ELECTRICAL AND COMPUTER ENGINEERING

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

Courses

ECE 101 Exploring Digital Info Technol credit: 3 Hours.
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.

ECE 110 Introduction to Electronics credit: 1 TO 3 Hours.
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.
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. Credit is not given for both ECE 120 and CS 233. 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.
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 199 Undergraduate Open Seminar credit: 1 TO 5 Hours.
Approved for both letter and S/U grading. May be repeated.

ECE 200 Seminar credit: 0 Hours.
Discussions of educational programs, career opportunities, and other topics in electrical and computer engineering. Approved for S/U grading only. For Computer Engineering and Electrical Engineering majors only.

ECE 205 Elec & Electronic Circuits credit: 3 Hours.
Basic principles of circuit analysis; transient analysis; AC steady-state analysis; introduction to semiconductor devices and fabrication; digital logic circuits; op-amps; A/D and D/A conversion. Credit is not given to Computer or Electrical Engineering majors. Prerequisite: PHYS 212.

ECE 206 Elec & Electronic Circuits Lab credit: 1 Hour.
Laboratory instruments and basic measurement techniques; electric circuits, CMOS logic circuits; DTL and TTL circuits; op-amps. Credit is not given to Computer or Electrical Engineering majors. Prerequisite: PHYS 212; concurrent registration in ECE 205.

ECE 210 Analog Signal Processing credit: 4 Hours.
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 series; Fourier transform; active filters; AM radio. Credit is not given for 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.
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 for 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.
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 279 Individual Study credit: 1 Hour.
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 297 Special Topics credit: 1 TO 4 Hours.
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.
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 Engrg Decisions credit: 3 Hours.
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.
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.
Companion laboratory for ECE 310. Prerequisite: Credit or concurrent registration in ECE 310.

ECE 313 Probability with Engrg Applic credit: 3 Hours.
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.
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 one of: ECE 313, IE 300, STAT 410.

ECE 316 Ethics and Engineering credit: 3 Hours.
Ethical issues in the practice of engineering: safety and liability, professional responsibility to clients and employers, whistle-blowing, codes of ethics, career choice, and legal obligations. Philosophical analysis of normative ethical theories. Case studies. Same as PHIL 316. Credit is not given for both ECE 316 and CS 210. Junior standing is required. Prerequisite: RHET 105.
This course satisfies the General Education Criteria for: UIUC: Advanced Composition UIUC: HistPhilosoph Perspect

ECE 317 ECE Technology & Management credit: 3 Hours.
Basic understanding of electrical and computer engineering concepts applicable to technology management. Circuit components; dc fundamentals; ac fundamentals; semiconductors; operational amplifiers; device fabrication; power distribution; digital devices; computer architecture (including microprocessors). Intended for the Business Majors in the Technology and Management program. Credit is not given to Computer or Electrical Engineering majors. Prerequisite: One of MATH 220, MATH 221, MATH 234.

ECE 329 Fields and Waves I credit: 3 Hours.
Electromagnetic fields and waves fundamentals and their engineering applications: static electric and magnetic fields; energy storage; Maxwell's equations for time-varying fields; wave solutions in free space, dielectrics and conducting media, transmission line systems; time- and frequency-domain analysis of transmission line circuits and Smith chart applications. Prerequisite: ECE 210.

ECE 330 Power Ckts & Electromechanics credit: 3 Hours.
Network equivalents; power and energy fundamentals, resonance, mutual inductance; three-phase power concepts, forces and torques of electric origin in electromagnetic and electrostatic systems; energy conversion cycles; principles of electric machines; transducers; relays; laboratory demonstration. Prerequisite: ECE 210.

ECE 333 Green Electric Energy credit: 3 Hours.
Electric power grid structure and policy; analysis of wind, solar, and fuels as raw resources; wind turbines and parks; solar cells, modules, arrays and systems; fuel cell power plants; energy and financial performance of green energy projects; integration of green energy into power grid; energy project report and presentation. Prerequisite: ECE 205 or ECE 210.

ECE 340 Semiconductor Electronics credit: 3 Hours.
Modern device electronics: semiconductor fundamentals including crystals and energy bands, charge carriers (electrons and holes), doping, and transport, (drift and diffusion); unipolar devices with the MOS field effect transistor as a logic device and circuit considerations; basic concepts of generation-recombination and the P-N junction as capacitors and current rectifier with applications in photonics; bipolar transistors as amplifiers and switching three-terminal devices. Prerequisite: ECE 210; PHYS 214; credit or concurrent registration in ECE 329.

ECE 342 Electronic Circuits credit: 3 Hours.
Analysis and design of analog and digital electronic circuits using MOS field effect transistors and bipolar junction transistors, with emphasis on amplifiers in integrated circuits. Credit is not given for both ECE 342 and PHYS 404. Prerequisite: ECE 210.

ECE 343 Electronic Circuits Laboratory credit: 1 Hour.
Companion laboratory for ECE 342. Credit is not given for both ECE 343 and PHYS 404. Prerequisite: Credit or concurrent registration in ECE 342.

ECE 350 Fields and Waves II credit: 3 Hours.
Continuation of ECE 329: radiation theory; antennas, radiation fields, radiation resistance and gain; transmitting arrays; plane-wave approximation of radiation fields; plane-wave propagation, reflection, and transmission; Doppler effect, evanescent waves and tunneling, dispersion, phase and group velocities; waveguides and resonant cavities; antenna reception and link budgets. Prerequisite: ECE 329.

ECE 361 Digital Communications credit: 3 Hours.
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. Prerequisite: ECE 210 and ECE 313.

ECE 374 Introduction to Algorithms & Models of Computation credit: 4 Hours.
Same as CS 374. See CS 374.

ECE 380 Biomedical Imaging credit: 3 Hours.
Physics and engineering principles associated with x-ray, computed tomography, nuclear, ultrasound, magnetic resonance, and optical imaging, including human visualization and perception of image data. Same as BIOE 380. Prerequisite: MATH 285 or MATH 286.
ECE 385  Digital Systems Laboratory  credit: 3 Hours.
Design, build, and test digital systems using transistor-transistor logic (TTL), SystemVerilog, and field-programmable gate arrays (FPGAs). Topics include combinational and sequential logic, storage elements, input/output and display, timing analysis, design tradeoffs, synchronous and asynchronous design methods, datapath and controller, microprocessor design, software/hardware co-design, and system-on-a-chip. Prerequisite: ECE 110 and ECE 220.

ECE 391  Computer Systems Engineering  credit: 4 Hours.
Concepts and abstractions central to the development of modern computing systems, with an emphasis on the systems software that controls interaction between devices and other hardware and application programs. Input-output semantics; synchronization; interrupts; multitasking; virtualization of abstractions. Term-based projects. Credit is not given for both ECE 391 and CS 241. Prerequisite: ECE 220 or CS 233.

ECE 395  Advanced Digital Projects Lab  credit: 2 or 3 Hours.
Planning, designing, executing, and documenting a microcomputer-based project. Emphasis on hardware but special projects may require an equal emphasis on software. Prerequisite: ECE 385.

ECE 396  Honors Project  credit: 1 to 4 Hours.
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.
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.
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.
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.
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.
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: MUS 103, ECE 290, and ECE 310.

ECE 403  Audio Engineering  credit: 3 Hours.
Resonance and wave phenomena; acoustics of rooms and auditoriums; artificial reverberation and sound localization-spatialization; loudspeakers, enclosures, and microphones; topics in digital audio. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 290, ECE 310, and ECE 473.

ECE 408  Applied Parallel Programming  credit: 4 Hours.
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.
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.
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.
Same as BIOE 414. See BIOE 414.

ECE 415  Biomedical Instrumentation Lab  credit: 2 Hours.
Same as BIOE 414. See BIOE 415.

ECE 416  Biosensors  credit: 3 Hours.
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 biochips; 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.
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.
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.
Same as CS 460. See CS 460.

ECE 420 Embedded DSP Laboratory credit: 2 Hours.
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: 3 Hours.
Same as CS 461. See CS 461.

ECE 424 Computer Security II credit: 3 or 4 Hours.
Same as CS 463. See CS 463.

ECE 425 Intro to VLSI System Design credit: 3 Hours.
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.
Same as CS 425. See CS 425.

ECE 431 Electric Machinery credit: 4 Hours.
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.
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 435 Computer Networking Laboratory credit: 3 or 4 Hours.
Design, application, analysis, and evaluation of communication network protocols under both Linux and Windows NT operating systems. Emphasis on identifying problems, proposing alternative solutions, implementing prototypes using available network protocols and evaluating results. Multiple programming team projects. Same as CS 436. 3 undergraduate hours. 3 or 4 graduate hours. Prerequisite: CS 438.

ECE 437 Sensors and Instrumentation credit: 3 Hours.
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.
Same as CS 438. See CS 438.

ECE 439 Wireless Networks credit: 3 or 4 Hours.
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.
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 444 IC Device Theory & Fabrication credit: 4 Hours.
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.
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:
UIUC: Advanced Composition

ECE 446 Principles of Experimental Research in Electrical Engineering credit: 4 Hours.
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 310, ECE 313, ECE 329, and MATH 415.

ECE 447 Active Microwave Ckt Design credit: 3 Hours.
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.
Same as CS 440. See CS 440.
ECE 451 Adv Microwave Measurements  credit: 3 Hours. 
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. 
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. 
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. 
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. 
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. 
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. 
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. 
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. 
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. 
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 462 Logic Synthesis  credit: 3 Hours. 
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. 4 graduate hours. Prerequisite: ECE 220 or CS 233.

ECE 463 Digital Communications Lab  credit: 2 Hours. 
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. 
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. 
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. 
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. 
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. 
Optical sensors including single element and area arrays (CCDs); optical systems including imagers, spectrometers, interferometers, and lidar; optical principles and light gathering power; electromagnetic in 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.
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.
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.
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.
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 undergraduate hours. 3 or 4 graduate hours. Prerequisite: MATH 285 or MATH 286.

ECE 476  Power System Analysis  credit: 3 Hours.
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.
Same as CS 477. See CS 477.

ECE 480  Magnetic Resonance Imaging  credit: 3 or 4 Hours.
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 481  Nanotechnology  credit: 4 Hours.
Fundamental physical properties of nanoscale systems. Nanofabrication techniques, semiconductor nanotechnology, molecular and biomolecular nanotechnology, carbon nanotechnology (nanotubes and graphene), nanowires, and nanoscale architectures and systems. 4 undergraduate hours. 4 graduate hours. Prerequisite: One of CHEM 442, CHBE 457, ME 485, MSE 401, PHYS 460.

ECE 482  Digital IC Design  credit: 3 Hours.
Bipolar and MOS field effect transistor characteristics; VLSI fabrication techniques for MOS and bipolar circuits; calculation of circuit parameters from the process parameters; design of VLSI circuits such as logic, memories, charge-coupled devices, and A/D and D/A converters. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 290 and ECE 342.

ECE 483  Analog IC Design  credit: 3 Hours.
Basic linear integrated circuit design techniques using bi-polar, JFET, and MOS technologies; operational amplifiers; wide-band feedback amplifiers; sinusoidal and relaxation oscillators; electric circuit noise; application of linear integrated circuits. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 342.

ECE 484  Prin Adv Microelec Processing  credit: 3 Hours.
Principles of advanced methods of pattern delineation, pattern transfer, and modern material growth; how these are applied to produce novel and high performance devices and circuits in various electronic materials with special emphasis on semiconductors. Computer simulation of processes and the manufacturing of devices and circuits. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 444.

ECE 485  MEMS Devices & Systems  credit: 3 Hours.
Introduction to principles, fabrication techniques, and applications of microelectromechanical systems (MEMS). In-depth analysis of sensors, actuator principles, and integrated microfabrication techniques for MEMS. Comprehensive investigation of state-of-the-art MEMS devices and systems. Same as ME 485. 3 undergraduate hours. 3 graduate hours.

ECE 486  Control Systems  credit: 4 Hours.
Analysis and design of control systems with emphasis on modeling, state variable representation, computer solutions, modern design principles, and laboratory techniques. 4 undergraduate hours. 4 graduate hours. Prerequisite: ECE 210.

ECE 487  Intro Quantum Electr for EEs  credit: 3 Hours.
Application of quantum mechanical concepts to electronics problems; detailed analysis of a calculable two-state laser system; incidental quantum ideas bearing on electronics. 3 undergraduate hours. 3 graduate hours. Prerequisite: PHYS 485.

ECE 488  Compound Semicond & Devices  credit: 3 Hours.
Advanced semiconductor materials and devices; elementary band theory; heterostructures; transport issues; three-terminal devices; two-terminal devices; including lasers and light modulators. 3 undergraduate hours. 3 graduate hours. Prerequisite: ECE 340 and ECE 350.

ECE 489  Robot Dynamics and Control  credit: 4 Hours.
Same as GE 422 and ME 446. See GE 422.

ECE 490  Introduction to Optimization  credit: 3 or 4 Hours.
Basic theory and methods for the solution of optimization problems; iterative techniques for unconstrained minimization; linear and nonlinear programming with engineering applications. Same as CSE 441. 3 undergraduate hours. 4 graduate hours. Prerequisite: ECE 190 and MATH 415.

ECE 491  Numerical Analysis  credit: 3 Hours.
Same as CS 450, CSE 401 and MATH 450. See CS 450.

ECE 492  Parallel Progrmg: Sci & Engrg  credit: 3 or 4 Hours.
Same as CS 420 and CSE 402. See CS 420.

ECE 493  Advanced Engineering Math  credit: 3 or 4 Hours.
Same as MATH 487. See MATH 487.

ECE 495  Photonic Device Laboratory  credit: 3 Hours.
Active photonic devices and lightwave 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.
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:
UIUC: Advanced Composition

ECE 498  Special Topics in ECE  credit: 0 to 4 Hours.
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.
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:
UIUC: Advanced Composition