ELECTRICAL AND COMPUTER ENGINEERING

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The Department of Electrical and Computer Engineering (ECE) offers an ABET accredited Bachelor of Science in Electrical Engineering (BSEE), an ABET accredited Bachelor of Science in Computer Engineering (BSCpE), and a Master of Science in Electrical Engineering (MSEE) in Electrical Engineering. Graduate students enrolled in the Master of Science in Electrical Engineering (MSEE) program may select from the following options: Communication Systems, Computer Systems, or Control and Robotics Systems. The B. S. in Electrical Engineering (BSEE) and the BS in Computer Engineering (BSCpE) are designed to produce well-educated engineering professionals.

Our undergraduate curriculum is designed to provide a well-rounded education encompassing both theory and the practice of engineering. Students are required to take many 'hands-on' laboratories where the practical application of classroom theory is experienced. Additionally, a senior project involving design, implementation, and evaluation is required of all undergraduates and often takes the form of a multi-disciplinary team project. Our undergraduate students are well-prepared upon graduation to begin either a professional career or continue their education in a graduate program.

Graduates from the ECE department are in demand by a broad cross-section of industry, government, public utilities and educational institutions as a result of the effective integration of theory and practical experience within the curriculum. The students are prepared for employment in design and development, test and evaluation, and applied research.

Students desiring to major in Electrical Engineering or Computer Engineering should have a aptitude for science and mathematics, and incoming high school graduates should have taken college preparatory courses in these disciplines. Incoming transfer students should consult an advisor in the ECE department at Cal Poly Pomona to determine which courses meet the program requirements.

Electrical Engineering and Computer Engineering students are encouraged to become active in the student chapter of the Institute of Electrical and Electronics Engineers as well as many other College of Engineering and University student organizations. Qualified students are invited to join the student chapter of Eta Kappa Nu, the national electrical engineering honor society.

ELECTRICAL ENGINEERING

The educational objective of the B.S. in Electrical Engineering (B.S.E.E.) is to prepare students to become successful practitioners of Electrical Engineering. Students are afforded the opportunity to specialize at the junior and senior level by choosing from a number of Specified Programs of Electives (S.P.E.). Some of the S.P.E.'s offered by the department are Power, Electronics including Analog and Digital Devices, Controls and Instrumentation including Robotics and Biomedical, Communications & Signal Processing including Analog and Digital, and Illumination Engineering.

Core Courses for Major

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Introduction to Electrical Engineering	ECE	109/L	(3/1)
C for Engineers	ECE	114/L	(3/1)
Introduction to Combinational Logic	ECE	204/L	(3/1)
Introduction to Sequential Logic	ECE	205/L	(3/1)
Network Analysis I	ECE	207/L	(3/1)
Network Analysis II	ECE	209/L	(3/1)
Electronic Devices and Circuits	ECE	220/L	(4/1)
Object Oriented Programming	ECE	256	(4)
or Programming for Engineering Applications	ECE	257	(4)
Electromagnetic Fields	ECE	302	(4)
Introduction to Discrete Time Signals & Systems	ECE	306/L	(4/1)
Network Analysis III	ECE	307	(3)
Control Systems Engineering	ECE	309/L	(4/1)
Introduction to Power Engineering	ECE	310/L	(4/1)
Probability, Statistics, and Random Processes	ECE	315	(4)
Linear Active Circuit Design	ECE	320/L	(3/1)
Introduction to Semiconductor Devices	ECE	330	(3)
Introduction to Microcontrollers	ECE	341/L	(3/1)
Communications Systems	ECE	405/L	(4/1)
Senior Project and Undergraduate Seminar Or Professional Topics for Engineers and Senior Design Team Project	ECE	464,467	(1) (1)
Specified Program of Electives (Students select an elective program with advisors' help from SPE table.)			(21)

Support and Directed Electives

The following major support courses should be used to satisfy the indicated GE requirements. If these courses are not used to satisfy GE, the total units to degree may be more than 198 units.

General Chemistry	CHM	121	(3)
General Chemistry Lab (B3)	CHM	121L	(1)
Project Design and Applications (B5)	EGR	481,482	(2,2)
Analytic Geometry and Calculus I (B4)	MAT	114	(4)
Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Elementary Linear Algebra and Differential Equations	MAT	224	(4)
Introduction to Electronic Materials and Properties	MTE	208	(3)
General Physics (B1, B3)	PHY	131/L	(3/1)
General Physics	PHY	132/L	(3/1)
General Physics	PHY	133/L	(3/1)

General Education Requirements

An alternate pattern from that listed here for partial fulfillment of Areas 1, 3 and 4 available for students in this major is the Interdisciplinary General Education (IGE) program. Please see the description of IGE elsewhere in your catalog.

Area A (12 units)

1. Oral Communication
2. Written Communication
3. Critical Thinking

Area B (16 units)

1. Physical Science
2. Biological Science
3. Laboratory Activity
4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Fine and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COMPUTER ENGINEERING

Computer engineers apply the theories and principles of physics and mathematics to the design of hardware, software, networks and processes to solve technical problems. The educational objective of the B.S. in Computer Engineering (B.S.Cp.E.) is to prepare students to become successful practitioners of Computer Engineering. Hardware design engineers design, develop, test and supervise the manufacture of computer hardware, including chips and device controllers. Software engineers design and develop software systems for control and automation of manufacturing, business and management processes. Software engineers may also be involved in creating customer application software.

Core Courses for Major

Required of all students. A 2.0 cumulative GPA is required in core courses in order to receive a degree in the major.

Introduction to Electrical Engineering	ECE	109/L	(3/1)
C for Engineers	ECE	114/L	(3/1)
Discrete Structures	ECE	130	(4)
Introduction to Combinational Logic	ECE	204/L	(3/1)
Introduction to Sequential Logic	ECE	205/L	(3/1)
Network Analysis I	ECE	207/L	(3/1)
Network Analysis II	ECE	209/L	(3/1)
Electronic Devices and Circuits	ECE	220/L	(4/1)
Object Oriented Programming	ECE	256	(4)
Electromagnetic Fields	ECE	302	(4)
Data Structures for Engineers	ECE	304	(4)
Discrete Time Signals and Systems/Lab	ECE	306/L	(4/1)
Control Systems Engineering	ECE	309/L	(4/1)
Probability, Statistics, and Random Processes	ECE	315	(4)
Electronic Design for Digital Circuits	ECE	325/L	(3/1)
Introduction to Microcontrollers	ECE	341/L	(3/1)
Computer Organization	ECE	342/L	(4/1)
or Microprocessor I	ECE	343/L	(4/1)
Digital Design using Verilog HDL	ECE	415/L	(3/1)
or State Machine Design Using VHDL	ECE	424/L	(3/1)
Computer Architecture	ECE	425/L	(3/1)
Operating Systems for Embedded Applications	ECE	426/L	(3/1)
Network Programming and Appliance Control using Java	ECE	429	(4)
Computer Networks	ECE	431/L	(4/1)
or TCP/IP Internetworking	ECE	433/L	(3/1)
Senior Project and Undergraduate Seminar			
Or Professional Topics for Engineers and Senior			
Design Team Project	ECE	464,467	(1) (1)
Software Engineering	ECE	480	(4)
Technical Electives	(3)		

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Analytic Geometry and Calculus II	MAT	115	(4)
Analytic Geometry and Calculus III	MAT	116	(4)
Calculus of Several Variables I	MAT	214	(3)
Calculus of Several Variables II	MAT	215	(3)
Elementary Linear Algebra and			
Differential Equations	MAT	224	(4)
General Physics (B1, B3)	PHY	131/L	(3/1)
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General Physics	PHY	133/L	(3/1)

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1. Physical Science
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4. Math/Quantitative Reasoning
5. Science and Technology Synthesis

Area C (16 units)

1. Fine and Performing Arts
2. Philosophy and Civilization
3. Literature and Foreign Languages
4. Humanities Synthesis

Area D (20 units)

1. U.S. History, Constitution, and American Ideals
2. History, Economics, and Political Science
3. Sociology, Anthropology, Ethnic, and Gender Studies
4. Social Science Synthesis

Area E (4 units)

Lifelong Understanding and Self-development

COURSE DESCRIPTIONS

ECE 109 Introduction to Electrical Engineering (3)

Introduction to the fundamental laws of electrical engineering, applications to circuit analysis, matrix methods. 3 lectures/problem-solving. Prerequisite: C or better in MAT 114. Corequisite: ECE 109L.

ECE 109L Introduction to Electrical Engineering Laboratory (1)

Selected laboratory experiments emphasizing the use and operation of electrical test equipment. 1 three-hour laboratory. Corequisite: ECE 109.

ECE 114 C for Engineers (3)

Computer programming for ECE. Problem-oriented computer language applications to electrical networks. 3 lectures/problem-solving. Prerequisite: MAT 114. Corequisite: ECE 114L.

ECE 114L Programming Laboratory for Engineers (1)

This laboratory helps students to learn how to apply the ECE 114 course materials with hands-on computer programming exercises and engineering application. Students practice algorithm development, programming style, and debugging techniques in the computer laboratory. 1 three-hour laboratory. Corequisite: ECE 114.

ECE 130 Discrete Structures (4)

Fundamental topics for computer engineering, including mathematical logic, sets and relations, basic counting rules, functions and recursion, graphs and trees. 4 lectures/problem solving. Prerequisites: ECE 114/L.

ECE 200 Special Problems for Lower Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, maximum of 2 units per quarter.

ECE 204 Introduction to Combinational Logic (3)

Analysis and design of combinational circuits. Use of HDL to synthesize combinational logic circuits. 3 hours of lecture/problem solving. Prerequisites: ECE 109/L, ECE 114/L, ENG 103 or 104. Corequisite: ECE 204L.

ECE 204L Introduction to Combinational Logic Laboratory(1)

Design, implementation, and testing of combinational circuits. 3 hours laboratory. Prerequisite: ECE 109/L. Corequisite: ECE 204.

ECE 205 Introduction to Sequential Logic (3)

Analysis and design of finite state machines with state diagrams and ASM charts. Design of finite state machines with HDL. 3 hours lecture/problem solving. Prerequisites: ECE 204/L. Corequisite: ECE 205L.

ECE 205L Introduction to Sequential Logic (1)

Implementation of finite state machines with FPGA's using Verilog. 3 hours laboratory. Prerequisites: ECE 204/204L. Corequisite: ECE 205.

ECE 207 Network Analysis I (3)

An introduction to network analysis in the time domain using differential equations with computer applications. 3 lectures/problem-solving. Prerequisites ECE 109L; MAT 224 or MAT 216; PHY 133, C- or better in ECE 109; ENG 103 or 104. Prerequisite or corequisite: ECE 256 or ECE 257.

ECE 207L Network Analysis I Laboratory (1)

Selected laboratory exercises in electrical networks. 1 three-hour laboratory. Prerequisites: ECE 109L, ECE 207, and PHY 133L.

ECE 209 Network Analysis II (3)

An introduction to network analysis in the frequency domain with computer applications. 3 lectures/problem-solving. Prerequisite: C- or better in ECE 207.

ECE 209L Network Analysis II Laboratory (1)

Selected laboratory exercises in electrical networks. 1 three-hour laboratory. Prerequisite: ECE 209, ECE 207L.

ECE 220 Electronic Devices and Circuits (4)

Structure, characteristics, operation and biasing fundamentals of 2 and 3-terminal semiconductor devices, i.e., diodes, FETs and BJTs. Biasing, bias stability, load line methods and use of transfer curves to bias and design simple amplifier and inverter configurations. Introduction to small-signal parameters. Introduction to CMOS. 4 lectures/problem-solving. Prerequisites: C- or better in ECE 207. Prerequisite or corequisite ECE 209.

ECE 220L Electronics Laboratory (1)

Experiments dealing with common types of semiconductor devices: Diodes and applications (rectifier, clipper, clamper); MOSFETs & BJTs. Device characterization, biasing and analysis/design of basic configurations. 1 three-hour laboratory. Prerequisites: C- or better in ECE 220.

ECE 231/231L Elements of Electrical Engineering/Laboratory (3/1)

Electrical principles, DC and AC circuit analysis, simple transients, three-phase circuits, magnetics and transformers for non-electrical engineering majors. 3 lectures/problem-solving. 1 three-hour laboratory. Prerequisites: MAT 116, PHY 133.

ECE 256 Object Oriented Programming (4)

Class encapsulation, inheritance, polymorphism, object storage management, and exception handling. Program debugging, software reuse and object-oriented programming. 4 lectures/problem solving. Prerequisite: ECE 114/L.

ECE 257 Programming for Engineering Applications (4)

Introduction to MATLAB and Simulink programming with applications for ECE. Development and debugging of programs using MATLAB and Simulink. Introduction of selected MATLAB toolboxes. 4 lectures/problem-solving. Prerequisites: ECE 109, ECE 114/L.

ECE 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Instruction is by lecture, laboratory or a combination. Prerequisite: or consent of the instructor.

ECE 302 Electromagnetic Fields (4)

Maxwell's equations and electromagnetic concepts. Introduction to static and time varying fields; plane waves, boundary conditions, and transmission line equations. Applications to analog and digital circuits. 4 lectures/problem-solving. Prerequisites: PHY 133; MAT 215; MAT 224 or MAT 216; ECE 204; and ECE 220.

ECE 304 Data Structures for Engineers (4)

Implementation of data structures using C++ programming language. Utilization of data structures such as stacks, linked lists, trees and graphs in solving engineering problems. Use of C++ standard template library (STL) in code development Four lecture/problem solving sessions. Prerequisites: ECE 130, ECE 256, ECE 204/L, and MAT 224.

ECE 306 Discrete Time Signals and Systems (4)

Time and frequency domain analysis of discrete time signals and systems. 4 lecture/problem-solving. Prerequisite: ECE 209.

ECE 306L Discrete Time Signals and Systems Laboratory (1)

Selected experiments and simulations of continuous-time and discrete-time signals and systems using Digital Signal Processing (DSP) board and simulation software packages. Prerequisite: ECE 306.

ECE 307 Network Analysis III (3)

Frequency selective and two-port networks in the complex frequency domain. Fourier series and fourier transforms with applications to circuit analysis. 3 lectures/problem-solving. Prerequisites: ECE 209, ECE 306.

ECE 309 Control Systems Engineering (4)

System modeling and performance specifications. Design and analysis of feedback control system via root locus and frequency response. Compensation techniques. 4 lectures/problem-solving. Prerequisite: ECE 209.

ECE 309L Control Systems Laboratory (1)

Control System design assignments based upon the course work of ECE 309. Verification of solutions through digital simulations. 1 three-hour laboratory. Prerequisite: ECE 309.

ECE 310 Introduction to Power and Electric Drive Systems (4)

Basic principles of power engineering with emphasis on magnetics, transformers, rotating AC and DC machines and an introduction to switch-mode power converters in electric drives. Magnetic fields and circuits, as they apply to power transformers and AC and DC machines. Steady-state operational models of electrical machines and transformers, basic feedback control for motor drives, and an introduction to space vectors in AC machine analysis and control. 4 lectures/problem-solving. Prerequisite: ECE 209.

ECE 310L Power Engineering Laboratory (1)

Selected experiments in power engineering including three phase circuits, magnetics, transformers, AC and DC machines. 1 three-hour laboratory. Prerequisite or Corequisite: ECE 310.

ECE 311 Engineering Reports, Specifications, Written and Oral Proposals (4)

Techniques of conveying and interpreting written and oral technical information, with emphasis on reports, specifications, and proposals. 4 lectures/problem-solving. Prerequisite: ENG 104, ECE 320, ECE 341.

ECE 315 Probability, Statistics, and Random Processes for Electrical and Computer Engineering (4)

Concept of probability, statistics, random variables, and random processes. Analysis of random signals through linear time invariant systems. 4 lectures/problem-solving. Prerequisites: MAT 215 and ECE 306.

ECE 317 Advanced Electric Drives (3)

Space vector analysis of asynchronous (induction) and synchronous AC machines. Vector and torque control strategies using pulse-width modulated inverters. 3 lectures/problem-solving. Prerequisite: ECE 310.

ECE 317L Advanced Electric Drives Laboratory (1)

Selected experiments are performed to demonstrate the principles and characteristics of advanced electric drives for AC and DC machines. 1 three-hour laboratory. Prerequisite or corequisite: ECE 317.

ECE 318 Electrical Machines (3)

AC machine analysis with an emphasis on the steady state and dynamic operation of synchronous generators with application to power utilities. 3 lectures/problem-solving. Prerequisite: ECE 310.

ECE 318L Electrical Machines Laboratory (1)

Experiments on the steady state operation and analysis of AC machines. 1 three-hour laboratory. Prerequisite or corequisite: ECE 318.

ECE 320 Linear Active Circuit Design (3)

Small-signal modeling and design of single stage FET and BJT amplifiers using device properties and appropriate device models. Included are gain and input/output impedances; multistate amplifiers such as Darlington pair, cascade amplifier differential and DC coupled amplifiers; frequency response of AC coupled single-stage amplifier, low and high frequency roll-offs; DC coupled multistage amplifiers. Use of active-load and CMOS for IC aplifiers included. 3 lectures/problem-solving. Prerequisites: ECE 209 and C- or better in ECE 220.

ECE 320L Basic Active Circuit Laboratory (1)

Design and evaluation of basic FET and BJT amplifier circuits, both single and multistage. Evaluate DC and AC performance. 1 three-hour laboratory. Prerequisites: ECE 220L, C- or better in ECE 320.

ECE 322 Operational Amplifiers and Electronic Feedback (4)

Elements of electronic circuit feedback, and stability. Operational amplifier systems. Waveshaping circuits and oscillators. 4 lectures/problem solving. Prerequisite: ECE 320.

ECE 322L Operational Amplifiers and Electronic Feedback Lab (1)

Design and evaluation of feedback, operational amplifier, oscillator, and signal conditioning circuits. 1 three-hour laboratory. Prerequisite: ECE 320L. Prerequisite or corequisite: ECE 322.

ECE 323 Instrumentation Systems (3)

Components of Instrumentation Systems. Typical power supplies and signal conditioners. A/D and D/A converters. Sensors for various parameters. Error analysis, readouts, recorders and actuators. 3 lectures/problem-solving. Prerequisites: ECE 220/220L or ECE 231. Corequisite: ECE 323L.

ECE 323L Instrumentation Systems Laboratory (1)

Instrumentation system assignments based upon the course work of ECE 323. Verification of design solutions. 1 three-hour laboratory. Corequisite: ECE 323.

ECE 325 Electronic Design of Digital Circuits (3)

Device structures for primary logic families. Analysis of switching characteristics and waveform propagation. Structures of various memory devices, logic arrays. 3 lectures/problem-solving. 1 three-hour laboratory. Prerequisites: ECE 205/L, ECE 220/L. Corequisite: ECE 325L.

ECE 325L Electronic Design of Digital Circuits Laboratory (1)

Laboratory exercises to complement the corequisite lecture course. 1 three-hour laboratory. Prerequisites: ECE 205/L, ECE 220/L. Corequisite: ECE 325.

ECE 330 Introduction to Semiconductor Devices (3)

Fundamentals of semiconductor devices: Characteristics of silicon and other semiconductors. Structure, operation and characteristics of junction and MES diodes, Field Effect Transistors. Overview of BJT structure and operation. 3 lectures/problem-solving. Recommended preparation: ECE 302. Prerequisites: MTE 208 and ECE 220.

ECE 341 Introduction to Microcontrollers (3)

Microcontroller programming, applications, and interfacing. 3 hours lecture/problem-solving. Prerequisites: ECE 205/205L. Corequisite: ECE 341L.

ECE 341L Introduction to Microcontrollers Laboratory (1)

Microcontroller applications and interfacing. 3 hours laboratory. Prerequisites: ECE 205/L, ECE 220. Corequisite: ECE 341.

ECE 342 Computer Engineering (4)

Analysis and design of computer engineering systems, based on the Intel 80x86 architecture. Topics include: hardware specifications, peripheral interfacing, interrupts and programming. 4 lectures/problem-solving. Prerequisite: ECE 341/L. Corequisite: ECE 342L.

ECE 342L Computer Engineering Laboratory (1)

Experiments demonstrating analysis and design of computer engineering systems, including computer architecture. 1 three-hour laboratory. Prerequisite: ECE 341/L. Corequisite: ECE 342.

ECE 343 Microprocessor I (4)

Analysis and design of computer engineering systems, including microprocessors. 4 lectures/problem-solving. Prerequisites: ECE 204/L. Corequisite: ECE 343L

ECE 343L Microprocessor I Laboratory (1)

Design and build Motorola 68000-based microcomputer from chip level. 1 three-hour laboratory. Prerequisite: ECE 204/L. Corequisite: ECE 343.

ECE 400 Special Problems for Upper Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

ECE 402 Fields and Waves in RF Electronics (4)

Electrodynamics, wave equations, and reflection and scattering of waves. Radio frequency applications of transmission line techniques, and impedance matching. S-parameter design techniques. Couplers, hybrids, and filters. Experiments on impedance matching, RF circuits, antennas, and S-parameter measurements using Network Analyzers. 4 lectures/problem-solving. Prerequisites: ECE 220L and ECE 302.

ECE 403 Introduction to Filter Design (4)

An introduction to the design of passive and active filters. 4 lectures/problem-solving. Prerequisites: C- or better in MAT 114; ECE 309.

ECE 404 Robotics Electronics I (3)

Introduction to robotics. Kinematics, position analysis, Denavit-Hartenberg representation, differential motion, dynamic analysis and control. Trajectory planning, actuators, sensors and low-level robotic vision. Artificial intelligence. 3 one-hour lecture/problem-solving sessions. Prerequisite: ECE 309.

ECE 404L Robotics Electronics I Laboratory (1)

Selected experiments on control schemes and performance, including but not limited to servomotor and encoder characteristics, and pulse-width modulator basics. One (1) three-hour laboratory. Prerequisite or corequisite: ECE 404.

ECE 405 Communications Systems (4)

Introduction to communication systems: continuous wave modulation and demodulation. Power efficiency, bandwidth efficiency and system complexity of modulation systems. Performance of communication systems in noise. Sampling process and various types of pulse modulation. 4 lectures/problem-solving. Prerequisites: ECE 307, ECE 315.

ECE 405L Communications Laboratory (1)

Demonstrations of several aspects of different communication techniques. 1 three-hour laboratory. Prerequisite: ECE 405.

ECE 406 Wireless Communication Technology (4)

Design and Performance Analysis of Digital Communication Systems including FSK, BPSK, QPSK, QAM, GMSK. Experiments will include performance evaluation of RF oscillators, mixers, ASK/FSK/BPSK modulators, transmitters, and digital receivers. Pseudo Noise (PN) Codes. PN-coded spread-spectrum BPSK Transmitter and Receiver. System level testing will include Wireless, and Optical Systems. Special Experiments on BER and FDMA/TDMA/CDMA will be conducted depending on the availability of equipment and parts. 4 lectures/problem-solving. Prerequisites: ECE 405 and ECE 405L.

ECE 407 CMOS Analog Circuits (4)

Analysis and design of analog circuits implemented using CMOS integrated circuit technology. 4 lectures/problem-solving. Prerequisite or corequisite: ECE 322.

ECE 408 Digital Signal Processing (3)

The analysis, design and implementation of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters. 3 lectures/problem-solving. Prerequisite: ECE 306.

ECE 408L Digital Signal Processing Laboratory (1)

Implementation of FIR filters, IIR filters, adaptive filters, and fast Fourier transforms on digital signal processing boards. 1 three-hour laboratory. Prerequisite: ECE 408.

ECE 409 Digital Communication Systems (4)

Introduction to communication systems: fundamental limitations of communication systems. Digital-based and transmission techniques. Nyquist intersymbol interface criterion. Matched filter concept. Digital modulation and demodulation techniques. 4 lectures/problem-solving. Prerequisite: ECE 405.

ECE 410 Microwave Engineering (3)

Principles of waveguide devices, and active microwave devices. Scattering parameter techniques. Design of microwave circuits and FET amplifiers. Microwave generation techniques. 3 lectures/problem-solving. Prerequisites: ECE 402.

ECE 410L Microwave Engineering Laboratory (1)

Electronic measurement equipment and techniques for measurements at microwave frequencies of such quantities as power, impedance, standing wave ratio and frequency, S-parameters, and impedance matching. Network analysis. Microwave amplifier and oscillator characteristics. 1 three-hour laboratory. Prerequisite: ECE 402. Co-requisite: ECE 410

ECE 412 Integrated Circuits: Devices and Modeling (4)

Theory, modeling and applications of devices used in modern integrated circuits. Emphasis is on field effect devices including MOSFETs, CMOS, gallium arsenide MESFETs, and charge-coupled devices. Four one-hour lectures/problem sessions. Prerequisite: ECE 330.

ECE 414 Microprocessor Applications in Process Control (3)

Process control fundamentals. Analog and digital signal conditioning, z-transformation techniques. Digital controller principles. Design of discrete time control systems. Development of digital control algorithms for microprocessor-based control systems. Introduction to fuzzy logic control systems. 3 lectures/problem-solving. Prerequisites: ECE 309, ECE 341/341L, and ECE 306/L; Concurrent: ECE 414L.

ECE 414L Microprocessor Applications in Process Control Laboratory (1)

Laboratory work involves applying the analysis and design methods presented in the lecture to selected process control systems using both simulated and actual processes. 1 three-hour laboratory. Corequisite: ECE 414.

ECE 415 Digital Design using Verilog HDL (3)

Review of digital design concepts, design using PLDs, CPLDs and FPGAs, hardware Modeling with Verilog HDL, behavioral descriptions in Verilog, synthesis of combinational circuit, and state machines, language constructs, and design for testability. Three one-hour lectures/problem sessions. Prerequisites: ECE 341/341L. Corequisite: ECE 415L.

ECE 415L Digital Design using Verilog HDL Laboratory (l)

Design, synthesis and testing of combinational logic circuits and state machines using an FPGA. 1 three-hour laboratory. Prerequisites: ECE 341/341L. Corequisite: ECE 415.

ECE 418 Integrated Circuits; Design and Fabrication (4)

Fundamentals of fabrication technologies and physical layout design of digital and analog integrated circuits with an emphasis on CMOS VLSI. Materials and device processing technologies. Introduction to layout design rule checking. 4 lectures/problem-solving. Prerequisites: ECE 320 (or ECE 325) and ECE 330.

ECE 419 Advanced Control Systems (3)

Time-domain and frequency-domain design of control systems; concepts of state and state space; description of dynamic systems in state-variable format; canonical forms; controllability and observability; state feedback and state estimation; applications and hardware. 3 one-hour lecture/problem-solving sessions. Prerequisite: ECE 309.

ECE 419L Advanced Control Systems Laboratory (1)

Time-domain and frequency-domain design of control systems; concepts of state and state space; description of dynamic systems in state-variable format; canonical form; controllability and observability; state feedback and state estimation; applications and hardware. 1 three-hour laboratory. Prerequisite. ECE 309.

ECE 420 Lasers (4)

Introduction to ray optics, beam optics, diffraction, coherence, and phoronoptics. Fundamental principles and applications of lasers, energy levels and mechanisms of excitation, basic types of lasers. Q switching and modes. Modulation and detection. 4 lectures/problem-solving. Prerequisites: ECE 302.

ECE 421 Power System Analysis I (3)

Power system transmission line design and operation. Advanced methods of analysis of power system, per-unit system, single-line representation of power systems, and the use of power systems analysis software for the solution of system problems, symmetrical faults, and power flow. 3 lectures/problem-solving. Prerequisites: ECE 310 or ECE 318.

ECE 421L Power System Analysis I Laboratory (1)

Experiments and computer modeling using available software to simulate the characteristics of power transmission systems under various operating conditions. 1 three-hour laboratory. Prerequisite or concurrrent: ECE 421.

ECE 422 Power System Analysis II (3)

Power system stability and fault conditions, specific design considerations, load flow studies, asymmetrical faults, symmetrical components, system protection, and economic operating practices. Standards governing industry and utility system operation. Use of computer software for load flow and stability analysis. 3 lectures/problem-solving. Prerequisite: ECE 421.

ECE 422L Power System Analysis II Laboratory (1)

Experiments and computer modeling to demonstrate fault conditions, instability, and protection methodology in power systems. 1 three-hour laboratory. Prerequisite or concurrent: ECE 422.

ECE 423 Very Large Scale Integrated (VLSI) Circuit Design (4)

Integrated circuit chip design in silicon CMOS technology. Computer aided physical layout design and simulation of Digital Integrated Circuits-Combinational logic and Sequential logic circuits. Static and dynamic operation of logic circuits. Timing issues in digital circuits. The influence of parasitic capacitances, inductances, and resistances on the design performance. Semiconductor memory and Array structures. Chip input and output circuits. Optimizing speed, area, power. 4 lecture /problem-solving. Prerequisite: ECE 320 or ECE 325.

ECE 424 Digital System Design using VHDL (3)

Design of digital systems. VHDL, modeling and simulation of digital systems using VHDL. Implementation of Digital Systems using FPGAs. 3 lectures/problem-solving. Prerequisite: ECE 341. Corequisite: ECE 424L.

ECE 424L Digital System Design Using VHDL Laboratory (1)

VHDL modeling of digital systems. Implementation of digital system using FPGAs. One (1) three-hour laboratory. Prerequisite: ECE 341. Corequisite: ECE 424.

ECE 425 Computer Architecture (3)

RISC architecture, instruction sets, programming, pipelining, and cache memories and the design of a single cycle RISC CPU. 3 lecture/problem-solving. Prerequisites: ECE 341/L; ECE 205/L or ECE 415/L. Corequisite: ECE 425L.

ECE 425L Computer Architecture Laboratory (1)

RISC architecture, instruction sets, programming, pipelining, and cache memories and the design of a single cycle CPU. 3 hours laboratory. Prerequisites: ECE341/341L; ECE 205/L or ECE 415/L. Corequisite: ECE 425.

ECE 426 Operating Systems for Embedded Applications (3)

Operating system concepts including memory, device and file management techniques and design of a real time operating system for embedded controllers. Three lectures/problem-solving. Prerequisites: ECE 256 and one of the following ECE 425/425L or ECE 342/342L or ECE 343/343L. Corequisite: ECE 426L.

ECE 426L Operating Systems for Embedded Applications Laboratory (1)

Operating system concepts including memory, device and file management techniques and design of a real time operating system for embedded controllers. 1 three- hour laboratory. Prerequisites: ECE 256 and one of the following ECE 425/L or ECE 342/L or ECE 343/L. Corequisite: ECE 426.

ECE 428 Digital Signal Processing II (4)

A continuation of digital filter design and an introduction to digital signal processing algorithms. 4 lectures/problem-solving. Prerequisite: ECE 408.

ECE 429 Application Development Using JAVA (4)

Essential object-oriented programming concepts: encapsulation, inheritance and polymorphism, GUI Development, multimedia applications, multi-tasking, network programming using Internet. 4 lectures/problem-solving. Prerequisite: ECE 256

ECE 431 Computer Networks (4)

Guided and unguided media; signals; flow and error control; MAC; networking devices; routing; IEEE standards for LANs, internet, networking of embedded systems. 4 lectures/problem-solving. Prerequisites: ECE 341/L. Corequisite: ECE 431L.

ECE 431L Computer Networks Laboratory (1)

Projects in the areas of data communication and embedded systems networking. Laboratory work involves hardware implementation, software development, testing and simulation. 1 three-hour laboratory. Corequisite: ECE 431.

ECE 432 Microprocessor II (3)

Microcomputer applications at the systems level. Course to include usage of both hardware and software design aids. 3 lectures/problem-solving. Prerequisites: ECE 343/L or ECE 341/L. Corequisite: ECE 432L.

ECE 432L Microprocessor II Laboratory (1)

Design and build Intel 8086-based microcomputer from chip level. Design and implementation of typical 32-bit microprocessor applications using Motorola M68EC030 or M68EC040 system. 1 three-hour laboratory. Prerequisites: ECE 343/L or ECE 341/L. Corequisite: ECE 432.

ECE 433 TCP/IP Internetworking (3)

Principles, protocols, architecture, coding, and performance analysis of transmission control protocol and Internet protocol. 3 lectures/problem-solving. Prerequisites: ECE 341/L and ECE 256; Corequisite: ECE 433L.

ECE 433L TCP/IP Internetworking Laboratory (1)

Principles, protocols, architecture, codings and performance analysis of transmission control protocol and internet protocol. 1 three-hour laboratory. Prerequisites: ECE 341/341L and ECE 256. Corequisite: ECE 433

ECE 434 Ocean Electronics (4)

Electronic instrumentation for basic underwater measurements of ocean depths, currents, wave motion, salinity, water analysis, etc. Data buoy instrumentation systems. Basic ocean surface electronics for communication, navigation, weather, underwater acoustics transducers. 4 lectures and one or more ocean field trips. Prerequisite: ECE 323.

ECE 435 Biomedical Instrumentation and Measurements (3)

Discussion of major body systems in terms of their physiology, measurable parameters and current instrumentation. The application of sound engineering principles to obtain reliable physiological data. A system design. 3 lectures/problem-solving. Prerequisite: BIO 110. Corequisite: ECE 435L.

ECE 435L Biomedical Instrumentation and Measurements Laboratory (1)

Selected experiments pertaining to biomedical instrumentation. 1 three-hour laboratory. Corequisite: ECE 435.

ECE 436 Optical Fiber Communications (4)

Introduction to optical fibers. Coupling and cabling. Optical sources and detectors and their application to optical communications. Modulation methods. Noise in detectors. Design and evaluation of optical transmitters, receivers, repeaters. Design specifications, options, tradeoffs and cost. Integrated optics. Laser technology applied to optical communications. New developments. 4 lectures/problem-solving. Prerequisites: ECE 302, ECE 330, ECE 405.

ECE 437 Introduction to Photonics (4)

The nature of light. Simple geometric optics. Thermal and atomic-line light sources, modulation of lights. Nonlinear optics and parametric oscillations. Luminescence. Display devices. Laser and laser light. Photodetectors, optical waveguides. Prerequisites: ECE 302 and ECE 330.

ECE 448/448L R.F. Design/Laboratory (3/1)

Principles of R.F. design of transmitters and receivers utilizing solid state electronics devices and integrated circuits. Design of oscillator, power amplifiers, mixers and detectors. 3 lectures/problem-solving and 1 three-hour laboratory. ECE 448 and ECE 448L are to be taken concurrently. Prerequisites: ECE 320 and ECE 402. Corequisites: ECE 448/448L.

ECE 464 Professional Topics for Engineers (1)

The course consists of developments, policies, practices, procedures and ethics in the areas of Electrical and Computer Engineering. 1 hour lecture/problem-solving. Prerequisites: GWT, all 100 and 200 level courses. All but 12 units of the 300 level courses. 50 units or less to graduate.

ECE 465, 466 and 467 Team Project I, II and III (2), (2), (1)

Completion of a capstone senior design team project under faculty supervision. Project results are presented in a formal report. Minimum 120 hours required. Prerequisites for ECE 465: Senior Standing. Prerequisites for ECE 466: ECE 465. Prerequisites for ECE 467: ECE 465/466 or EGR 481/482 taken within the department or with the department pre-approval.

ECE 468 Power System Electronics (3)

Power electronics applications for industry and power utilities. The emphasis is on the analysis and design of power system components, including single and three-phase DC rectifiers, controlled rectifiers, and DC to AC converters. Selected applications include HV-DC transmission, resonant converters, AC and DC motor drives, static var control, and power quality issues. 3 lectures/problem-solving. Prerequisite: ECE 220.

ECE 468L Power System Electronics Laboratory (1)

Selected experiments in Power Electronics covering single and three-phase DC rectifiers using power diodes and thyristors and utility applications including static var correction, thyristor controlled inductors, etc. 1 three-hour laboratory. Prerequisite or corequisite: ECE 468.

ECE 469 Power Electronics (3)

Basic principles of power electronics with an emphasis on the analysis and design of DC switch-mode power supplies and DC to AC inverters using pulse-width modulation (pwm). Basic circuit topologies, control modes (voltage/current, etc), control stability, high power factor design, pwm amplifiers, design of magnetic components and output filters. 3 lectures/problem-solving. Prerequisites: ECE 220.

ECE 469L Power Electronics Laboratory (1)

Selected experiments to study the basic topologies used in DC to DC switch-mode converters, pulse-width modulated integrated circuits for voltage/current regulation, air-gaps in magnetic circuits, and output filters. 1 three-hour laboratory. Prerequisite or corequisite: ECE 469.

ECE 480 Software Engineering (4)

Software engineering processes including requirements engineering, specification techniques, design concepts and methods, software testing and integration concepts, verification and validation, quality assurance, configuration management, and software documentation. 4 lectures/problem solving. Prerequisites: ECE 304, ECE 426, and ECE 429.

ECE 490 Introduction to Illumination Engineering (4)

An introduction to light as waves and particles, photometric units, color, vision, daylighting, incandescent of luminescent light sources, luminairs and controls. Basic measurements and calculations, basic indoor lighting analysis and design. 4 lectures/problem-solving. Prerequisites: ECE 209 or ECE 231 or PHY 123. Corequisite: ECE 490L.

ECE 490L Illumination Engineering (ILE) Laboratory (1)

This lab is a demo tool and a practical platform for lighting experimentation. Experiments comprise of light sources and systems, photometric and electrical analysis and the practical use of photometric and electrical analytic equipment. Lab experiments verify various physical laws, cover outside measurements, photometry of sources and luminaries, and practical analysis and design of indoor lighting systems. Detailed individual and team reports are required; industrial manufacturing and utilities' lab visits are included and required. 1 three-hour Laboratory. Corequisite: ECE 490.

ECE 492/492L Lighting Control/Design (4/1)

Analysis and design of light control systems, occupancy sensors, and magnetic/electric ballasts. Selected sections of both State and Federal regulations covering lighting systems and ANSI specifications. 4 lectures/problem-solving. 1 three-hour laboratory. Prerequisite: ECE 209 or ECE 231 or PHY 123.

ECE 499/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Instruction is by lecture, laboratory or a combination.