

2007-2009 Cal Poly Catalog

Updated Course Descriptions.

See catalog pages as printed for [original descriptions](#).

[Electrical Engineering Department](#)

EE–ELECTRICAL ENGINEERING

EE 111 Introduction to Electrical Engineering (1)

A general overview of the field of electrical engineering. Preparation for successful completion of the Electrical Engineering (EE) program at Cal Poly. 1 lecture. Concurrent: EE 151. Not required for students with transfer credit for EE 211 or EE 241.

EE 112 Electric Circuit Analysis I (2)

Introduction to basic circuit analysis. Resistive circuits, voltage and current sources, network theorems, op-amp circuits. 2 lectures. Prerequisite: MATH 142 or equivalent. Concurrent or prerequisite: PHYS 133. Suggested: EE 111/151.

EE 129 Digital Design (3) (Also listed as CPE 129)

Number systems, Boolean algebra, Boolean functions, and minimization. Analysis and design of combinational logic circuits. Feedback circuits. Analysis and design of sequential logic circuits. Applying Hardware Description Language (HDL) to synthesize digital logic circuits in Programmable Logic Devices (PLDs). 3 lectures. Prerequisite: An orientation course in student's major (EE 111&151 for EE students, CPE 100 for CPE students), CPE/CSC 101. Concurrent: EE 169.

EE 151 Introduction to Electrical Engineering Laboratory (1)

A variety of hands-on experiments and demonstrations in electrical engineering, providing background and motivation for successful completion of the Electrical Engineering (EE) program at Cal Poly. 1 laboratory. Concurrent: EE 111. Not open to students with credit for EE 241.

EE 169 Digital Design Laboratory (1) (Also listed as CPE 169)

Experiments to analyze and design combinational and sequential logic circuits with discrete ICs and PLDs. Introduction to laboratory equipment such as the logic state analyzer for testing circuits. Introduction to a hardware description language for logic simulation and design. 1 laboratory. Prerequisite: An orientation course in student's major (EE 111&151 for EE students, CPE 100 for CPE students), CPE/CSC 101. Concurrent: EE 129.

EE 200 Special Problems for Undergraduates (1–2)

Individual investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisite: Consent of department chair.

EE 201 Electric Circuit Theory (3)

Application of fundamental circuit laws and theorems to the analysis of DC, and steady-state single-phase and three-phase circuits. Not for electrical engineering majors. 3 lectures. Prerequisite: MATH 244, PHYS 133.

EE 211 Electric Circuit Analysis II (3)

Continuation of basic circuit analysis. Energy storage elements, RC and RL circuits, and phasors. 3 lectures. Prerequisite: EE 112 with a C- grade or better, PHYS 133. Prerequisite or Concurrent: MATH 244. Concurrent: EE 241.

EE 212 Electric Circuit Analysis III (3)

AC power, 3-phase circuits. Mutual inductance, series and parallel resonance and two-port networks. 3 lectures. Prerequisite: MATH 244, EE 211 with a C- grade or better. Concurrent: EE 242.

EE 228 Continuous-Time Signals and Systems (4)

Continuous-time systems analysis, with emphasis on linear time-invariant (LTI) systems. Classification of continuous-time systems. Convolution and

its application to LTI systems. The Laplace transform, Fourier transform, and Fourier series, and their application to the analysis of LTI systems. 4 lectures. Prerequisite: EE 212&242 with a C- grade or better. Recommended: MATH 241.

EE 229 Computer Design and Assembly Language Programming (3) (Also listed as CPE 229)

Design and implementation of digital computer circuits via CAD tools for programmable logic devices (PLDs). Basic computer design with its data path components and control unit. Introduction to assembly language programming of an off-the-shelf RISC-based microcontroller. 3 lectures. Prerequisite: EE 129&169 with a C- grade or better. Concurrent: EE 269.

EE 241 Electric Circuit Analysis Laboratory II (1)

Use of electrical and electronic test equipment. Experimental verification of circuit analysis concepts including Kirchhoff's Laws, Thevenin's Theorem, maximum power transfer and superposition. 1 laboratory. Prerequisite: EE 112 with a C- grade or better, PHYS 133, EE 151 for EE students and CPE 169 for CPE students. Prerequisite or concurrent: MATH 244. Concurrent: EE 211.

EE 242 Electric Circuit Analysis Laboratory III (1)

Observation of transient and steady-state phenomena, phase-shift circuits, resonance. Use of phasor diagrams. 1 laboratory. Prerequisite: MATH 244, EE 241 with a C- grade or better or consent of department chair. Concurrent: EE 212.

EE 251 Electric Circuits Laboratory (1)

Techniques of measurement of DC and steady-state AC circuit parameters. Equivalent circuits, nonlinear elements, resonance. 1 laboratory. Concurrent: EE 201.

EE 255 Energy Conversion Electromagnetics (3)

Fundamentals of electro-mechanical energy conversion. Magnetic circuits and electromagnetic devices. Theory of operation and operating characteristics of transformers, DC machines, and AC induction and synchronous machines. 3 lectures. Prerequisite: EE 212&242 with a C- grade or better, or EE 201&251. Concurrent: EE 295.

EE 269 Computer Design and Assembly Language Programming Laboratory (1) (Also listed as CPE 269)

Experiments to design and test digital computer circuits and systems with programmable logic devices (PLDs). Design projects to implement a basic computer with data path components and control. Assembly language programming projects for an off-the-shelf RISC-based microcontroller. 1 laboratory. Prerequisite: EE 129&169 with a C- grade or better. Concurrent: EE 229.

EE 295 Energy Conversion Electromagnetics Laboratory (1)

Single-phase and three-phase transformers. Starting of rotating machines, evaluation of characteristics of rotating machines. 1 laboratory. Prerequisite: EE 212&242 with a C- grade or better or EE 201&251. Concurrent: EE 255.

EE 302 Classical Control Systems (3)

Introduction to feedback control systems. System modeling. Transfer functions. Graphical system representation. System time response, stability. Root Locus. Frequency response. Compensation. 3 lectures. Prerequisite: EE 228, EE 255&295. Concurrent: EE 342. Suggested: EE 368.

EE 306 Semiconductor Device Electronics (3)

Internal operation, semiconductor physics, terminal characteristics, models and application of diodes (LEDs, solar cells, and photo-diodes) and transistors (field-effect and bipolar). 3 lectures. Prerequisite: CHEM 124, EE 212&242 with a C- grade or better, IME 156 or IME 157 or IME 458, PHYS 211. Concurrent: EE 346.

EE 307 Digital Electronics and Integrated Circuits (3)

Analysis, design, application and interfacing of integrated logic circuits, including NMOS, CMOS, TTL, ECL, and other logic families. 3 lectures. Prerequisite: EE 129&169 with a C- grade or better, EE 306&346 with a C- grade or better. Concurrent: EE 347, EE 229 (may be taken previously).

EE 308 Analog Electronics and Integrated Circuits (3)

Analysis and design of integrated circuits for use in analog applications. Gain, frequency response, and feedback of linear small-signal amplifiers. 3 lectures. Prerequisite: EE 302&342 with a C- grade or better, EE 307&347 with a C- grade or better. Concurrent: EE 348.

EE 314 Introduction to Communication Systems (3)

Analog modulation, including: double-sideband modulation, amplitude modulation, single-sideband modulation, frequency modulation, phase modulation. Performances of such systems in the presence of white Gaussian noise. Implementations of transmitters and receivers. 3 lectures. Prerequisite: STAT 350, with a C- grade or better.

EE 321 Electronics (3)

Semiconductor devices and circuits. Instrumentation amplifiers, power control rectifiers, feedback, pulse circuits, digital logic circuits. Not for Electrical Engineering majors. 3 lectures. Prerequisite: EE 201 or BRAE 216 for BRAE majors. [Change effective Winter 2008.](#)

EE 328 Discrete Time Signals and Systems (3)

Discrete-time systems and analysis, with emphasis on linear time-invariant (LTI) systems. Sampling theorem. Classification of discrete-time systems. Convolution and its application to LTI systems. The z transform, discrete-time Fourier transform, and discrete Fourier transform. Introduction to digital filters. 3 lectures. Prerequisite: EE 228 with a C- grade or better. Concurrent: EE 368.

EE 329 Programmable Logic and Microprocessor-Based Systems Design (4) (Also listed as CPE 329)

Design, implementation and testing of programmable logic microprocessor-based systems. Hardware/software tradeoffs (such as timing analysis and power considerations), system economics of programmable logic and microprocessor-based system design. Interfacing hardware components (such as ADCs/DACs, sensors, transducers). 3 lectures, 1 laboratory. Prerequisite: EE 307&347 with a C- grade or better, EE 229&269 with a C- grade or better.

EE 335 Electromagnetic Fields and Transmission (4)

Maxwell's equations. Plane wave propagation in free space. Static electric and magnetic fields. Distributed-circuit concepts and transmission line parameters. Reflections and standing waves. The Smith chart and its applications. Transmission line measurements and impedance matching techniques. 4 lectures. Prerequisite: MATH 241, EE 212&242 with a C- grade or better. Concurrent: EE 375.

EE 336 Microprocessor System Design (4) (Also listed as CPE 336)

Introduction to microcontrollers and integrated microprocessor systems. Emphasis on the Intel 8051 and Motorola 68HC12 families and derivatives. Hardware/software trade-offs, system economics, and functional configurations. Interface design, real-time clocks, interrupts, A/D conversion, serial and parallel communications, watch-dog timers, low power operation, and assembly language programming techniques. Architecture and design of sampled data and digital control systems. Case studies of representative applications. 3 lectures, 1 laboratory. Prerequisite: EE 129&169 with a C- grade or better.

EE 342 Classical Control Systems Laboratory (1)

Laboratory work pertaining to classical control systems, including servo control, transient and frequency responses, stability, and computer-aided analysis of control systems. 1 laboratory. Prerequisite: EE 228 with a C- grade or better, EE 255&295. Concurrent: EE 302. Suggested: EE 368.

EE 346 Semiconductor Device Electronics Laboratory (1)

Experimental determination of device characteristics and models. 1 laboratory. Prerequisite: CHEM 124, EE 212&242 with a C- grade or better, IME 156 or IME 157 or IME 458, PHYS 211. Concurrent: EE 306. Suggested: ENGL 134.

EE 347 Digital Electronics and Integrated Circuits Laboratory (1)

Computer simulation and experimental investigation of the characteristics, applications and interfacing of different logic families. 1 laboratory. Prerequisite: EE 129&169 with a C- grade or better, EE 306&346 with a C- grade or better. Concurrent: EE 307, EE 229 (may be taken previously).

EE 348 Analog Electronics and Integrated Circuits Laboratory (1)

Design, simulation, construction and testing of solid state amplifiers and sub-circuits to meet stated specifications. 1 laboratory. Prerequisite: EE 302&342 with a C- grade or better, EE 307&347 with a C- grade or better. Concurrent: EE 308.

EE 361 Electronics Laboratory (1)

Instrumentation amplifiers, feedback, rectifiers and power control, pulse and digital logic circuits. 1 laboratory. Prerequisite: EE 251 or BRAE 216 for BRAE majors. Concurrent: EE 321. [Change effective Winter 2008.](#)

EE 368 Signals and Systems Laboratory (1)

Laboratory work pertaining to linear systems, including Fourier analysis, time and frequency responses, and system transfer function. 1 laboratory. Prerequisite: EE 228 with a C- grade or better. Concurrent: EE 328.

EE 375 Electromagnetic Fields and Transmission Laboratory (1) (formerly EE 442)

Transmission line characterization. Load determination and standing wave patterns using the slotted line technique. Application of the Smith Chart in transmission line characterization and impedance matching techniques. Time domain response to voltage pulses. 1 laboratory. Concurrent: EE 335.

EE 400 Special Problems for Advanced Undergraduates (1-5)

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 5 units. Prerequisite: Consent of department chair.

EE 402 Electromagnetic Waves (4)

Maxwell's equations and plane wave propagation in materials. Reflection and transmission of normal and oblique incidence plane waves at planar boundaries between different media. Wave guides. Antennas. 4 lectures. Prerequisite: EE 335 with a C- grade or better.

EE 403 Fiber Optic Communication (3)

Propagation of light in optical fibers, attenuation and bandwidth. LED and Laser Diode sources for use with optical fibers. Optical sources, detectors, and receivers. Design of optical communication systems with applications in telecommunications and local area networks (LANs). 3 lectures. Prerequisite: EE 335 with a C- grade or better or PHYS 323. Concurrent: EE 443.

EE 405 High-frequency Amplifier Design (3)

Design of modern electronic amplifiers and amplifier systems with advanced techniques. UHF and microwave small signal amplifier design utilizing microstrip transmission lines, S parameters of GaAs FET, and bipolar transistors. Low noise, broadband, and power amplifier designs. Oscillator designs. 3 lectures. Prerequisite: EE 308&348 with a C- grade or better, EE 335 with a C- grade or better. Concurrent: EE 445.

EE 406 Power Systems Analysis I (4)

Introduction to electric power systems. Representation of power systems and its components including transmission lines, synchronous machines, transformers and loads. One line diagrams and per unit calculations. symmetrical faults. Load flow analysis. 4 lectures. Prerequisite: EE 335 with a C- grade or better, EE 255&295.

EE 407 Power Systems Analysis II (4)

Symmetrical components, unbalanced faults, power system stability, system protection, relays and relay systems, power system instrumentation and measurement techniques, economic operation. 4 lectures. Prerequisite: EE 406.

EE 409 Electronic Design (3)

Design of electronic systems and subsystems using analog and digital integrated circuits. Design principles and techniques. Analysis and design of feedback amplifiers; operational amplifier applications. Design of analog/digital and digital/analog converters. Power supply design. Emphasis on IC implementation. 3 lectures. Prerequisite: EE 308&348 with a C- grade or better, EE 328&368 with a C- grade or better, EE 329 with a C- grade or better. Concurrent: EE 449.

EE 410 Power Electronics I (4)

Introduction to power electronics and power semiconductor devices. Analysis, performance characterization, and design of power electronics converters such as: rectifiers, DC choppers, AC voltage controllers, and

single-phase inverters. Operation of DC motor drives. Use of commercially available software. 3 lectures, 1 laboratory. Prerequisite: EE 409&449 (or concurrent) and EE 255&295, or EE 321 and consent of instructor. →

EE 411 Power Electronics II (4)

Switching losses. Analysis, performance characterization, and design of snubber circuits and resonant converters. Operation of DC transmission lines, flexible AC transmission system (FACTS) controllers, three-phase inverters, and AC motor drives. Use of commercially available software. 3 lectures, 1 laboratory. Prerequisite: EE 410.

EE 412 Advanced Analog Circuits (3)

Application of linear integrated circuits to data acquisition problems: transducer interfacing, linear and nonlinear preprocessing, phase-locked loops, and high performance quantization and recovery (A/D, D/A conversion). 3 lectures. Prerequisite: EE 409&449, EE 314.

EE 413 Advanced Electronic Design (4)

Advanced design of electronic circuits and subsystems. Design as a process. Implementation of specific design projects. Automated test using GPIB instruments. 3 lectures, 1 laboratory. Prerequisite: CSC 101, EE 409&449.

EE 415 Communication Systems Design (3)

Design of modern electronic communication and telemetry systems. Emphasis: practical implementation and comparative evaluation of various modulation systems. 3 lectures. Prerequisite: EE 409&449, EE 314 with a C- grade or better.

EE 416 Digital Communication Systems (3)

Baseband (PCM, PAM, DM) signals and transmission. Bandpass (PSK, FSK, ASK) modulation and demodulation techniques. Digital communication signals in the presence of noise and detection of signals in Gaussian noise. Other topics such as: quantization, multiplexing and multiple access, spread spectrum techniques, coding, synchronization. 3 lectures. Prerequisite: EE 314 with a C- grade or better, EE 328 with a C- grade or better.

EE 417 Alternating Current Machines (4)

Alternating current machines. Generalized, operational and dynamic analysis. Steady-state and transient operation of synchronous machines and linear induction machines. 3 lectures, 1 laboratory. Prerequisite: EE 255&295.

EE 418 Photonic Engineering (3)

Modern optical design with emphasis on the use of computers to design simple optical systems and to evaluate existing optical designs. Paraxial and exact ray tracing through thin and thick lenses, mirrors, and prisms. Radiometry and photometry. Electro-optic, acousto-optic, and magneto-optic modulators and their applications. Thermal detectors, semiconductor detectors, and charge coupled device (CCD) arrays. 3 lectures. Prerequisite: EE 335 with a C- grade or better or PHYS 323. Concurrent: EE 458.

EE 419 Digital Signal Processing (3)

Review of Z-transform, convolution and discrete Fourier Transform. Digital filter design. Fast Fourier Transform. Theory and applications of digital signal processors. 3 lectures. Prerequisite: CSC 101, EE 328&368 with a C- grade or better. Concurrent: EE 459.

EE 420 Sustainable Electric Energy Conversion (4)

→ Electrical engineering aspects of photovoltaic and wind power generation and usage, and electrochemical energy conversion. Power control, processing, and quality for grid-connected and stand-alone systems. Distribution and storage of electric energy. Hydrogen and synthetic fuels. Distributed generation. 3 lectures, 1 laboratory. Prerequisite: CHEM 124 and EE 255&295 or consent of instructor. [Corrected effective Fall 2008.](#)

EE 421 Solid-state Microelectronics (3)

Physical basis of solid-state microelectronics. Passive and active integrated circuit components in Bipolar, MOS, thin and thick film systems. Diffusion, oxidation, ion implantation and other fabrication techniques. Microcircuit layout and design: system development, reliability and economic considerations. Future trends. 3 lectures. Prerequisite: EE 307 with a C- grade or better.

EE 422 Polymer Electronics Laboratory (1) (Also listed as PHYS 422)

Experimental procedures in polymer electronics. Investigation of the characteristics of a polymer electronic device. 1 laboratory. Prerequisite: EE 347 with a C- grade or better or MATE 340 or CHEM 319 or PHYS 340. [Changed \(crosslisted\) effective Fall 2008.](#)

EE 424 Introduction to Remote Sensing (4)

Radiation characteristics, sensor technology and platforms, satellite systems, system design tradeoffs, collection and transmission of radio-metric data, GPS, thermal remote sensing, active radar and microwave remote sensing, interpretation and exploitation of remotely sensed data for various applications. 3 lectures, 1 laboratory. Prerequisite: MATH 244, senior or graduate standing in engineering, or consent of instructor.

EE 425 Analog Filter Design (3)

Approximation Theory. All pole filters. Frequency transformations. Elements of passive synthesis. Time delay filters. Theory and design of active filters. Sensitivity analysis. 3 lectures. Prerequisite: EE 409&449. Concurrent: EE 455.

EE 427 Digital Computer Subsystems (4) (Also listed as CPE 427)

Design of components and subsystems in digital computers. Use of modern techniques and devices (CPLDs and FPGAs) in implementation. Consideration given to cost/speed tradeoffs. Implementation of a basic digital computer using pre-designed subsystems. 3 lectures, 1 laboratory. Prerequisite: EE 329 with a C- grade or better.

EE 431 Computer-Aided Design of VLSI Devices (4)

Design of VLSI circuits, design of subsystems using static CMOS, transmission gates, and other methods. Variety of CAD tools for design, verification, test, and simulation. Several design projects. 3 lectures, 1 laboratory. Prerequisite: EE 307&347 with a C- grade or better, EE 308&348 with a C- grade or better or consent of instructor.

EE 432 Digital Control Systems (3) (Also listed as CPE 432)

Theory and applications of digital computers in linear control systems. Discrete time methods are used in analysis and design studies. Digital control systems are synthesized. 3 lectures. Prerequisite: EE 302&342 with a C- grade or better. Prior background in discrete time systems, e.g., EE 328, EE 368 recommended. Concurrent: EE 472.

EE 433 Introduction to Magnetic Design (4)

Design of magnetic components. Fundamentals of magnetics, magnetic cores, design of power transformer, three-phase transformer, dc inductor, ac inductors, dc-dc converter transformer design, actuators. Use of commercially available software. 3 lectures, 1 laboratory. Prerequisite: EE 255&295 or consent of instructor.

EE 438 Digital Computer Systems (3) (Also listed as CPE 438)

Design of computer ALUs, microprogram controllers, memory systems, and I/O controllers. Use of LSI components in CPU design. Microprogram and nanoprogram development. 3 lectures. Prerequisite: EE 427 or consent of instructor.

EE 439 Computer Peripheral Interfacing (4) (Also listed as CPE 439)

Systems-level design and implementation of common computer peripheral devices with emphasis placed on controller and interface aspects. Use of standard and softcore microcontroller platforms with communications to discrete peripherals with I2C, SPI, CAN, and other common bus interfaces. 3 lectures, 1 laboratory. Prerequisite: EE/CPE 329 with a C- grade or better, or consent of instructor.

EE 440 Wireless Communications (3)

Wireless microwave system design and analysis. RF transmission lines, microwave networks, receiver design, modulation techniques, and mixer characterization and realizations. Noise and distortion, RF oscillators and frequency synthesizers, filter design. Radiating systems and electromagnetic wave propagation, microwave amplifier design. 3 lectures. Prerequisite: EE 335, EE 314. Concurrent: EE 480.

EE 443 Fiber Optics Laboratory (1)

Experimental investigation of the properties of optical fibers, sources, and detectors. Measurement of fiber physical characteristics, attenuation, losses,

and bandwidth. Evaluation of an analog and digital fiber optic data link. 1 laboratory. Concurrent: EE 403.

EE 444 Power Systems Laboratory (1)

Protective relaying, coordination, and relay calibration. Power control using transformers, parallel operation of generators, and computer simulation of power systems. 1 laboratory. Prerequisite: EE 406.

EE 445 High Frequency Amplifier Design Laboratory (1)

Experimental investigation employing advanced techniques. Design of high-frequency electronic amplifiers utilizing S-parameters of bipolar transistors, network analyzers, and computer simulation techniques. 1 laboratory. Prerequisite: EE 308&348 with a C- grade or better, EE 335 with a C- grade or better. Concurrent or prerequisite: EE 405.

EE 449 Electronic Design Laboratory (1)

Design of electronic systems and subsystems using integrated circuits. 1 laboratory. Prerequisite: EE 308&348 with a C- grade or better, EE 328&368 with a C- grade or better, EE 329 with a C- grade or better. Concurrent: EE 409.

EE 452 Advanced Analog Circuits Laboratory (1)

Advanced laboratory study of LC and VCO oscillators, phase detectors, phase-locked loop circuits, transducer interface circuits, noise sources and signal-to-noise determination, ADC and DAC for data conversion. Formal experiments and computer SPICE simulation. 1 laboratory. Prerequisite: EE 314, EE 409&449. Concurrent: EE 412.

EE 455 Analog Filter Design Laboratory (1)

Advanced laboratory study of sensitivity and stability of active networks prescribed for realization of transfer functions by active network synthesis techniques. Formal experiments and individual project work. 1 laboratory. Prerequisite: EE 409&449. Concurrent: EE 425.

EE 456 Communication Systems Laboratory (1)

Methods of analog modulation and demodulation. Emphasis on spectral analysis, bandwidth requirements and other practical considerations of modulation and demodulation. 1 laboratory. Prerequisite: EE 328&368 with a C- grade or better, EE 314 with a C- grade or better.

EE 458 Photonic Engineering Laboratory (1)

Experimental investigation of the techniques used in processing optical signals. Formal experiments on electro-optic modulation, acousto-optic modulation. Construction of an RF spectrum analyzer. Analog processing of optical signals, and charge-coupled array devices. 1 laboratory. Concurrent: EE 418.

EE 459 Digital Signal Processing Laboratory (1)

Experiments in digital filter design and digital signal processing emphasizing various areas of applications (communications, audio signals, speech processing). Formal experiments and individual project work. 1 laboratory. Prerequisite: CSC 101, EE 328&368 with a C- grade or better. Concurrent: EE 419.

EE 460 Senior Project Preparation (2)

Introduction to teamwork and team-oriented project execution. Project planning, scheduling and analysis. Usage of tools for project management including Gantt and Pert Charts. Project development, cost and time estimation using top-down and bottom-up approaches. Ethics and ethical issues as they pertain to the conduct of engineering. Development of senior project proposal. 2 lectures. Prerequisite: EE 314 with a C- grade or better, EE 335 with a C- grade or better. Prerequisite or concurrent: EE 409&449.

EE 461, 462 Senior Project I, II (3) (2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 150 hours total time. Prerequisite: EE 409&449, EE 460.

EE 463, 464 Senior Project Design Laboratory I, II (3) (2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. EE 463: 3 laboratories; prerequisite: EE 409&449, EE 460. EE 464: 2 laboratories;

prerequisite: EE 463. Note: although EE 463, 464 substitute for EE 461, 462, students may not use repeat credit for the purpose of increasing GPA.

EE 470 Selected Advanced Topics (1–4)

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 1–4 lectures. Prerequisite: Consent of instructor.

EE 471 Selected Advanced Laboratory (1–4)

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 1–4 laboratories. Prerequisite: Consent of instructor.

**EE 472 Digital Control Systems Laboratory (1)
(Also listed as CPE 472)**

Design and programming of microprocessor-based digital controls for electro-mechanical plants. Topics include digital control laws, translation of transfer functions into algorithms, assembly language programming, real-time software design, sample rate selection, finite word-length considerations. 1 laboratory. Concurrent: EE 432.

EE 480 Wireless Communications Laboratory (1)

Wireless microwave system design and analysis. RF transmission lines, microwave networks, receiver design, modulation techniques, and mixer characterization and realizations. Noise and distortion, RF oscillators and frequency synthesizers, filter design. Radiating systems and electromagnetic wave propagation, microwave amplifier design. 1 laboratory. Prerequisite: EE 335, EE 314. Concurrent: EE 440.

EE 493 Cooperative Education Experience (2) (CR/NC)

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. Total credit limited to 6 units. Prerequisite: Sophomore standing and consent of instructor.

EE 494 Cooperative Education Experience (6) (CR/NC)

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. Total credit limited to 18 units. Prerequisite: Sophomore standing and consent of instructor.

EE 495 Cooperative Education Experience (12) (CR/NC)

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. Total credit limited to 24 units. Prerequisite: Sophomore standing and consent of instructor.

EE 500 Individual Study (1–3)

Advanced study planned and completed under the direction of a member of the department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Prerequisite: Consent of department chair, graduate advisor, and supervising faculty member. Total credit limit at discretion of graduate advisor, not to exceed 9 units.

EE 502 Microwave Engineering (4)

Application of Maxwell's equations and boundary value problems to waveguide structures. Striplines and microstrip lines. S-parameters. Microwave equivalent circuit theorem. Passive microwave devices. Charge and field interactions in oscillators and amplifiers. Transferred electron devices, avalanche transit-time devices, and microwave transistors. Circuits associated with oscillators and reflection type amplifiers. 4 seminars. Prerequisite: EE 402 or equivalent.

EE 511 Electric Machines Theory (4)

Advanced topics in electric machines theory. Introduction to Park's transformation. Analysis of electric machines using Kron's generalized concept. Vector control of induction machines. 4 seminars. Prerequisite: EE 255 or equivalent, and graduate standing or consent of instructor.

EE 513 Control Systems Theory (4)

State representation of dynamic systems. Mathematical models of physical devices, controllability and observability. Design of closed-loop systems. Optimal control theory. 4 seminars. Prerequisite: EE 302 with a C- grade or better or equivalent, and graduate standing or consent of instructor.

EE 514 Advanced Topics in Automatic Control (4)

Summary course covering five selected graduate-level topics in automatic control theory and practice; implementation issues in digital control, nonlinear control theory and design, LQ and time optimal control, variable structure control, and fuzzy logic/model-free control. 4 seminars.

Prerequisite: EE 513 or equivalent, EE 328 with a C- grade or better or similar course on discrete-time linear systems.

EE 515 Discrete Time Filters (4)

Advanced topics in filter design and implementation. Emphasis placed on current applications and on the processing of real signals. Topics may include signal analysis via spectral estimation, short time Fourier transforms, and spectrograms. Effects of coefficient quantization, and limits of practical filters. State space realization. Optimal and adaptive filters for signal prediction, system identification, and noise cancellation. Techniques implemented in programming assignments. 4 seminars. Prerequisite: EE 314 with a C- grade or better or equivalent, and graduate standing or consent of instructor.

EE 517 Information Theory (4)

Introduction to information theory and coding. Self and mutual information. Discrete and continuous information sources and transmission channels. Additive white Gaussian noise channel. Channel capacity. The Source- and Channel-Coding Theorems. Data compression. Huffman code. Block codes, including Hamming and linear codes. Parity and syndrome decoding. Convolutional codes. 4 seminars. Prerequisite: EE 314 with a C- grade or better or equivalent, EE 525, and graduate standing or consent of instructor.

EE 518 Power System Protection (4)

Unsymmetrical faults. Protection fundamentals. Instrument transformers. Power system grounding. Generator protection, transformer protection, busbar protection, line and motor protection. 4 seminars. Prerequisite: EE 407 or equivalent, and graduate standing or consent of instructor.

EE 519 Advanced Analysis of Power Systems (4)

Advanced power system stability analysis, numerical methods in power system analysis. 4 seminars. Prerequisite: EE 406 or equivalent, and graduate standing or consent of instructor.

EE 520 Solar-Photovoltaic Systems Design (4)

Solar radiation and insolation variability. Solar cell theory. Photovoltaic module and array design. Interfacing PV generators with various kinds of loads. Power processing circuits and systems. Energy storage options. Stand-alone and grid-connected systems. Economic and policy issues. 4 seminars. Prerequisite: Graduate standing or consent of instructor.

EE 521 Computer Systems (4)

Organization of modern general purpose, high speed digital computer systems. Arithmetic units, control units, memories and memory subsystems. Peripheral equipment. Cost and speed trade-offs in the design of such systems. 4 seminars. Prerequisite: EE 329 with a C- grade or better, or equivalent, and graduate standing or consent of instructor.

EE 522 Advanced Real-Time Embedded Systems Design (4)
(Also listed as CPE 522)

Theory, design and implementation of real-time operating system-based embedded systems. Scheduling algorithms, operating system resources, peripheral device interfacing and embedded system architecture. Resource management issues in a resource-limited (microcontroller-based) environment. 3 seminars, 1 laboratory. Prerequisite: Advanced C

programming skills, EE 329 with a C- grade or better or equivalent, or consent of instructor. [Changed effective Spring 2009.](#)

EE 523 Digital Systems Design (4)

Design of asynchronous sequential machines. Selected automata theory topics include state compatibility analysis, state partition analysis, threshold logic, fuzzy logic. Modern digital system design. Analysis of MOS-LSI multiphase logic structures. Comparison of digital subsystems.

Microprocessor as a digital subsystem module. 3 seminars, 1 laboratory. Prerequisite: EE 329 with a C- grade or better and EE 307 with a C- grade or better, and graduate standing or consent of instructor.

EE 524 Solid State Electronics (3)

Physical theory of solid-state devices. Properties of metal-semiconductor junctions and p-n junctions. Derivation of properties of diodes, transistors, and four-layer devices from basic physical and mathematical considerations. 3 seminars. Prerequisite: PHYS 412 or equivalent, and graduate standing or consent of instructor.

EE 525 Stochastic Processes for Engineers (4)

Probability and stochastic processes used in random signal analysis. Response of linear systems to random inputs. Auto-correlation and power spectral densities. Applications in signal processing using the discrete Kalman filter. 4 seminars. Prerequisite: STAT 350 or equivalent, and graduate standing or consent of instructor.

EE 526 Digital Communications (4)

M-ary signals. Vector space representation of signals. Optimum receiver principles. Common signal sets. Signal space dimensionality versus time-bandwidth product. 4 seminars. Prerequisite: EE 314 with a C- grade or better or equivalent, EE 525, and graduate standing or consent of instructor.

EE 527 Advanced Topics in Power Electronics (4)

Selected advanced topics in power electronics such as dc-dc converters, phase-controlled rectifiers, switched-mode inverters, ac and dc drives, HVDC transmission, or utility applications of power electronics. 4 seminars. Prerequisite: EE 410 or equivalent, and graduate standing or consent of instructor.

EE 528 Digital Image Processing (4)

Processing and interpretation of images by computer. Emphasis on current applications with real images used in programming assignments. Topics may include histogram equalization, 2-D convolution, correlation, frequency-domain processing, median filtering, compression, Hough transform, segmentation and region growing, morphological operations, texture description, shape description, Bayes classifier. 4 seminars. Prerequisite: EE 314 with a C- grade or better or equivalent, EE 525, and graduate standing or consent of instructor.

EE 529 Advanced Topics in Microwave Device Electronics (3)

Emphasis on device and circuit principles of active microwave solid-state devices, their noise aspects and systems applications. 3 seminars. Prerequisite: EE 402 or equivalent, PHYS 412 or equivalent, and graduate standing or consent of instructor.

EE 530 Fourier Optics (4)

Approach to the design and analysis of optical systems using linear communication theory, including Fourier analysis. Analysis of two-dimensional signals and systems, foundations of scalar diffraction theory. Fresnel and Fraunhofer diffraction. Wave-optics analysis of coherent optical systems, frequency analysis of optical imaging systems, holo-graphy. 4 seminars. Prerequisite: EE 402 or equivalent, EE 314 with a C- grade or better or equivalent, and graduate standing or consent of instructor.

EE 533 Antennas (4)

Principles of antenna theory. Antenna parameters, radiation integrals. Duality and reciprocity theorems. Wire antennas. Antenna arrays. Traveling wave antennas. Broadband and frequency independent antennas. Aperture and reflector antennas. Microstrip antennas. Antenna design. 4 seminars. Prerequisite: EE 402 or equivalent.

EE 541 Advanced Microwave Laboratory (2)

Experimental measurement in waveguide and microstrip circuits employing the advanced Network Analyzer. Design of both passive and active

microwave circuits using microstrip. Graphical and analytical design techniques as well as the use of computer-aided design codes. 2 laboratories. Prerequisite: EE 402 or equivalent. Concurrent or prerequisite: EE 502, and graduate standing or consent of instructor.

EE 544 Solid-state Electronics Laboratory (1)

Experimental procedures in solid-state electronics. Investigation and improvement of the characteristics of a solid-state electronic device. 1 laboratory. Prerequisite: Graduate standing or consent of instructor. Concurrent: EE 524, and graduate standing or consent of instructor.

EE 563 Graduate Seminar (1) (CR/NC)

Current developments in the fields of electrical and electronic engineering. Participation by students, faculty and guest lecturers. Open to graduate students with a background in electrical or electronic engineering. Credit/No Credit grading only. Total credit limited to 3 units. 1 seminar.

EE 570 Selected Advanced Topics (1-4)

Directed group study of selected topics for advanced students. Open to graduate students and selected seniors with electrical and electronic engineering background. The Schedule of Classes will list topic selected. Total credit limited to 8 units. 1-4 seminars. Prerequisite: Graduate standing or consent of instructor.

EE 593 Cooperative Education Experience (2) (CR/NC)

Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

EE 594 Cooperative Education Experience (6) (CR/NC)

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

EE 595 Cooperative Education Experience (12) (CR/NC)

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. A fully-developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

EE 599 Design Project (Thesis) (1-9)

Each individual or group will select, with faculty guidance and approval, a topic for independent research or investigation resulting in a thesis or project to be used to satisfy the requirement for the degree. An appropriate experimental or analytical thesis or project may be accepted. Prerequisite: Graduate standing and consent of instructor.