

Electrical and Computer Engineering

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Interim Department Chair: Tommy Morris, PhD

Associate Chair: Laurie Joiner, PhD

Mission

The mission of the Electrical and Computer Engineering Department is to develop and maintain high quality undergraduate and graduate programs in Computer, Cybersecurity, and Electrical Engineering to meet the needs of its constituents, and to participate in scholarly and productive research that contributes to the economic well-being and quality of life for the residents of Huntsville, the State of Alabama, and the citizens of the United States of America.

Computer, Cybersecurity, & Electrical Engineering Programs

The Department of Electrical and Computer Engineering (ECE) offers three undergraduate programs. The Computer Engineering program deals with the analysis, design, and application of both computer hardware and software and computer systems through a blend of Computer Engineering, Computer Science, and Electrical Engineering courses. The Cybersecurity Engineering program offers coursework that enables students to pursue careers in the cybersecurity and information assurance fields. The program provides a foundation in computer programming, computer hardware and software, and digital circuits before delving into cybersecurity topics such as digital forensics, software reverse-engineering, network security and cybersecurity management. The Electrical Engineering program offers coursework that enables students to pursue careers in any of the many diverse facets of Electrical Engineering such as electronics, networks, power systems, instrumentation, communications, and controls.

The Departments of Electrical and Computer Engineering offer the following degree programs:

- Bachelor of Science in Computer Engineering (<http://catalog.uah.edu/undergrad/colleges-departments/engineering/electrical-computer-engineering/computer-engineering-bscpe/>)
- Bachelor of Science in Cybersecurity Engineering (<http://catalog.uah.edu/undergrad/colleges-departments/engineering/electrical-computer-engineering/cybersecurity/>)
- Bachelor of Science in Electrical Engineering (<http://catalog.uah.edu/undergrad/colleges-departments/engineering/electrical-computer-engineering/electrical-engineering-bsee/>)

Program Educational Objectives

Within a few years of graduation, **computer engineering** graduates will have:

- Established successful careers as computer engineers and received recognition as emerging leaders in government, industry and academia
- Created viable solutions through the application of their knowledge base and capacity for communicating ideas effectively to advance the state-of-the-art
- Demonstrated continuous professional development and pursued advanced-study opportunities

Within a few years of graduation, **cybersecurity engineering** graduates will have:

- Established successful careers as cybersecurity professionals and received recognition as emerging leaders in government, industry and academia
- Created viable solutions through the application of their knowledge base and capacity for communicating ideas effectively to advance the state-of-the-art
- Demonstrated continuous professional development and pursued advanced-study opportunities

Within a few years of graduation, **electrical engineering** graduates will have:

- Established successful careers as electrical engineers and received recognition as emerging leaders in government, industry and academia
- Created viable solutions through the application of their knowledge base and capacity for communicating ideas effectively to advance the state-of-the-art
- Demonstrated continuous professional development and pursued advanced-study opportunities

Majors in Computer, Cybersecurity, and Electrical Engineering

- Computer Engineering, BSCpE (<http://catalog.uah.edu/undergrad/colleges-departments/engineering/electrical-computer-engineering/computer-engineering-bscpe/>)
- Cybersecurity Engineering, BSCBSY (<http://catalog.uah.edu/undergrad/colleges-departments/engineering/electrical-computer-engineering/cybersecurity/>)
- Electrical Engineering, BSEE (<http://catalog.uah.edu/undergrad/colleges-departments/engineering/electrical-computer-engineering/electrical-engineering-bsee/>)

CPE 211 - INTRO COMPUTER PROG FOR ENGR

Semester Hours: 3

Advanced programming in a high level language such as C++ with an emphasis on practice in solving engineering problems using top-down design and algorithms. Prerequisites: EGR 101 and MA 171 (with concurrency).

CPE 211L - LABORATORY

Semester Hours: 0

This lab is the 0-credit lab component of the 3 credit course.

CPE 212 - FUNDAMENTALS SOFTWARE ENGRG

Semester Hours: 3

Introduction to structured programming using C++. Search and sort algorithms. Introduction to data structures. Applications to engineering related problems. Prerequisite: CPE 211.

CPE 221 - COMPUTER ORGANIZATION

Semester Hours: 3

Functional organization of stored-program digital computers including number representation, assembly language programming, computer hardware, micro-operations, and control logic; microprocessor architecture. Prerequisite: CPE 211 and EE 202 w/concurrency.

CPE 299 - CPE MENTORING I

Semester Hours: 0

Yearly mentoring and advising from engineering faculty and staff. Prerequisite w/ concurrency: CPE 211.

CPE 322 - DIGITAL HDWR DESIGN FUNDMNTLS

Semester Hours: 3

Advanced concepts in Boolean algebra, use of hardware description languages as a practical means to implement hybrid sequential and combinational designs, digital logic simulation, rapid prototyping techniques, and design for testability concepts. Focuses on the actual design and implementation of sizeable digital design problems using representative Computer Aided Design (CAD) tools. Laboratory required CPE 324. Prerequisite: CPE 221.

CPE 323 - INTRO TO EMBEDDED COMPUTER SYS

Semester Hours: 3

Hardware and software aspects in building embedded computer systems. Includes methods to evaluate design tradeoffs of different technology choices and technology capabilities and limitations of system components necessary to design and implement an embedded system and interface it to the outside world. Laboratory required CPE 325. Prerequisite: CPE 221.

CPE 324 - ADV LOGIC DESIGN LABORATORY

Semester Hour: 1

This course includes experimentation of fundamental concepts in digital logic design. Use of hardware description languages as a practical means to implement hybrid sequential and combinational digital designs, digital logic simulation, and rapid prototyping techniques. Corequisite laboratory component of CPE 322.

CPE 325 - EMBEDDED SYSTEMS LAB

Semester Hour: 1

Student gain experience working with modern integrated software development environments and hardware platforms to solve practical problems. Corequisite laboratory component of CPE 323.

CPE 348 - INTRO TO COMPUTER NETWORKS

Semester Hours: 3

Introduction to the concepts and architecture of computer networks. Review of communication protocols using the Internet and the TCP/IP model as major examples. High-speed networking, congestion control, data compression, security and distributed processing. Prerequisites: CPE 211 and CPE 221.

CPE 353 - SOFTWARE DESIGN & ENGINEERING

Semester Hours: 3

Hands-on experience developing a substantial software project using software design tools such as SQL database system and the Qt graphical interface development environment. Introduction to a software process including requirements elicitation and testing techniques. Prerequisites CPE 212 and CS 317 (with concurrency).

CPE 381 - FUND SIGNALS & SYS FOR COMP EN

Semester Hours: 3

Introduction to the fundamental concepts in continuous and discrete signals and systems, and methods of signal and system analysis for computer engineers. No credit for EE or OPE students. Prerequisites: EE 213 and MA 238.

CPE 399 - CPE MENTORING II

Semester Hours: 0

Yearly mentoring and advising from engineering faculty and staff. Prerequisites: CPE 299 and CPE 212.

CPE 412 - INTRO TO PARALLEL PROGRAMMING

Semester Hours: 3

Introduction to processing in parallel and distributed computing environments. Design and analysis of parallel algorithms. Parallel programming environments: Pthreads for shared memory multiprocessor systems, and PVM/MPI for distributed networked computers. (Same as CPE 512) Prerequisites: CPE 212 and CS 317.

CPE 423 - HARDWARE/SOFTWARE CO-DESIGN

Semester Hours: 3

Study and design of Systems On A Chip (SOC). Emphasis on Field Programmable realizations of SOC systems. (Same as CPE 523) Prerequisites: CPE 322 and CPE 426.

CPE 426 - VLSI HARDWARE DESC LANG/MODL/S

Semester Hours: 3

Modern VLSI design techniques and tools, such as silicon compilers, (V)HDL modeling languages, placement and routing tools, synthesis tools, and simulators. Students will design, simulate, and layout using both programmable logic families and ASIC libraries. (Same as CPE 526) Prerequisites: EE 202 and EE 315.

CPE 427 - VLSI DESIGN I

Semester Hours: 3

Introduction to VLSI design using CAD tools, CMOS logic, switch level modeling, circuit characterization, logic design in CMOS, systems design methods, test subsystem design, design examples, student design project. Laboratory required CPE 427L. (Same as CPE 527) Prerequisites: EE 202 and EE 315.

CPE 427L - LABORATORY

Semester Hours: 0

Students enrolling in CPE 427L must enroll concurrently in CPE 427.

CPE 431 - INTRO COMPUTER ARCHITECTURE

Semester Hours: 3

Study of existing computer structures. Computer organization with emphasis on busing systems, storage systems, and instruction sets. Performance models and measures, pipelining, cache and virtual memory, introduction to parallel processing. (Same as CPE 531) Prerequisites: CPE 322 and CPE 323.

CPE 434 - OPERATING SYSTEMS

Semester Hours: 3

Study of the fundamentals of operating systems. Emphasis on processes, file management, interprocess communication, input-output, virtual memory, networking and security. Course must be taken concurrently with CPE 435. Prerequisites: CPE 221 and CPE 353/.

CPE 435 - OPERATING SYSTEMS LABORATORY

Semester Hour: 1

Laboratory component of Operating Systems course. Experiments include implementation of device drivers, process and thread management, virtual memory management, dynamic memory management, file-systems. Students must take this course concurrently with CPE 434.

CPE 436 - INTERNALS OF MODERN OPER SYS

Semester Hours: 3

In-depth study of the design of modern operating systems such as Unix, NT and Linux. Emphasis on the internals and implementation details of interrupt processing, real-time clocks, device independent I/O, process management, memory management, file management. (Same as CPE 536) Prerequisite: CPE 434.

CPE 449 - INTRO TO CYBERSECURITY ENGINRG

Semester Hours: 3

Introduction to cryptography and computer security through hardware and physical security to a knowledge of audit methods, security management, and public law. Includes skills such as business process analysis, software security, IAE evaluation, and IAE testing. (Same as CPE 549) Prerequisite: CPE 348.

CPE 453 - SENIOR SOFTWARE STUDIO

Semester Hours: 3

Basic concepts of software engineering. Software project management including specifications, design, implementation, testing and documentation. Software design and management tools. Includes a multi-student software project. Prerequisites: CPE 353 and CS 317.

CPE 455 - SECURE SOFTWARE DEVELOPMENT

Semester Hours: 3

Overview of methodologies for development of high-assurance software. Major topics include analysis of security and safety risks, software certification criteria, the software development lifecycle, risk mitigation, design and coding best practices, verification techniques, and auditing of software for insecure and unsafe coding constructs. Prerequisites: CPE 353 or CS 307.

CPE 457 - SOFTWARE REVERSE ENGINEERING

Semester Hours: 3

This course provides fundamental knowledge of software reverse engineering. The course provides the ability (a) to understand software of unknown origin or software for which source code is unavailable, (b) to determine how something works, (c) to discover data used by software, and (d) to aid in the analysis of software. The course introduces tools for reverse engineering, including disassemblers, debuggers, monitors, virtual machines and modern tools for software analysis. Prerequisites: CPE 353 or CS 307.

CPE 459 - SYSTEMS SECURITY

Semester Hours: 3

This course (1) introduces cyber physical, industrial control, embedded, and Supervisory Control and Data Acquisition (SCADA) control systems, (2) examines common vulnerabilities and threats associated with these systems, and (3) examine techniques to defend these systems from cyber-attacks. Prerequisite: CPE 348 and CPE 449.

CPE 488 - CYBERSECURITY ENG CAPSTONE I

Semester Hours: 3

Students will participate in a team based cybersecurity project which is a culminating experience for the cybersecurity degree. For a target system, students teams will conduct and document a risk assessment, then design, implement, and test cybersecurity controls to mitigate threats to the system. Prerequisites: CPE 399 and Prerequisite with concurrency: CPE 449, CPE 457, CS 465.

CPE 490 - SPECIAL TOPICS IN COMP ENGR

Semester Hours: 1-3

Topics will vary. The course may be repeated when topics vary. Consent of advisor.

CPE 490L - SPECIAL TOPICS LABORATORY

Semester Hours: 0

CPE 495 - COMPUTER ENGINEERING DESIGN I

Semester Hours: 3

First course in the senior capstone design sequence. Application of techniques to the design of electronic systems that have digital hardware and software components. Application of engineering courses to solve real-world design problems. Must be taken in the same academic year as CPE 496. Prerequisites: CPE 323, CPE 353, EE 315, EE 322 and CPE 399 or EGR 399.

CPE 496 - COMPUTER ENGINEERING DESIGN II

Semester Hours: 3

Second course in the senior capstone design sequence. Must be taken in the same academic year as CPE 495. Prerequisite: CPE 495.

CPE 497 - COMPUTER ENGR INTERNSHIP

Semester Hours: 1-3

Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance to the student. Junior/senior standing and approval from Engineering Faculty advisor.

CPE 498 - CYBERSECY ENGR CAPSTONE II

Semester Hours: 3

Students will participate in a team based cybersecurity project which is a culminating experience for the cybersecurity degree. For a target system, student teams will conduct and document a risk assessment, then design, implement, and test cybersecurity controls to mitigate threats to the system. Prerequisite: CPE 488. Prerequisite w/ concurrency: CPE 459.

CPE 499 - PROJECT IN COMPUTER ENGRG

Semester Hours: 3

Individual design project under the direction of an ECE faculty member. Senior standing and permission of instructor required.

EE 202 - INTRO DIGITAL LOGIC DSGN

Semester Hours: 3

Engineering approaches to design and analysis of digital logic circuits. Boolean algebra, Karnaugh maps, design using Hardware Description Languages, digital computer building blocks, standard logic (SSI MSI) vs. programmable logic (PLD, PGA0, finite state machine design). Prerequisites: EGR 101.

EE 203 - DIGITAL LOGIC DESIGN LAB

Semester Hour: 1

Experiments in applying Boolean logic concepts to digital design. The course introduces students to small-scale prototyping and simulation techniques that are used to implement and evaluate digital combinational and sequential logic designs. Prerequisite: EE 202.

EE 213 - ELECTRICAL CIRCUIT ANALYSIS I

Semester Hours: 3

Basic concepts of DC and AC circuit theory and analysis. Includes both DC and AC power. Prerequisites: MA 201 and PH 112 both w/concurrency.

EE 223 - DES & MOD ELEC CIR & SYS

Semester Hours: 3

Electrical circuit and systems design and modeling. Includes using modern tools (i.e. Matlab and simulink) to design and model circuits. Introduces and reinforces engineering design principles. Prerequisites: EE 202 & EE 213.

EE 299 - EE MENTORING I

Semester Hours: 0

Sophomore-level mentoring and advising from engineering faculty and staff. Prerequisite w/ concurrency: CPE 211.

EE 307 - ELECTRICITY & MAGNETISM

Semester Hours: 3

Basic concepts of electrostatics, electric potential theory, electric fields and currents, fields of moving charge, magnetic fields, time varying electromagnetic fields and Maxwell's equations. Prerequisites: EE 213, MA 238 and MA 244.

EE 308 - ELECTROMAGNETIC ENGR

Semester Hours: 3

Review of Maxwell's equations, uniform plane waves in different types of media, reflection, transmission of uniform plane waves, transmission lines, waveguides, and antennas. Prerequisites: EE 307.

EE 310 - SOLID STATE FUNDAMENTALS

Semester Hours: 3

Introduction to semiconductors including crystalline structure, energy bands and charge carriers, excess carriers, and thermal properties. Introduction to semiconductor junctions, the bipolar junction transistor, and the MOSFET. Prerequisites: PH 113 and MA 238.

EE 315 - INTRO ELECTRONIC ANAL & DESIGN

Semester Hours: 3

Properties of diode, bipolar transistors, FET and operational amplifiers, analysis of DC and AC small-signal operation and circuit models for the design and analysis of electronic circuits. Prerequisite: EE 213.

EE 316 - ELE CIRCUITS & ELTRNC DSGN LAB

Semester Hour: 1

Electric circuit experiments including first and second order DC circuits, maximum power transfer, impedance measurements, transformers, measurement of electronic device characteristics, and design and testing of operational amplifier circuits and single-stage amplifiers using MOSFETs and BJTs. Prerequisite: EE 315.

EE 382 - ANALY METH CONTINUOUS TIME SYS

Semester Hours: 3

Fourier Series, Fourier and Laplace transforms with emphasis on their physical interpretation. System representation by transfer functions and impulse response functions, convolution integral, transient response, and modeling and simulation. Prerequisites: EE 213, MA 238, and MA 244.

EE 383 - ANALY METH MULTIVARIABLE

Semester Hours: 3

Discrete time signals and systems, sampling techniques, Z and discrete Fourier transforms, multivariable systems. Introduction to digital signal processing. Prerequisite: EE 382.

EE 384 - DIG SIGNAL PROCESS LAB

Semester Hour: 1

Design and programming of digital processing algorithms such as DFT, FFT, IIR, and FIR filtering. Prerequisites: EE 383 or CPE 381.

EE 385 - RANDOM SIGNALS & NOISE

Semester Hours: 3

Random variables and probabilities description of signals. Introduction to random processes such as autocorrelations, cross correlation, and power spectral density, Noise analysis of thermal, shot, white, and colored. Response of electrical systems to random inputs. Prerequisites: EE 382 or CPE 381.

EE 386 - INTRO CONTROL/ROBOTIC SYS

Semester Hours: 3

Theory and analytical techniques for modeling, analysis and control of dynamical systems. Transfer functions, block-diagrams, frequency response, stability criteria, series and feedback controller design, and digital control. Introduction to the dynamic analysis and control of robotic systems. Prerequisites: EE 382 or CPE 381.

EE 399 - EE MENTORING II

Semester Hours: 0

Junior level mentoring and advising from engineering faculty and staff. Prerequisites: EE 299 and EE 223.

EE 401 - REAL-TIME DIGITAL SIGNAL PROCE

Semester Hours: 3

Introduction to digital signal processor architectures, applications, assembly language programming, and development tools for designing and implementing DSP systems. Prerequisites: EE 383 or CPE 381.

EE 410 - SELECTED TOPICS/ECE

Semester Hours: 1-6

Special topics in Electrical Engineering.

EE 410L - SELECTED TOPIC LABORATORY

Semester Hours: 0

EE 411 - ELECTRIC POWER SYSTEM

Semester Hours: 3

Power generation, transmission and distribution. Three-phase circuits, conventional and renewable power systems, transformers and motors, protection and control. Prerequisite: EE 382.

EE 412 - SR DSGN PROJ ELECT ENGR

Semester Hours: 1-6

Individual design project under the direction of an ECE faculty member. Prerequisites: Senior standing and permission of instructor.

EE 414 - ANALOG & DIGITAL FILTER DESIGN

Semester Hours: 3

Analog filter design via Butterworth, Chebyshev, and elliptical approximation. Active filter design using operational amplifiers. Digital filter design methods. Prerequisites: EE 315 and EE 383.

EE 416 - ELECTRONICS II

Semester Hours: 3

Integrated circuits and micro-devices related to multistage amplifiers, oscillators, design specifications, operational amplifiers, and microunits. Computer simulation. Prerequisites: EE 313 and EE 315.

EE 417 - PHOTOVOLTAIC FUNDAMENTALS

Semester Hours: 3

The course will cover fundamental device physics for solar cell operation, reliability issues in panel and module design, partial shading problems on PV module, and cost and efficiency analysis. Prerequisite: EE 310.

EE 421 - ANTENNA DESIGN & ANALYSIS

Semester Hours: 3

Covers analytical methods and mathematical foundations for solving antenna radiation problems, based on Maxwell's equations. Different types of antennas will be studied, including wire, phased array, aperture, microstrip, and reflector antennas. Prerequisite: EE 308.

EE 423 - COMM SYS & SIMULATION W/ LAB

Semester Hours: 3

Modern test equipment and computer-based simulation methods are used to conduct experiments in the area of communication systems. Includes experiments to investigate signal modulation, demodulation, and filters. (Same as EE 523) Prerequisite: EE 426.

EE 424 - INTRO DATA COMMUN NETWORKS

Semester Hours: 3

Overview of historic development of modern telephone and data communication systems, system architecture, standards, broadband switching systems, modems, protocols, personal and mobile communications, digital modulation techniques. (Same as EE 504) Prerequisites: EE 383 and EE 385.

EE 426 - COMMUNICATION THEORY

Semester Hours: 3

Signals and systems including the Hilbert transform, cross and auto correlation, power density spectrum, and the Wiener-Khinchine theorem. Filter design. Linear and nonlinear modulation and demodulation methods and circuits. Phase lock and frequency feedback techniques. (Same as EE 506). Prerequisites: EE 382 or CPE 381.

EE 436 - DIGITAL ELECTRONICS

Semester Hours: 3

Introduction to digital electronics. The Metal-Oxide-Semiconductor (MOS) transistor. MOS inverters and gate circuits. Bipolar junction transistors, ECL inverters, and bipolar digital gates. Semiconductor Memories. (Same as EE 516) Prerequisites: EE 202 and EE 315.

EE 437 - ELECTRONICS MANUF PROCESSES

Semester Hours: 3

Concepts, facilities, and technology utilized in the manufacture of electronic components and products. Includes printed wiring board fabrication and component mounting methods, automation, quality and reliability, product testing, and economic issues. Prerequisite: Senior standing. (Same as ISE 437 and EE 537).

EE 451 - OPTOELECTRONICS

Semester Hours: 3

Basic concepts for understanding electro-optic devices and systems. Blackbody radiation, light sources, quantum and thermal detectors, noise in detectors, optical heterodyning, acousto-optic, magneto-optic, and electro-optic modulation. (Same as OPE 451) Prerequisites: EE 307 and EE 315.

EE 453 - LASER SYSTEMS

Semester Hours: 3

Spontaneous and stimulated emission, population inversion, optical resonators, three- and four-level systems, Q-switching and mode-locking, semiconductor lasers, integrated optic waveguides and couplers, scanning systems, high-power industrial application. Prerequisite: EE 307.

EE 454 - OPTICAL FIBER COMMUNICA

Semester Hours: 3

Introduction to optical fibers and their transmission characteristics, optical fiber measurements, sources and detectors, noise considerations for digital and analog communication, and optical fiber systems. (Same as OPE 454) Prerequisites: (EE 307 or PH 432) and (EE 382 or CPE 381).

EE 486 - INTRO MODERN CONTROL SYSTEMS

Semester Hours: 3

Modern control theory including techniques for modeling, analysis and control of MIMO dynamic systems, state-variable feedback control design and state observers. Kalman-filtering. Fundamentals of nonlinear systems analysis and discrete-time system modeling, analysis and control. Prerequisites: EE 386.

EE 494 - EE DESIGN PROJECTS

Semester Hours: 3

Senior Capstone Course. Design, simulation, and construction of technical projects. Review of legal, economic, and ethical issues. Students work as individuals or teams to design, implement, test, and evaluate their projects. Oral presentation and written reports are required. Senior Standing. Prerequisites: Senior Standing and ISE 321, EE 308, EE 310, EE 313, EE 315, CPE 323, EE 383, EE 386 and EE 399.

EE 497 - ELEC ENGR INTERNSHIP

Semester Hours: 1-3

Active involvement in an engineering project in an engineering enterprise, professional organization, or government agency that has particular interest and relevance in the student. Prerequisites: Junior or Senior standing and Approval of Engineering Faculty Advisor.