ELECTRICAL AND COMPUTER ENGINEERING

Electrical engineers design, develop, and produce the electrical and electronic systems upon which modern society has come to depend: basic infrastructure, such as the electric power grid and fiber optic communication lines; public conveniences, such as mag lev transporters and LED signs; consumer products, such as smart appliances; personal communication devices, such as smart phones; military systems, such as rail guns and laser weapons; instruments that can image the ocean floor or analyze the Earth's atmosphere from satellites; and medical diagnostic machines like CAT and MRI scanners. Almost every facet of modern life is touched by the work of electrical engineers. Students electing this major gain knowledge of advanced electronic circuit and system design through the use of computer-aided design tools, hardware circuit prototyping, and hands-on laboratory testing.

Computers have become embedded in virtually every engineering system, including everyday items ranging from smart watches to electric vehicles. Computer engineering, is a rapidly growing field that emphasizes the design, interfacing, hardware/software tradeoffs, real-time applications of embedded computers, and IOT devices. Students who elect this major will gain a knowledge of both hardware and software concepts, and will learn to design, build, and test systems containing digital computers.

Embedded in both the electrical engineering and computer engineering programs is the biomedical engineering option. The option provides core knowledge expected of a computer and/or electrical engineer to provide engineering services in the biomedical field. Electrical and/or computer engineers with this option combine engineering principles with medical and biological sciences to design and create equipment, devices, computer systems, and software applications used in the healthcare field.

At UNH, the cornerstone of the electrical and computer engineering programs are the involvement of students in the solution of real-world problems.

ECE Department Mission

The mission of the department is to foster and advance knowledge in electrical and computer engineering.

The mission involves:

- teaching courses in electrical and computer engineering and related fields at the bachelor's, master's, and doctoral levels;
- advancing knowledge through research and scholarship;
- serving the state and nation by making the department's intellectual resources available to industry and government agencies. The undergraduate EE and CE programs shall provide a firm foundation in electrical and computer engineering theory and practice, with a mix of laboratory and design experiences. The programs also shall foster teamwork and project management skills.

The department recognizes the need to conduct periodic reviews and adjustments to meet the current and projected needs of the state and nation according to its mission objectives.

Program Educational Objectives

The Department of Electrical and Computer Engineering has adopted a set of program educational objectives that consists of statements describing the expected accomplishments of graduates during the first several years following graduation from either programs:

Electrical Engineering:

Depth: To be effective in applying electrical engineering principles in engineering practice or for advanced study.

Breadth: To have a productive career in the many diverse fields of electrical engineering such as analog engineering, biomedical engineering, communications, and electromagnetics and waves, or in the pursuit of graduate education in disciplines such as electrical engineering, medicine, law or business.

Professionalism: To function effectively in the complex modern work environment with the ability to assume professional leadership roles.

Electrical Engineering Biomedical Engineering Option:

Depth: To be effective in applying electrical engineering principles in engineering practice or for advanced study.

Breadth: To have a productive career in the many diverse fields of electrical engineering such as analog engineering, biomedical engineering, communications, and electromagnetics and waves, or in the pursuit of graduate education in disciplines such as electrical engineering, medicine, law or business.

Professionalism: To function effectively in the complex modern work environment with the ability to assume professional leadership roles.

Computer Engineering:

Depth: To be effective in applying computer engineering principles in engineering practice or for advanced study.

Breadth: To have a productive career in the many diverse fields of computer engineering such as digital engineering, biomedical engineering, security, communications, and embedded systems, or in the pursuit of graduate education in disciplines such as computer engineering, medicine, law or business.

Professionalism: To function effectively in the complex modern work environment with the ability to assume professional leadership roles.

Computer Engineering Biomedical Engineering Option:

Depth: To be effective in applying computer engineering principles in engineering practice or for advanced study.

Breadth: To have a productive career in the many diverse fields of computer engineering such as digital engineering, biomedical engineering, security, communications, and embedded systems, or in the pursuit of graduate education in disciplines such as computer engineering, medicine, law or business.

Professionalism: To function effectively in the complex modern work environment with the ability to assume professional leadership roles.

Student Outcomes

The Department of Electrical and Computer Engineering has adopted a set of student outcomes that consists of statements describing what students are expected to know and be able to do by the time

of graduation, the achievement of which indicates that the student is equipped to achieve the program objectives. The current student outcomes are:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

https://ceps.unh.edu/ece

Programs

- Computer Engineering Major (B.S.)
- Computer Engineering Major: Biomedical Engineering Option (B.S.)
- Electrical Engineering Major (B.S.)
- Electrical Engineering Major: Biomedical Engineering Option (B.S.)
- Electrical and Computer Engineering Minor

Courses

Electrical Computer Engineering (ECE)

ECE 401 - Perspectives in Electrical and Computer Engineering
Credits: 4
An introductory course for electrical and computer engineering majors that introduces incoming students to the fundamental concepts of analysis and design. Concepts are presented through an examination of real-world problems. Students are introduced to electrical and computer engineering problem solving and design through active learning techniques in lecture and in a laboratory setting. Provides a context for the electrical engineering and computer engineering curriculum and introduces the profession and activities of electrical and computer engineering. Lab.
Attributes: Inquiry (Discovery)
Grade Mode: Letter Grading

ECE 537 - Introduction to Electrical Engineering
Credits: 4
Fundamentals of electrical engineering. Topics are circuit elements; signal waveforms; circuit laws and theorems; transfer functions; free, forced, and steady state responses; power calculations; amplifiers; and magnetic circuits. Lab.
Prerequisite(s): (PHYS 408 with a minimum grade of D- or PHYS 408S with a minimum grade of D- or PHYS 408H with a minimum grade of D-) and MATH 527 (may be taken concurrently) with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 541 - Electric Circuits
Credits: 4
Linear passive circuits beginning with resistive circuits, power and energy relations, mesh and node analysis. Transient and steady-state behavior of simple circuits containing energy storage elements (capacitors, inductors). Introduction to linear active circuits using dependent source models and ideal op amps. Introduction to transfer function and frequency response concepts. Lab.
Prerequisite(s): MATH 426 (may be taken concurrently) with a minimum grade of D- and (PHYS 408 (may be taken concurrently) with a minimum grade of D- or PHYS 408S (may be taken concurrently) with a minimum grade of D- or PHYS 408H (may be taken concurrently) with a minimum grade of D-).
Grade Mode: Letter Grading

ECE 543 - Introduction to Digital Systems
Credits: 4
Fundamental analysis and design principles. Number systems, codes, Boolean algebra, and combinational and sequential digital circuits. Lab: student-built systems using modern integrated circuit technology and an introductory design session on a CAD workstation. Lab.
Grade Mode: Letter Grading

ECE 548 - Electronic Design I
Credits: 4
Introduction to electronic design for analog signal processing. Basic Concepts of Semiconductor Materials (electrons and holes, n-type and p-type semiconductors), Diodes (Modeling, Biasing, Zener Diodes, and Rectifier Circuits), FETs (Device Structure, Modes of Operation, and I-V Characteristics), BJTs (Device Structure, Modes of Operation, and I-V Characteristics), Transistor Amplifiers (Biasing a Transistor, Small-Signal Modeling, and Configurations), Operational Amplifier circuits for amplification and filtering. Lab.
Prerequisite(s): ECE 541 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 562 - Computer Organization
Credits: 4
Basic computer structure, including arithmetic, memory, control, and input/output units; the tradeoffs between hardware, instruction sets, speed, and cost. Laboratory experiments will use hardware and software to understand the concepts of instruction set architecture, machine language programming, control and data path design, and I/O interfacing.
Prerequisite(s): ECE 543 with a minimum grade of D- and CS 410C with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 583 - Designing with Programmable Logic
Credits: 6
This course covers topics related to field programmable logic devices. Students will be introduced to Hardware Description Language (HDL) design entry languages and simulation procedures, along with common logic synthesis tools. In laboratory exercises, each student will prototype a digital system starting with HDL entry, functional and timing simulations, logic synthesis, device programming, logic probing, and system verification. Labs will develop report writing skills. This course is required for CE majors and optional for EE majors.
Prerequisite(s): ECE 543 with a minimum grade of D- and ECE 562 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 602 - Engineering Analysis
Credits: 3
Analyze and solve engineering problems using linear algebra and integral and differential calculus of functions of several variables. Boundary-value problems in mechanics, fluid dynamics, and electrostatics. Examination of electrostatics, magnetostatics, and fluid and wave mechanics using vector differential and integral calculus. Introduction of approximation and error analysis methods as fundamental engineering tools.
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 645 (may be taken concurrently) with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 603 - Electromagnetic Fields and Waves I
Credits: 3
Maxwell's equations in integral and differential form with applications to static and dynamic fields. Uniform plane waves in free space and material media. Boundary conditions; simple transmission line theory; parallel plate and rectangular waveguides; simple radiating systems.
Prerequisite(s): (PHYS 408 with a minimum grade of D- or PHYS 408S with a minimum grade of D- or PHYS 408H with a minimum grade of D-) and ECE 602 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 617 - Junior Laboratory I
Credits: 4
Application of laboratory instrumentation to the investigation of active and passive circuit characteristics; introduction to computer-aided design, analysis, and testing; development of report writing and oral presentation skills.
Attributes: Writing Intensive Course
Prerequisite(s): ECE 633 (may be taken concurrently) with a minimum grade of D- and ECE 651 (may be taken concurrently) with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 618 - Junior Laboratory II
Credits: 4
Laboratory exercises in the design and analysis of active circuits, techniques of signal processing, and the properties of distributed circuits. Continued development of report writing and oral presentation skills.
Attributes: Writing Intensive Course
Prerequisite(s): ECE 617 with a minimum grade of D- and ECE 603 (may be taken concurrently) with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 633 - Signals and Systems I
Credits: 3
Mathematical characterization of continuous-time systems using time- and frequency-domain concepts. Properties of linear systems described by ordinary differential equations. Fourier analysis of signals and system frequency response functions. Applications to communication and control systems. Introduction to system simulation using computer methods.
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 645 (may be taken concurrently) with a minimum grade of D-.
Equivalent(s): ECE 633H
Grade Mode: Letter Grading

ECE 633H - Honors/Signals and Systems I
Credits: 4
Mathematical characterization of continuous-time systems using time- and frequency-domain concepts. Properties of linear systems described by ordinary differential equations. Fourier analysis of signals and system frequency response functions. Applications to communication and control systems. Introduction to system simulation using computer methods. Honors students will attend an additional one-hour meeting each week.
Attributes: Honors course
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 645 (may be taken concurrently) with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 634 - Signals and Systems II
Credits: 3
Transient response analysis of linear systems using Laplace transforms, application to feedback control systems. Introduction to discrete-time linear systems; system response determination using Z-transform; elementary design of digital filters and controllers. State variable formulation of dynamical systems.
Prerequisite(s): ECE 633 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 647 - Random Processes and Signals in Engineering
Credits: 3
Emphasis on applied engineering concepts such as component failure, quality control, noise propagation. Topics include random variables, probability distributions, mean and variance, conditional probability, correlation, power spectral density.
Prerequisite(s): MATH 426 with a minimum grade of D- and ECE 602 with a minimum grade of D-.
Equivalent(s): ECE 647H
Grade Mode: Letter Grading

ECE 647H - Honors/Random Processes and Signals
Credits: 4
Emphasis on applied engineering concepts such as component failure, quality control, noise propagation. Topics include random variables, probability distributions, mean and variance, conditional probability, correlation, power spectral density. Honors students attend an additional one-hour meeting each week.
Attributes: Honors course
Prerequisite(s): MATH 426 with a minimum grade of D- and ECE 602 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 649 - Embedded Microcomputer Based Design
Credits: 6
This course covers topics related to architectures for embedded processors, hardware and software aspects of interfacing, handling interrupts, low-level programming including debugging of real-time systems, and embedded application implementations. Laboratory exercises will reinforce theoretical and applied concepts using an embedded architecture and develop report writing skills. Programming experience required. This course is required for CE majors and is optional for EE majors.
Attributes: Writing Intensive Course
Prerequisite(s): ECE 562 with a minimum grade of D- and ECE 583 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 651 - Electronic Design II
Credits: 4
Design of fundamental circuit blocks in electronic systems. Multistage amplifiers; feedback systems and stability; power amplifiers. Nonlinear electronic circuits: oscillators, function generators; clippers and peak detectors; A/D and D/A conversion. Switching mode and logic circuits.
Prerequisite(s): ECE 548 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 652 - Electronic Design II
Credits: 6
Design of fundamental circuit blocks in electronic systems. Multistage amplifiers; feedback systems and stability; power amplifiers. Laboratory exercises in the design and analysis of active circuits. Application of laboratory instrumentation to the investigation of active circuit characteristics; computer-aided design, analysis, and testing; development of report writing skills. This course is required of EE majors, but it is not required of CE majors.
Prerequisite(s): ECE 548 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 653 - Electronic Design III
Credits: 6
Continuation of ECE 652 with emphasis on more advanced circuits including: active filters, Nonlinear electronic circuits: oscillators, function generators, phase-locked loops; clippers and peak detectors; A/D and D/A conversion, switching mode circuits. Laboratory exercises in the design and analysis of active circuits. Further advanced application of laboratory instrumentation to the investigation of active circuit characteristics; computer-aided design, analysis, and testing; development of report writing skills. This course is required of EE majors, but it is not required of CE majors.
Attributes: Writing Intensive Course
Prerequisite(s): ECE 652 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 712 - Advanced Digital Systems Design and Verification
Credits: 4
This course will introduce standard on-chip communication networks for digital systems, off-chip wired/wireless communication protocols and the implementation of standard I/O interfaces. This course will also teach the advanced FPGA architecture, design flow, and debugging methods, and reinforce students' prototyping skills on standalone FPGAs and cloud FPGAs. Modern digital design and optimization techniques will be presented and examined, as well. Reliability and security issues in digital system design will be emphasized in this course.
Prerequisite(s): ECE 543 with a minimum grade of D- and ECE 562 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 714 - Introduction to Digital Signal Processing
Credits: 4
Introduction to digital signal processing theory and practice, including coverage of discrete time signals and systems, frequency domain transforms and practical spectral analysis, digital filter terminology and design, and sampling and reconstruction of continuous time signals. Laboratory component providing an introduction to DSP design tools and real-time algorithm implementation. Lab.
Prerequisite(s): ECE 634 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 715 - Introduction to VLSI
Credits: 4
Principles of VLSI (Very Large Scale Integration) systems at the physical level. CMOS circuit and logic design, CAD tools, CMOS system case studies. Students exercise the whole development cycle of a VLSI chip: design and layout with the up-to-date commercial EDA tools. An IA (continuous grading) grade is given at the end of semester I. Lab.
Grade Mode: Letter Grading

ECE 717 - Introduction to Digital Image Processing
Credits: 4
Digital image representation; elements of digital processing systems; multidimensional sampling and quantization; image perception by humans, image transformations including the Fourier, the Walsh, and the Hough Transforms; image enhancement techniques including image smoothing, sharpening, histogram equalization, and pseudo color processing; image restoration fundamentals; image compression techniques, image segmentation and use of descriptors for image representation and classification. Lab.
Prerequisite(s): ECE 634 with a minimum grade of D- and ECE 647 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 757 - Fundamentals of Communication Systems
Credits: 4
Spectra of deterministic and random signals; baseband and bandpass digital and analog signaling techniques; transmitter and receiver architectures; performance analysis of digital and analog signaling in additive noise channels; carrier and symbol timing synchronization methods. Lab.
Prerequisite(s): ECE 634 with a minimum grade of D- and ECE 647 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 772 - Control Systems
Credits: 4
Development of advanced control system design concepts such as Nyquist analysis; lead-lag compensation; state feedback; parameter sensitivity; controllability; observability; introduction to non-linear and modern control. Includes interactive computer-aided design and real-time digital control. Lab.
Prerequisite(s): ECE 634 with a minimum grade of D-.
Equivalent(s): ME 772
Grade Mode: Letter Grading

ECE 775 - Applications of Integrated Circuits
Credits: 4
Design and construction of linear and nonlinear electronic circuits using existing integrated circuits. Limitations and use of operational amplifiers. Laboratory course in practical applications of non-digital integrated circuit devices. Lab.
Prerequisite(s): ECE 651 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 784 - Biomedical Instrumentation
Credits: 4
Principles of physiological and biological instrumentation design including transducers, signal conditioning, recording equipment, and patient safety. Laboratory includes the design and use of instrumentation for electrocardiography, electromyography, electroencephalography, pulse measurement, blood pressure, phonocardiography, spirometry, and temperature. Current research topics such as biotelemetry, ultrasonic diagnosis, and computer applications.
Prerequisite(s): ECE 548 with a minimum grade of D- or ECE 537 with a minimum grade of D-.
Grade Mode: Letter Grading

ECE 791 - Senior Project I
Credits: 3
First semester of the capstone design experience. Topics include creativity, design methodology, specification development, project management, ethics, safety, reliability and preparation for oral and written reports. Students develop project plans, and prepare and present written and oral project proposals. The project plans must include aspects of design, implementation and evaluation. At the end of the semester, students prepare a written progress report. All ECE Core Course Requirements must be met prior to enrolling in Senior Project I.
Attributes: Writing Intensive Course
Equivalent(s): ECE 791H
Grade Mode: Letter Grading

ECE 791H - Senior Honors Project I
Credits: 4
First semester of the capstone honors senior thesis research. Topics include creativity, design methodology, specification development, project management, ethics, safety, reliability and preparation for oral and written reports. Students develop project plans, and prepare and present written and oral project proposals. The project plans must include aspects of design, implementation and evaluation, similar to ECE 791. However, honors thesis research must also include independent research beyond the normal scope of ECE 791. At the end of the semester students prepare a written progress report. All ECE Core Course Requirements must be met prior to enrolling in Senior Honors Project I.
Attributes: Honors course; Writing Intensive Course
Equivalent(s): ECE 791
Grade Mode: Letter Grading

ECE 792 - Senior Project II
Credits: 3
This course requires the completion of the capstone design experience begun in ECE 791. At the end of the semester students prepare written final project reports, and present their results in a research poster session.
Attributes: Writing Intensive Course
Prerequisite(s): ECE 791 with a minimum grade of D-.
Equivalent(s): ECE 792H
Grade Mode: Letter Grading

ECE 792H - Senior Honors Project II
Credits: 4
This course requires the completion of the capstone honors thesis research begun in ECE 791H. At the end of the semester students prepare honors theses, and present their research results in a research poster session. ECE 791H/792H fulfills the requirement of one professional elective.
Attributes: Honors course; Writing Intensive Course
Prerequisite(s): ECE 791H with a minimum grade of D-.
Equivalent(s): ECE 792
Grade Mode: Letter Grading

ECE 795 - Electrical and Computer Engineering Projects
Credits: 1-4
Laboratory course. Student undertakes a project of mutual interest with an ECE faculty advisor. A written final report must be filed with the ECE Department.
Grade Mode: Letter Grading

ECE 796 - Special Topics
Credits: 1-4
New or specialized courses and/or independent study. 1 to 4 credits some sections may use credit/fail grading.
Repeat Rule: May be repeated for a maximum of 8 credits. May be repeated up to 2 times.
Grade Mode: Letter Grading

Faculty

Electrical and Computer Engineering Faculty