment portfolio analysis. Prerequisite: Concurrent enrollment in ECE 313 or credit in one of: ECE 313, IE 300, STAT 410.
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ECE 395 Advanced Digital Projects Lab credit: 2 or 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/395)
Planning, designing, executing, and documenting a microcomputer-based project. Emphasis on hardware but special projects may require an equal emphasis on software. May be repeated in separate terms. Prerequisite: ECE 385.

ECE 396 Honors Project credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/396)
Special project or reading course for James Scholars in engineering. May be repeated. Prerequisite: Consent of instructor.

ECE 397 Individual Study in ECE credit: 0 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/397)
Individual Projects. Approved for both letter and S/U grading. May be repeated. Prerequisite: Consent of instructor. Approved written application to department as specified by department or instructor is required.

ECE 398 Special Topics in ECE credit: 0 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/398)
Subject offerings of new and developing areas of knowledge in electrical and computer engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. Approved for both letter and S/U grading. May be repeated in the same or separate terms if topics vary.

ECE 399 Honors Seminar credit: 1 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/399)
Special lecture sequences or discussion groups arranged each term to bring James Scholars in engineering into direct contact with the various aspects of engineering practices and philosophy. For Computer Engineering and Electrical Engineering majors with senior standing. Prerequisite: Consent of instructor.

ECE 401 Signal and Image Analysis credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/401)
An introduction to signal analysis and processing methods for advanced undergraduates or graduate students in the biological, physical, social, engineering and computer sciences. Signal analysis methods and their capabilities, weaknesses, and artifacts with an emphasis on their practical application. Significant hands-on processing and interpretation of real data using MATLAB. 4 undergraduate hours. 4 graduate hours. Credit is not given for both ECE 310 and ECE 401. Prerequisite: MATH 220.

ECE 402 Electronic Music Synthesis credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/402)
Historical survey of electronic and computer music technology; parameters of musical expression and their codification; analysis and synthesis of fixed sound spectra; time-variant spectrum analysis/synthesis of musical sounds; algorithms for dynamic sound synthesis. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 310.

ECE 403 Audio Engineering credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/403)
Resonance and wave phenomena; Acoustics of rooms and transmission lines (e.g., horns); How loudspeakers work: A lab component has been added to measure and model real loudspeakers and enclosures; Topics in digital audio, including AD and DA (Sigma-Delta) audio converters. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 210 and ECE 310.

ECE 408 Applied Parallel Programming credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/408)
Parallel programming with emphasis on developing applications for processors with many computation cores. Computational thinking, forms of parallelism, programming models, mapping computations to parallel hardware, efficient data structures, paradigms for efficient parallel algorithms, and application case studies. Same as CS 483 and CSE 408. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 220.

ECE 411 Computer Organization & Design credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/411)
Basic computer organization and design: integer and floating-point computer arithmetic; control unit design; pipelining; system interconnect; memory organization; I/O design; reliability and performance evaluation. Laboratory for computer design implementation, simulation, and layout. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 391 or CS 241.

ECE 412 Microcomputer Laboratory credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/412)
Design, construction, and use of a small general-purpose computer with a micro-processor CPU; MSI and LSI circuits used extensively; control panel, peripheral controllers, control logic, central processor, and programming experiments. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 385; ECE 391 or CS 233. Recommended: Credit or concurrent registration in ECE 411.

ECE 414 Biomedical Instrumentation credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/414)
Same as BIOE 415. See BIOE 414.

ECE 415 Biomedical Instrumentation Lab credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ECE/415)
Same as BIOE 415. See BIOE 415.

ECE 416 Biosensors credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/416)
Underlying engineering principles used to detect small molecules, DNA, proteins, and cells in the context of applications in diagnostic testing, pharmaceutical research, and environmental monitoring. Biosensor approaches including electrochemistry, fluorescence, acoustics, and optics; aspects of selective surface chemistry including methods for biomolecule attachment to transducer surfaces; characterization of biosensor performance; blood glucose detection; fluorescent DNA microarrays; label-free biosips; bead-based assay methods. Case studies and analysis of commercial biosensor. Same as BIOE 416. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 329.

ECE 417 Multimedia Signal Processing credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/417)
Characteristics of speech and image signals; important analysis and synthesis tools for multimedia signal processing including subspace methods, Bayesian networks, hidden Markov models, and factor graphs; applications to biometrics (person identification), human-computer interaction (face and gesture recognition and synthesis), and audio-visual databases (indexing and retrieval). Emphasis on a set of MATLAB machine problems providing hands-on experience. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 310 and ECE 313.
ECE 418 Image & Video Processing credit: 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/418](https://courses.illinois.edu/schedule/terms/ECE/418))
Concepts and applications in image and video processing; introduction to multidimensional signal processing: sampling, Fourier transform, filtering, interpolation, and decimation; human visual perception; scanning and display of images and video; image enhancement, restoration and segmentation; digital image and video compression; image analysis. Laboratory exercises promote experience with topics and development of C and MATLAB programs. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 310; credit or concurrent registration in one of ECE 313, STAT 400, IE 300, MATH 461; MATH 415; experience with C programming language.

ECE 419 Security Laboratory credit: 3 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/419](https://courses.illinois.edu/schedule/terms/ECE/419))
Same as CS 460. See CS 460.

ECE 420 Embedded DSP Laboratory credit: 2 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/420](https://courses.illinois.edu/schedule/terms/ECE/420))
Development of real-time digital signal processing (DSP) systems using a DSP microprocessor; several structured laboratory exercises, such as sampling and digital filtering; followed by an extensive DSP project of the student's choice. 2 undergraduate hours. 2 graduate hours. Prerequisite: ECE 310.

ECE 422 Computer Security I credit: 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/422](https://courses.illinois.edu/schedule/terms/ECE/422))
Same as CS 461. See CS 461.

ECE 424 Computer Security II credit: 3 or 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/424](https://courses.illinois.edu/schedule/terms/ECE/424))
Same as CS 463. See CS 463.

ECE 425 Intro to VLSI System Design credit: 3 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/425](https://courses.illinois.edu/schedule/terms/ECE/425))
Complementary Metal-Oxide Semiconductor (CMOS) technology and theory; CMOS circuit and logic design; layout rules and techniques; circuit characterization and performance estimation; CMOS subsystem design; Very-Large-Scale Integrated (VLSI) systems design methods; VLSI Computer Aided Design (CAD) tools; workstation-based custom VLSI chip design using concepts of cell hierarchy; final project involving specification, design, and evaluation of a VLSI chip or VLSI CAD program; written report and oral presentation on the final project. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 385 and ECE 411; or CS 233.

ECE 428 Distributed Systems credit: 3 or 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/428](https://courses.illinois.edu/schedule/terms/ECE/428))
Same as CS 425. See CS 425.

ECE 431 Electric Machinery credit: 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/431](https://courses.illinois.edu/schedule/terms/ECE/431))
Theory and laboratory experimentation with three-phase power, power-factor correction, single- and three-phase transformers, induction machines, DC machines, and synchronous machines; project work on energy control systems; digital simulation of machine dynamics. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 330.

ECE 432 Advanced Electric Machinery credit: 3 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/432](https://courses.illinois.edu/schedule/terms/ECE/432))
Advanced rotating machine theory and practice: dynamic analysis of machines using reference frame transformations; tests for parameter determination; reduced order modeling of machines; mechanical subsystems including governors, prime movers and excitation systems; digital simulation of inter-connected machines. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 431.

ECE 434 Mobile Computing & Application credit: 3 or 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/434](https://courses.illinois.edu/schedule/terms/ECE/434))
Introduction to cross-disciplinary ideas and techniques in mobile computing, with an emphasis on how they can be composed to build systems and applications on smartphones, tablets, and wearable devices. Topics of interest include smartphone sensing, energy efficiency, indoor localization, augmented reality, context-awareness, gesture recognition, and data analytics. Various techniques and methods utilized to combine them into functional systems, propose a new system, define the underlying problems, and solve them end to end. Same as CS 434. 3 undergraduate hours. 4 graduate hours. Prerequisite: ECE 391, CS 241, or ECE 310.

ECE 435 Computer Networking Laboratory credit: 3 or 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/435](https://courses.illinois.edu/schedule/terms/ECE/435))
Same as CS 436. See CS 436.

ECE 437 Sensors and Instrumentation credit: 3 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/437](https://courses.illinois.edu/schedule/terms/ECE/437))
Hands-on exposure to fundamental technology and practical application of sensors. Capacitive, inductive, optical, electromagnetic, and other sensing methods are examined. Instrumentation techniques incorporating computer control, sampling, and data collection and analysis are reviewed in the context of real-world scenarios. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 329.

ECE 438 Communication Networks credit: 3 or 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/438](https://courses.illinois.edu/schedule/terms/ECE/438))
Same as CS 438. See CS 438.

ECE 439 Wireless Networks credit: 3 or 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/439](https://courses.illinois.edu/schedule/terms/ECE/439))
Overview of wireless network architectures including cellular networks, local area networks, multi-hop wireless networks such as ad hoc networks, mesh networks, and sensor networks; capacity of wireless networks; medium access control, routing protocols, and transport protocols for wireless networks; mechanisms to improve performance and security in wireless networks; energy-efficient protocols for sensor networks. Same as CS 439. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 241 or ECE 391; one of MATH 461, MATH 463, ECE 313.

ECE 441 Physics & Modeling Semicond Dev credit: 3 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/441](https://courses.illinois.edu/schedule/terms/ECE/441))
Advanced concepts including generation-recombination, hot electron effects, and breakdown mechanisms; essential features of small ac characteristics, switching and transient behavior of p-n junctions, and bipolar and MOS transistors; fundamental issues for device modeling; perspective and limitations of Si-devices. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 340.

ECE 443 LEDs and Solar Cells credit: 4 Hours. ([https://courses.illinois.edu/schedule/terms/ECE/443](https://courses.illinois.edu/schedule/terms/ECE/443))
This course explores the energy conversion devices from fundamentals to system-levels including electronic structure of semiconductors; quantum physics; compound semiconductors; semiconductor heterostructures and low dimensional quantum structures; energy transfer between photons and electron-hole pairs; photon emission and capture processes; radiative and non-radiative processes; light extraction and trapping; emission and absorption engineering; electrical and optical modelling via numerical and TCAD simulation tools; hands-on characterization of modern light emitting diodes and solar cells. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 340.

Information listed in this catalog is current as of 01/2020
ECE 444  IC Device Theory & Fabrication  credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/444)
Fabrication lab emphasizing physical theory and design of devices suitable for integrated circuitry; electrical properties of semiconductors and techniques (epitaxial growth, oxidation, photolithography diffusion, ion implantation, metallization, and characterization) for fabricating integrated circuit devices such as p-n junction diodes, bipolar transistors, and field effect transistors. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 340.

ECE 445  Senior Design Project Lab  credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/445)
Individual design projects in various areas of electrical and computer engineering; projects are chosen by students with approval of instructor. A professionally kept lab notebook, a written report, prepared to journal publication standards, and an oral presentation required. 4 undergraduate hours. No graduate credit. This course satisfies the General Education Criteria for: Advanced Composition

ECE 446  Principles of Experimental Research in Electrical Engineering credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/446)
Interdisciplinary approach to learning principles of experimental research. Focuses on: 1) experimental design 2) prevalent experimental techniques 3) data organization, analysis, and presentation and 4) scientific computing. Presentation methods explored include poster session, conference talk, and journal paper. Open-ended labs and a project reinforce concepts discussed in class. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 313.

ECE 447  Active Microwave Ckt Design  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/447)
Microwave circuit design of amplifiers, oscillators, and mixers. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 350 and ECE 453.

ECE 448  Artificial Intelligence  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/448)
Same as CS 440. See CS 440.

ECE 449  Machine Learning  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/449)
Same as CS 446. See CS 446.

ECE 451  Adv Microwave Measurements  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/451)
Manual- and computer-controlled laboratory analysis of circuits at microwave frequencies. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 350.

ECE 452  Electromagnetic Fields  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/452)
Plane waves at oblique incidence; wave polarization; anisotropic media; radiation; space communications; waveguides. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 350.

ECE 453  Wireless Communication Systems  credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/453)
Design of a radio system for transmission of information; modulation, receivers, impedance matching, oscillators, two-port network analysis, receiver and antenna noise, nonlinear effects, mixers, phase-locked loops. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 329, credit or concurrent registration in ECE 342.

ECE 454  Antennas  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/454)
Antenna parameters; polarization of electromagnetic waves; basic antenna types; antenna arrays; broadband antenna design; antenna measurements. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 350.

ECE 455  Optical Electronics  credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/455)
Optical beams and cavities; semiclassical theory of gain; characteristics of typical lasers (gas, solid state, and semiconductor); application of optical devices. 3 undergraduate hours. 4 graduate hours. Prerequisite: ECE 350 or PHYS 436.

ECE 456  Global Nav Satellite Systems  credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/456)
Engineering aspects of space-based navigation systems, such as the Global Positioning System (GPS). Engineering and physical principles on which GPS operates, including orbital dynamics, electromagnetic wave propagation in a plasma, signal encoding, receiver design, error analysis, and numerical methods for obtaining a navigation solution. GPS as a case study for performing an end-to-end analysis of a complex engineering system. Laboratory exercises focus on understanding receiver design and developing a MATLAB-based GPS receiver. Same as AE 456. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 329 and ECE 310 or AE 352 and AE 353.

ECE 457  Microwave Devices & Circuits  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/457)
Electromagnetic wave propagation, microwave transmission systems, passive components, microwave tubes, solid state microwave devices, microwave integrated circuits, S-parameter analysis, and microstrip transmission lines. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 340 and ECE 350.

ECE 458  Applic of Radio Wave Propag  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/458)
Terrestrial atmosphere, radio wave propagation, and applications to radio sensing and radio communication. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 350.

ECE 459  Communications Systems  credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/459)
Analog underpinning of analog and digital communication systems: representation of signals and systems in the time and frequency domains; analog modulation schemes; random processes; prediction and noise analysis using random processes; noise sensitivity and bandwidth requirements of modulation schemes. Brief introduction to digital communications. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 313.

ECE 460  Optical Imaging  credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/460)
Scalar fields, geometrical optics, wave optics, Gaussian beams, Fourier optics, spatial and temporal coherence, microscopy, interference chromatic and geometric aberrations, Jones matrices, waveplates, electromagnetic fields, and electro-optic and acousto-optic effects. Laboratory covers numerical signal processing, spectroscopy, ray optics, diffraction, Fourier optics, microscopy, spatial coherence, temporal coherence, polarimetry, fiber optics, electro-optic modulation and acousto-optic modulation. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 329; credit or concurrent registration in ECE 313.
ECE 460    Digital Communications    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/461)
Reliable communication of one bit of information over three types of channels: additive Gaussian noise, wireline, and wireless. Emphasis on the impact of bandwidth and power on the data rate and reliability, using discrete-time models. Technological examples used as case studies. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 210 and ECE 313.

ECE 462    Logic Synthesis    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/462)
Unate function theory, unate recursive paradigm, synthesis of two-level logic, synthesis of incompletely specified combinational logic, multi-level logic synthesis, binary decision diagrams, finite state machine synthesis, automatic test pattern generation and design for test, equivalence checking and reachability analysis of finite machines, and technology mapping. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 220 or CS 233.

ECE 463    Digital Communications Lab    credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ECE/463)
Hands-on experience in the configuration and performance evaluation of digital communication systems employing both radio and optical signals. 2 undergraduate hours. 2 graduate hours. Prerequisite: ECE 361 or ECE 459.

ECE 464    Power Electronics    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/464)
Switching functions and methods of control such as pulse-width modulation, phase control, and phase modulation; dc-dc, ac-dc, dc-ac, and ac-ac power converters; power components, including magnetic components and power semiconductor switching devices. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 342.

ECE 465    Optical Communications Systems    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/465)
Fundamentals of lightwave systems: characterization of lightwave channels, optical transmitters, receivers, and amplifiers; quantum and thermal noise processes; design of optical receivers; multimode and single-mode link analysis. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 313 and ECE 350. Recommended: credit or concurrent registration in ECE 459 and ECE 466.

ECE 466    Optical Communications Lab    credit: 1 Hour. (https://courses.illinois.edu/schedule/terms/ECE/466)
Fiber components and measurements, transmitters and detectors, fiber amplifiers, multimode fiber links, and wavelength division multiplexing. 1 undergraduate hour. 1 graduate hour. Prerequisite: Credit or concurrent registration in ECE 465.

ECE 467    Biophotonics    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/467)
Overview of the field of biophotonics, in three segments: (1) fundamental principles of light, optics, lasers, biology, and medicine; (2) diagnostic biophotonics including imaging, spectroscopy, and optical biosensors; (3) therapeutic applications of biophotonics including laser ablation and photodynamic therapies. Reviews and presentations of current scientific literature by students. Tours of microscopy facilities. Same as BIOE 467, 3 undergraduate hours. 3 graduate hours. Prerequisite: One of ECE 455, ECE 460, PHYS 402.

ECE 468    Optical Remote Sensing    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/468)
Optical sensors including single element and area arrays (CCDs); optical systems including imagers, spectrometers, interferometers, and lidar; optical principles and light gathering power; electromagnetics of atomic and molecular emission and scattering with applications to the atmosphere the prime example; applications to ground and spacecraft platforms. Four laboratory sessions (4.5 hours each) arranged during term in lieu of four lectures. Same as AE 468. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 329, ECE 313.

ECE 469    Power Electronics Laboratory    credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ECE/469)
Circuits and devices used for switching power converters, solid-state motor drives, and power controllers; dc-dc, ac-dc, and dc-ac converters and applications; high-power transistors and magnetic components; design considerations including heat transfer. 2 undergraduate hours. 2 graduate hours. Prerequisite: ECE 343; credit or concurrent registration in ECE 464.

ECE 470    Introduction to Robotics    credit: 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/470)
Fundamentals of robotics including rigid motions; homogeneous transformations; forward and inverse kinematics; velocity kinematics; motion planning; trajectory generation; sensing, vision, control. Same as AE 482 and ME 445. 4 undergraduate hours. 4 graduate hours. Prerequisite: One of MATH 225, MATH 286, MATH 415, MATH 418.

ECE 472    Biomedical Ultrasound Imaging    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/472)
Theoretical and engineering foundations of ultrasonic imaging for medical diagnostics. Conventional, Doppler, and advanced ultrasonic imaging techniques; medical applications of different ultrasonic imaging techniques; engineering problems related to characterization of ultrasonic sources and arrays, image production, image quality, the role of contrast agents in ultrasonic imaging, and system design. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 329.

ECE 473    Fund of Engrg Acoustics    credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/473)
Development of the basic theoretical concepts of acoustical systems; mechanical vibration, plane and spherical wave phenomena in fluid media, lumped and distributed resonant systems, and absorption phenomena and hearing. Same as TAM 413. 3 or 4 undergraduate hours. Prerequisite: MATH 285 or MATH 286.

ECE 476    Power System Analysis    credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/476)
Development of power system equivalents by phase network analysis, load flow, symmetrical components, sequence networks, fault analysis, and digital simulation. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 330.

ECE 478    Formal Software Devel Methods    credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/478)
Same as CS 477. See CS 477.

ECE 480    Magnetic Resonance Imaging    credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/480)
Fundamental physical, mathematical, and computational principles governing the data acquisition and image reconstruction of magnetic resonance imaging. Same as BIOE 480. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: Recommended. ECE 310.
ECE 415  
Undergraduate hours. 4 graduate hours. Prerequisite: ECE 220 and programming with engineering applications. Same as CSE 441. 3 iterative techniques for unconstrained minimization; linear and nonlinear courses.illinois.edu/schedule/terms/ECE/490)  
ECE 490  
Introduction to Optimization  
credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/490)  
Same as CS 420 and CSE 402. See CS 420.  
ECE 493  
Advanced Engineering Math  
credit: 3 or 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/493)  
Same as MATH 487. See MATH 487.  
ECE 495  
Photonic Device Laboratory  
credit: 3 Hours. (https://courses.illinois.edu/schedule/terms/ECE/495)  
Active photonic devices and lightweight technology. Hands-on experience with several classes of lasers (HeNe laser, semiconductor edge emitting lasers, vertical cavity surface emitting lasers), photodetectors, and photonic systems. Familiarization with experimental optical characterization techniques and equipment. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 487 recommended.  
ECE 496  
Senior Research Project  
credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ECE/496)  
Individual research project under the guidance of a faculty member. For example, mathematical analysis, laboratory experiments, computer simulations, software development, circuit design, or device fabrication. Preparation of a written research proposal, including preliminary results. 2 undergraduate hours. No graduate credit. May be repeated. ECE 496 and ECE 499 taken in sequence fulfill the Advanced Composition Requirement. Prerequisite: RHET 105; consent of instructor. This course satisfies the General Education Criteria for: Advanced Composition  
ECE 498  
Special Topics in ECE  
credit: 0 to 4 Hours. (https://courses.illinois.edu/schedule/terms/ECE/498)  
Subject offerings of new and developing areas of knowledge in electrical and computer engineering intended to augment the existing curriculum. See Class Schedule or departmental course information for topics and prerequisites. 0 to 4 undergraduate hours. 0 to 4 graduate hours. May be repeated in the same or separate terms if topics vary.  
ECE 499  
Senior Thesis  
credit: 2 Hours. (https://courses.illinois.edu/schedule/terms/ECE/499)  
Completion of the research project begun under ECE 496. Preparation and oral presentation of a written thesis that reports the results of the project. 2 undergraduate hours. No graduate credit. To fulfill the Advanced Composition Requirement, credit must be earned for both ECE 496 and ECE 499. Prerequisite: ECE 496 and consent of instructor. This course satisfies the General Education Criteria for: Advanced Composition