Department of Electrical and Computer Engineering

Electrical engineering, the largest of the engineering fields, is the application of mathematics, sciences and electrical and electronic technologies to the needs of society. This broad and diverse discipline touches almost every aspect of people’s lives and occupations, from communication systems such as cellular phones, radio, television and the Internet to computer systems, including personal computers and the hidden processors that control automobiles and household appliances.

Electrical and computer engineering at The University of Alabama offer programs in traditional electrical engineering and in computer engineering. Electrical engineering students get deeply involved in technical areas, including communication systems, computers, control systems, electromagnetics, electronics and microelectronics, power systems and signal processing. Students in the computer engineering option specialize in the software and hardware components of modern computing systems. The programs provide a sound foundation for entry into the engineering profession, and opportunities for graduates are extensive, often depending only on the interests of the individual. Graduates work in most industries, including the computer, telecommunications, power, aerospace, manufacturing, defense and electronics industries. They design high-tech devices ranging from tiny microelectronic chips to powerful computers that utilize those chips, to efficient telecommunication systems that interconnect those computers. They design and operate a wide array of complex technological systems, such as power generation and distribution systems and modern computer-controlled manufacturing plants. They are also involved in sales, marketing, testing, quality control and research. With additional training, they may even contribute in other professions, including education, medicine and law.

Program Educational Objectives and Program Outcomes

The mission of the undergraduate electrical engineering and computer engineering programs is to provide high-quality and broad-based education in electrical engineering or computer engineering that emphasizes critical thinking and communication skills while preparing graduates for professional careers and lifelong learning. The faculty has adopted the educational objectives listed below for the electrical and computer engineering undergraduate programs. The department has included a process to provide continual improvement of the curricula. Graduates will:

- excel in engineering careers and/or postgraduate education utilizing knowledge of electrical or computer engineering disciplines and underlying fundamental principles of science and mathematics, engineering analysis, problem solving and design
- expand their knowledge of current and emerging issues in electrical and computer engineering and continue career-long professional development through engagement in lifelong learning
- grow professionally and advance throughout their engineering careers utilizing skills in effective communication; responsible, multidisciplinary teamwork; and adherence to principles of professional accountability and ethics
- To facilitate attainment of these career-long objectives, the department has defined a set of program outcomes and associated assessments to demonstrate that, by graduation, students have:
  - an ability to apply the necessary knowledge of mathematics, science and engineering to analyze and design electrical and electronic devices, as well as software and systems containing hardware and software components, as appropriate to program objectives
  - an ability to design and conduct experiments, as well as analyze and interpret data
  - an ability to design a system, component or process to meet desired needs
  - an ability to function on multidisciplinary teams
  - an ability to identify, formulate and solve engineering problems
  - an understanding of professional and ethical behavior
  - an ability to communicate effectively in oral, written and graphical formats
  - the broad education necessary to understand the impact of electrical or computer engineering solutions in a global, societal and environmental context consistent with the principles of sustainable development
  - a recognition for the need for and an ability to engage in lifelong learning
  - a knowledge of contemporary issues
  - an ability to use the techniques, skills and modern engineering tools necessary for engineering practice
  - knowledge of probability and statistics, specifically applied to problems in electrical or computer engineering
  - for electrical engineering graduates, knowledge of advanced mathematics, typically including differential equations, linear algebra, complex variables and discrete mathematics; for graduates with the computer engineering option, knowledge of discrete mathematics

The information contained here describes the undergraduate curricula in electrical engineering and computer engineering. Graduate students and students participating in the Scholars Program should consult the graduate catalog for information on all cross-listed and graduate-only courses. More information about various programs within the department is available in the electrical and computer engineering office.

Electrical Engineering Curriculum

The overall goal of the electrical engineering program is to prepare students for engineering careers within the discipline. The first year and a half of the electrical engineering curriculum includes basic courses in mathematics and physical science, broadening courses in humanities and social science, and foundation courses in engineering. The next three semesters provide the core education in electrical engineering, with courses in computers, electronics, circuits, systems and electromagnetics. The last year of study includes technical electives to allow students to concentrate in selected areas of the discipline. For seniors, the department offers advanced courses in computers, communication, control, electromagnetics, microelectronics, materials and power.

Students must select two electrical engineering electives with labs. The elective areas are computers, microelectronics, electromagnetics, power systems, communication systems and control systems. Materials that describe each area are available in the electrical and computer engineering office.

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<th>Freshman</th>
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<th>Hours</th>
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Total Hours: 125

1. Students must satisfy the College of Engineering in-depth requirement (minimum of six hours in one discipline).
2. The Professional Elective must be chosen from the list approved by the Department of Electrical and Computer Engineering.
3. The College of Engineering core curriculum requires a minimum of: nine hours of HU, L or FA courses; nine hours of H or SB courses; six hours of FC courses; six hours of W courses (300- and 400-level ECE courses); 12 hours of N courses (eight hours of calculus-based physics); 12 hours of MA courses (MATH 125 Calculus I or higher); and six hours of C or FL courses.
4. The Restricted Area Elective must be chosen from the list approved by the Department of Electrical and Computer Engineering.
Computer Engineering Option in Electrical Engineering

The computer engineering option is offered within the electrical engineering department in order to give students a broad knowledge of the software and hardware components of modern computing systems, detailed computer-systems design, and the role of computer systems in various engineering disciplines. A primary goal of the program is to prepare the student for a computer-oriented engineering career with emphasis on computer applications within various disciplines of electrical engineering.

The computer engineering option includes a broad spectrum of electrical engineering and computer science courses, as well as electives to allow the student to study a specific area in depth and to gain additional design experience. Areas of specialization may include computer architecture, integrated circuit design, microprocessor-based systems, sensor networks, image processing, robotics and applications-oriented study in other disciplines of electrical engineering.

Minor in Electrical Engineering (EE)

A student who is not a major in Electrical Engineering or the Computer Engineering Minor in Electrical Engineering (EE) may earn a B.S. minor in Electrical Engineering by completing the following:

- A student who is not a major in Electrical Engineering or the Computer Engineering Minor in Electrical Engineering (EE)
- Option can earn a B.S. minor in Electrical Engineering by completing the following
- Requirements:
- The Restricted Area Elective must be chosen from the list approved by the Department of Electrical and Computer Engineering.
- Students must satisfy the College of Engineering in-depth requirement (minimum of six hours in one discipline).
- At least 50% of the coursework required for the EE minor must be taken on the UA campus.
- A student should apply for the EE minor prior to achieving senior standing in order to have sufficient time to complete all requirements. A student indicates his/her intent for the EE minor by completing the necessary steps online (DegreeWorks). Interested students may find that several of these ECE courses meet his/her department's required or technical electives options.

Faculty

Department Head

Haskew, Tim

Alabama Power Endowed Professor

Burkett, Susan

E.A. Larry Drummond Endowed Chair of Computer Engineering

Hong, Yang-Ki

Professors

Balasubramanian, Bharat

Haskew, Tim

Jackson, Jeff

Associate Professors

Abu Qahouq, Jaber

Hu, Fei

Kim, Seongsin

Kotru, Sushma

Kung, Patrick

Li, Dawen

Li, Shuhui

Ricks, Kenneth

Sazonov, Edward

Scharstein, Robert

Assistant Professors

Cakareski, Jakov

Lemmon, Andrew

Courses

ECE 121. Introduction to Electrical and Computer Engineering. 1 sem. hr.
Introduction to electrical and computer engineering disciplines, specializations, the engineering design process, mathematics required for these disciplines, computer-based modeling and simulation tools, and professional responsibilities. Prerequisite(s): MATH 110.

ECE 225. Electric Circuits. 4 sem. hrs.
Physical concepts and mathematical techniques of circuit analysis; DC, transient, and sinusoidal steady-state analysis of circuits; Includes laboratory experiments. Prerequisite(s): PH 106 and PH 126, MATH 227 and MATH 238.

Algorithm design, programming, test and debugging skills using the C programming language. Applications to engineering problem solving in electrical and computer engineering. Prerequisite(s): MATH 125 or MATH 145. Prerequisite(s) with concurrency: CS 150.

ECE 320. Fundmtl Electrical Engr. 3 sem. hrs.
Introduction to circuit analysis, methods, resistive circuits, AC circuits, first-order transients, AC power, operational amplifiers and machines. Not open to electrical engineering majors or to students who have earned credit for ECE 225. Prerequisite(s): PH 106 and MATH 238 or MATH 247. Prerequisite(s) with concurrency: MATH 238 or MATH 247.

ECE 326. Electric Networks. 3 sem. hrs.

Total Hours: 123

1 Students must satisfy the College of Engineering in-depth requirement (minimum of six hours in one discipline).
2 The Professional Elective must be chosen from the list approved by the Department of Electrical and Computer Engineering.
3 The Restricted Area Elective must be chosen from the list approved by the Department of Electrical and Computer Engineering.
4 The College of Engineering core curriculum requires a minimum of: nine hours of HU, L, or FA courses; nine hours of HU, L, or FA courses; six hours of HU, L, or FA courses; six hours of W courses (300- 400-level ECE courses); 12 hours of N courses (eight hours of calculus-based physics); 12 hours of MA courses (MATH 125 Calculus I or higher); and six hours of C or FL courses.

Minor in Electrical Engineering (EE)

A student who is not a major in Electrical Engineering or the Computer Engineering Option can earn a B.S. minor in Electrical Engineering by completing the following requirements:

- The student must complete 18 hours of ECE designated courses at the 200-level or above.
- A letter grade of a "C-" or higher is required in all coursework for the EE minor.
- All prerequisites for ECE courses are required to be met.
ECE 330. Intro. to Semiconductor Device. 3 sem. hrs.
Semiconductor device physics, PN junction, Schottky diodes, BJT, MOS capacitor, MOSFET, and optoelectronic devices. Brief introduction of microelectronic fabrication.
Prerequisite(s): PH 253 and ECE 225
Prerequisite(s) with concurrency: ECE 225.

ECE 332. Electronics I. 0-4 sem. hrs.
Semiconductor materials and properties, fundamentals of p-n junctions, diodes, diode circuits and operation, signal generators, rectifiers, and wave-shaping circuits, bipolar and field effect transistors, MOSFET, transistor DC circuit analysis, basic transistor amplifiers. Writing proficiency is required for a passing grade in this course.
Prerequisite(s): ECE 225 or ECE 320; and EN 102.

ECE 333. Electronics II. 4 sem. hrs.
Operational amplifiers, BJTs, MOSFETs, integrated current biasing and active loads, differential and multistage amplifiers, frequency response, feedback and stability, power amplifiers, and introduction to digital circuits. The lab deals with experiments illustrating concepts in electronics. Writing proficiency within this discipline is required for a passing grade in this course.
Prerequisite(s): ECE 332.

ECE 340. Electromagnetics. 4 sem. hrs.
Electrostatics, magnetostatics, Maxwell's equations, plane waves, guided waves, and radiation.
Prerequisite(s): PH 106 and MATH 227 and MATH 238
Prerequisite(s) with concurrency: MATH 238.

ECE 350. Electric Power & Machines. 3 sem. hrs.
Single- and three-phase power system analysis. Theory and operation of electromechanical devices, including magnetic circuits, transformers, as well as DC and AC rotating machines. Fundamentals of power electronics.
Prerequisite(s): ECE 225 or ECE 320.

ECE 370. Signals And Systems. 3 sem. hrs.
Time domain and frequency domain analysis of continuous and discrete signals and systems; Fourier integral, Fourier series, Z-transform. Numerical implementation using MATLAB.
Prerequisite(s): ECE 225 and ECE 285.

ECE 380. Digital Logic. 4 sem. hrs.
Number systems, Boolean algebra, logic functions and gates, design of combinational logic systems, flip-flops, design of synchronous sequential systems, and iterative networks. Includes laboratory experiments.
Prerequisite(s): (CS 150 or CBH 101) and (MATH 125 or MATH 145).

ECE 383. Microprocessors. 4 sem. hrs.
Microprocessors, microcontrollers, assembly-language programming, interrupts, polling and hardware interfaces. Computing proficiency is required for a passing grade in this course.
Prerequisite(s): (ECE 285 or CS 250 or CBH 101) and ECE 380.

ECE 403. Electromechanical Systems. 3 sem. hrs.
Introduction to CMOS digital design methodology, layout techniques, behavior models, circuit simulation and testing of complex systems.
Prerequisite(s): ECE 332.

ECE 432. VLSI Design. 3 sem. hrs.
Design and testing issues in the context of mixed-signal embedded systems. Introduction to CMOS mixed-signal design methodology, layout techniques, analog to digital converters, digital to analog converters, circuit simulation, and testing and packaging of complex mixed-signal systems.
Prerequisite(s): ECE 332.

ECE 434. Mixed Signal Circuits. 3 sem. hrs.
Design and testing issues in the context of mixed-signal embedded systems. Introduction to CMOS mixed-signal design methodology, layout techniques, analog to digital converters, digital to analog converters, circuit simulation, and testing and packaging of complex mixed-signal systems.
Prerequisite(s): ECE 332.

ECE 438. Intrgr Circuit Fabr Prin. 3 sem. hrs.
Study of the processing tools used in semiconductor device fabrication. Topics include semiconductor fundamentals, semiconductor device fabrication processes, interconnections and contacts, integrated circuit packaging, and chip yield.
Prerequisite(s): ECE 333 or MTE 271.

ECE 439. Thin Film Technology. 3 sem. hrs.
Crystal structure and defects, film nucleation and growth models, growth of polycrystalline and epitaxial films, vacuum science technology, physical and chemical vapor deposition, solution based methods and thin film characterization techniques.
Prerequisite(s): ECE 225 or PH 253.

ECE 440. Electromagnetic Waves. 3 sem. hrs.
Mathematics and physics of the radiation, propagation and scattering of electromagnetic waves. Boundary value problems involving finite and infinite structures, waveguides, antennas and media.
Prerequisite(s): ECE 340.

ECE 451. Power Electronics. 3 sem. hrs.
Detailed study on the theory and operation of power electronics converters and systems. Overview of enabling power semiconductors switching devices. Introduction to feedback control of converters. Machine drive fundamentals.
Prerequisite(s): ECE 332 and ECE 350.

ECE 452. Power Electronics Laboratory. 1 sem. hr.
Laboratory experience in three phase power systems and electric machinery. Laboratory experience on the theory and operation of power electronic converters, systems and machine drives.
Prerequisite(s): ECE 332 and ECE 350
Prerequisite(s) with concurrency: ECE 452.

ECE 453. Power Systems. 3 sem. hrs.
Basic power systems concepts and per unit quantities; transmissions line, transformer and rotating machine modeling; power flow; symmetrical component of power systems; faulted power system analysis.
Prerequisite(s): ECE 350.

ECE 454. Power Systems Laboratory. 1 sem. hr.
Test and analysis of power systems and machine devices and the design of systems using devices.
Prerequisite(s): ECE 350 and ECE 453
Prerequisite(s) with concurrency: ECE 453.

ECE 455. Electromechanical Systems. 3 sem. hrs.
Static and dynamic modeling, analysis, and simulation of mechanical, electrical, hydraulic and mixed systems. MATLAB and SIMULINK model development and simulation.
Prerequisite(s): ECE 225 and MATH 238.

ECE 461. Quantum Well Elec & Devices. 3 sem. hrs.
Introductory course to the field of quantum electronics. Theory and operation of quantum confinement devices; quantum well lasers, quantum well light emitters, electro-optic devices, quantum well modulators, and quantum-well intersubband photodetectors.
Prerequisite(s): ECE 330 or PH 253.

ECE 462. Semiconductor Optoelectronics. 3 sem. hrs.
Elemental and compound semiconductors; fundamentals of semiconductor physics; solid state physics of semiconductor devices; semiconductor device fabrication processes; selection rules; quantum confined Stark Effect; Wannier-Stark localization; field-effect transistors, tunneling devices, quantum well lasers, electro-optic modulators and quantum-well intersubband photodetectors.
Prerequisite(s): ECE 330 or PH 253.

ECE 466. Fund of Nanotechnology. 3 sem. hrs.
Nanofabrication with electron beam lithography, focused ion beam lithography, and nanoimprint; microscopes for nanostructures, including SEM, EDX, TEM, AFM, STM; nanoscale devices based on nanostructured materials (carbon nanotubes and metal oxide nanomaterials).
Prerequisite(s): ECE 330 or PH 253.
ECE 475. Control Systems Analysis. 3 sem. hrs.
Classical and modern feedback control system methods; stability; Bode, root locus, state variables, and computer analysis.
Prerequisite(s): ECE 326.

ECE 476. Control Systems Lab. 1 sem. hr.
Practical analysis and design of feedback control systems and components; electrical, mechanical, and electromechanical systems.
Prerequisite(s): ECE 326
Prerequisite(s) with concurrency: ECE 475.

ECE 479. Digital Control Systems. 3 sem. hrs.
Frequency and time methods in discrete time control systems; sampling of continuous-time signals, stability, transform design techniques, and state variable analysis and design techniques.
Prerequisite(s): MATH 237 and ECE 370 and ECE 475.

ECE 480. Digital Systems Design. 3 sem. hrs.
Digital systems design with hardware description languages, programmable implementation technologies, electronic design automation design flows, design considerations and constraints, design for test, system-on-a-chip designs, IP cores, reconfigurable computing and digital system design examples and applications.
Prerequisite(s): ECE 383
Prerequisite(s) with concurrency: ECE 481.

ECE 481. Digital Systems Design Lab. 1 sem. hr.
Logic design and simulation via hardware description languages, use of electronic design automation tools, and CPU design.
Prerequisite(s) with concurrency: ECE 480.

ECE 482. Comp Visn Dig Image Proc. 3 sem. hrs.
Introduction to computer vision and digital image processing with an emphasis on image representation, transforms, filtering, compression, boundary detection, and pattern matching.
Prerequisite(s): MATH 355 and ECE 285.

ECE 484. Computer Architecture. 3 sem. hrs.
Basic computer organization, computer arithmetic, assembly language, machine language, simple and pipelined central-processing organization, memory system hierarchy, and measuring computer performance.
Prerequisite(s): ECE 383.

ECE 485. Programmable Logic Controllers. 3 sem. hrs.
Programmable Logic Controllers, fundamentals of ladder logic programming and PLC systems, advanced PLC operation, and related topics, including networking, control applications and human-machine interface design.
Prerequisite(s): ECE 383.

ECE 486. Embedded Systems. 3 sem. hrs.
Integration of microprocessors into digital systems. Includes hardware interfacing, bus protocols and peripheral systems, embedded and real-time operating systems, real-time constraints, networking, and memory system performance.
Prerequisite(s): ECE 383
Prerequisite(s) with concurrency: ECE 487.

ECE 487. Embedded Systems Laboratory. 1 sem. hr.
Projects provide hands-on experience in hardware interfacing, system-level design, real-time concepts and memory system performance.
Prerequisite(s): ECE 383
Prerequisite(s) with concurrency: ECE 486.

ECE 491. Special Problems. 1-8 sem. hr.
Investigation of a problem or problems, usually involving research with a faculty member. Credit is based on the individual assignment.

ECE 492. Capstone Design I. 2 sem. hrs.
First of a two-course sequence to provide design experience through capstone design, a team-based two-semester-long design project. Also, the first-semester course will include instruction in design methodology, engineering ethics, societal impacts, project economics, and management tools.
Prerequisite(s) with concurrency: ECE 333.

ECE 493. Selected Topics. 1-8 sem. hr.
Special courses in all areas of electrical or computer engineering, offered as the need arises. Credit is based on the course requirements.

ECE 494. Capstone Design II. 2 sem. hrs.
Second of a two-course sequence to provide design experience through capstone design, a team-based two-semester-long design project.
Prerequisite(s): ECE 492.

ECE 498. 1-3 sem. hr.
Investigation of an electrical or computer engineering research or design problem.

ECE 499. 1-3 sem. hr.
Investigation of an electrical or computer engineering research or design problem.