Electrical Engineering (EL ENG)

Courses

EL ENG 16A Designing Information Devices and Systems I 4 Units
This course and its follow-on EE16B focus on the fundamentals of designing and building modern information devices and systems that interface with the real world. The course sequence provides a comprehensive introduction to core EECS topics in circuit design, signals, and systems in an application-driven context. The courses are delivered assuming mathematical maturity and aptitude at roughly the level of having completed MATH 1A (http://guide.berkeley.edu/search/?P=MATH%201A)-1B, and are aimed at entering students as well as non-majors seeking a broad introduction to the field.
Rules & Requirements

Credit Restrictions: Students will receive no credit for Electrical Engineering 16A after completing Electrical Engineering 20 or 40.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 2 hours of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Alon, Ayazifar, Lustig, Maharbiz, Subramanian, Tomlin, Courtade, Niknejad, Sahai

EL ENG 16B Designing Information Devices and Systems II 4 Units
This course is a follow-on to Electrical Engineering 16A, and focuses on the fundamentals of designing and building modern information devices and systems that interface with the real world. The course sequence provides a comprehensive introduction to core EECS topics in circuit design, signals, and systems in an application-driven context. The courses are delivered assuming mathematical maturity and aptitude at roughly the level of having completed MATH 1A (http://guide.berkeley.edu/search/?P=MATH%201A)-1B, and are aimed at entering students as well as non-majors seeking a broad introduction to the field.
Rules & Requirements

Prerequisites: Electrical Engineering 16A, Designing Information Devices and Systems I

Credit Restrictions: Students will receive no credit for Electrical Engineering 16B after completing Electrical Engineering 20 or 40.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 2 hours of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Alon, Ayazifar, Lustig, Maharbiz, Subramanian, Tomlin

EL ENG 20 Structure and Interpretation of Systems and Signals 4 Units
Mathematical modeling of signals and systems. Continous and discrete signals, with applications to audio, images, video, communications, and control. State-based models, beginning with automata and evolving to LTI systems. Frequency domain models for signals and frequency response for systems, and sampling of continuous-time signals. A Matlab-based laboratory is an integral part of the course.
Rules & Requirements

Prerequisites: Mathematics 1B

Credit Restrictions: Students will receive no credit for Electrical Engineering 20N after completing Electrical Engineering 20. A deficient grade in Electrical Engineering 20 may be removed by taking Electrical Engineering 20N.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Zakhor

EL ENG 24 Freshman Seminar 1 Unit
The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman seminars are offered in all campus departments, and topics may vary from department to department and semester to semester.
Rules & Requirements

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of seminar per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

EL ENG 25 What Electrical Engineers Do--Feedback from Recent Graduates 1 Unit
A Berkeley Electrical Engineering and Computer Sciences degree opens the door to many opportunities, but what exactly are they? Graduation is only a few years away and it's not too early to find out. In this seminar students will hear from practicing engineers who recently graduated. What are they working on? Are they working in a team? What do they wish they had learned better? How did they find their jobs?
Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Instructor: Boser

EL ENG 40 Introduction to Microelectronic Circuits 4 Units
Fundamental circuit concepts and analysis techniques in the context of digital electronic circuits. Transient analysis of CMOS logic gates; basic integrated-circuit technology and layout.
Rules & Requirements

Prerequisites: Mathematics 1B

Credit Restrictions: Students will receive one unit of credit for 40 taking 42 and no credit after taking 100.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, and 6 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 42 Introduction to Digital Electronics 3 Units
This course serves as an introduction to the principles of electrical engineering, starting from the basic concepts of voltage and current and circuit elements of resistors, capacitors, and inductors. Circuit analysis is taught using Kirchhoff's voltage and current laws with Thevenin and Norton equivalents. Operational amplifiers with feedback are introduced as basic building blocks for amplication and filtering. Semiconductor devices including diodes and MOSFETS and their IV characteristics are covered. Applications of diodes for rectification, and design of MOSFETs in common source amplifiers are taught. Digital logic gates and design using CMOS as well as simple flip-flops are introduced. Speed and scaling issues for CMOS are considered. The course includes as motivating examples designs of high level applications including logic circuits, amplifiers, power supplies, and communication links.
Rules & Requirements

Prerequisites: Mathematics 1B

Credit Restrictions: Students will receive no credit for 42 after taking 40 or 100.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 43 Introductory Electronics Laboratory 1 Unit
Using and understanding electronics laboratory equipment such as oscilloscope, power supplies, function generator, multimeter, curve-tracer, and RLC-meter. Includes a term project of constructing and testing a robot or other appropriate electromechanical device.
Rules & Requirements

Prerequisites: 42 (may be taken concurrently) or equivalent or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of laboratory per week

Summer: 8 weeks - 3.5 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 97 Field Study 1 - 4 Units
Students take part in organized individual field sponsored programs with off-campus companies or tutoring/mentoring relevant to specific aspects and applications of computer science on or off campus. Note Summer CPT or OPT students: written report required. Course does not count toward major requirements, but will be counted in the cumulative units toward graduation.
Rules & Requirements

Prerequisites: Consent of instructor (see department adviser)

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of fieldwork per week

Summer:
6 weeks - 2.5-10 hours of fieldwork per week
8 weeks - 2-7.5 hours of fieldwork per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 98 Directed Group Study for Undergraduates 1 - 4 Units
Group study of selected topics in electrical engineering, usually relating to new developments.
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 99 Individual Study and Research for Undergraduates 1 - 4 Units
Supervised independent study and research for students with fewer than 60 units completed.
Rules & Requirements

Prerequisites: Freshman or sophomore standing and consent of instructor. Minimum GPA of 3.4 required

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 100 Electronic Techniques for Engineering 4 Units
This course serves as an introduction to the principles of electrical engineering, starting from the basic concepts of voltage and current and circuit elements of resistors, capacitors, and inductors. Circuit analysis is taught using Kirchhoff's voltage and current laws with Thevenin and Norton equivalents. Operational amplifiers with feedback are introduced as basic building blocks for amplification and filtering. Semiconductor devices including diodes and MOSFETS and their IV characteristics are covered. Applications of diodes for rectification, and design of MOSFETs in common source amplifiers are taught. Digital logic gates and design using CMOS as well as simple flip-flops are introduced. Speed and scaling issues for CMOS are considered. The course includes as motivating examples designs of high level applications including logic circuits, amplifiers, power supplies, and communication links.
Rules & Requirements

Prerequisites: Mathematics 1B

Credit Restrictions: Students will receive one unit of credit for 100 after taking 42 and no credit after taking 40.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 105 Microelectronic Devices and Circuits 4 Units
This course covers the fundamental circuit and device concepts needed to understand analog integrated circuits. After an overview of the basic properties of semiconductors, the p-n junction and MOS capacitors are described and the MOSFET is modeled as a large-signal device. Two port small-signal amplifiers and their realization using single stage and multistage CMOS building blocks are discussed. Sinusoidal steady-state signals are introduced and the techniques of phasor analysis are developed, including impedance and the magnitude and phase response of linear circuits. The frequency responses of single and multi-stage amplifiers are analyzed. Differential amplifiers are introduced.
Rules & Requirements

Prerequisites: 40

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG C106A Introduction to Robotics 4 Units
An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course covers forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and control. It presents elementary principles on proximity, tactile, and force sensing, vision sensors, camera calibration, stereo construction, and motion detection. The course concludes with current applications of robotics in active perception, medical robotics, and other areas.
Rules & Requirements

Prerequisites: EE 120 or equivalent, consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Bajcsy

Formerly known as: Electrical Engineering C125/Bioengineering C125

Also listed as: BIO ENG C125

EL ENG C106B Robotic Manipulation and Interaction 4 Units
This course is a sequel to Electrical Engineering C106A/Bioengineering C125, which covers kinematics, dynamics and control of a single robot. This course will cover dynamics and control of groups of robotic manipulators coordinating with each other and interacting with the environment. Concepts will include an introduction to grasping and the constrained manipulation, contacts and force control for interaction with the environment. We will also cover active perception guided manipulation, as well as the manipulation of non-rigid objects. Throughout, we will emphasize design and human-robot interactions, and applications to applications in manufacturing, service robotics, tele-surgery, and locomotion.
Rules & Requirements

Prerequisites: Electrical Engineering C106A/Bioengineering C125 or consent of the instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructors: Bajcsy, Sastry

Also listed as: BIO ENG 125B

EL ENG 113 Power Electronics 4 Units
Power conversion circuits and techniques. Characterization and design of magnetic devices including transformers, reactors, and electromagnetic machinery. Characteristics of bipolar and MOS power semiconductor devices. Applications to motor control, switching power supplies, lighting, power systems, and other areas as appropriate.
Rules & Requirements

Prerequisites: 105 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 117 Electromagnetic Fields and Waves 4 Units
Review of static electric and magnetic fields and applications; Maxwell's equations; transmission lines; propagation and reflection of plane waves; introduction to guided waves, microwave networks, and radiation and antennas. Minilabs on statics, transmission lines, and waves.
Rules & Requirements

Prerequisites: 40, Mathematics 53, 54, knowledge of phasor analysis (e.g. as taught in 105)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1.5 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Formerly known as: 117A-117B

EL ENG 118 Introduction to Optical Engineering 3 Units
Fundamental principles of optical systems. Geometrical optics and aberration theory. Stops and apertures, prisms, and mirrors. Diffraction and interference. Optical materials and coatings. Radiometry and photometry. Basic optical devices and the human eye. The design of optical systems. Lasers, fiber optics, and holography.
Rules & Requirements

Credit Restrictions: Students will receive no credit for Electrical Engineering 118 after taking Electrical Engineering 218A. A deficient grade in Electrical Engineering 119 may be removed by taking Electrical Engineering 118.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Waller

Formerly known as: Electrical Engineering 119

EL ENG 120 Signals and Systems 4 Units
Continuous and discrete-time transform analysis techniques with illustrative applications. Linear and time-invariant systems, transfer functions. Fourier series, Fourier transform, Laplace and Z-transforms. Sampling and reconstruction. Solution of differential and difference equations using transforms. Frequency response, Bode plots, stability analysis. Illustrated by analysis of communication systems and feedback control systems.
Rules & Requirements

Prerequisites: 20N, Mathematics 53, 54

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture and 1 hour of recitation per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 121 Introduction to Digital Communication Systems 4 Units
Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization. Applications to design of digital telephone modems, compact disks, and digital wireless communication systems. Concepts illustrated by a sequence of MATLAB exercises.
Rules & Requirements

Prerequisites: 120, 126

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 122 Introduction to Communication Networks 4 Units
This course focuses on the fundamentals of the wired and wireless communication networks. The course covers both the architectural principles for making these networks scalable and robust, as well as the key techniques essential for analyzing and designing them. The topics include graph theory, Markov chains, queuing, optimization techniques, the physical and link layers, switching, transport, cellular networks and Wi-Fi.
Rules & Requirements

Prerequisites: Computer Science 70. Computer Science 70

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 123 Digital Signal Processing 4 Units
Discrete time signals and systems: Fourier and Z transforms, DFT, 2-dimensional versions. Digital signal processing topics: flow graphs, realizations, FFT, chirp-Z algorithms, Hilbert transform relations, quantization effects, linear prediction. Digital filter design methods: windowing, frequency sampling, S-to-Z methods, frequency-transformation methods, optimization methods, 2-dimensional filter design.
Rules & Requirements

Prerequisites: 120

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 126 Probability and Random Processes 4 Units
This course covers the fundamentals of probability and random processes useful in fields such as networks, communication, signal processing, and control. Sample space, events, probability law. Conditional probability. Independence. Random variables. Distribution, density functions. Random vectors. Law of large numbers. Central limit theorem. Estimation and detection. Markov chains.
Rules & Requirements

Prerequisites: 20

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 127 Optimization Models in Engineering 4 Units
This course offers an introduction to optimization models and their applications, ranging from machine learning and statistics to decision-making and control, with emphasis on numerically tractable problems, such as linear or constrained least-squares optimization.
Rules & Requirements

Prerequisites: MATH 54 (http://guide.berkeley.edu/search/?P=MATH%2054) or equivalent or consent of instructor

Credit Restrictions: Students will receive no credit for Electrical Engineering 127 after taking Electrical Engineering 227A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: El Ghaoui

EL ENG C128 Feedback Control Systems 4 Units
Analysis and synthesis of linear feedback control systems in transform and time domains. Control system design by root locus, frequency response, and state space methods. Applications to electro-mechanical and mechatronics systems.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Also listed as: MEC ENG C134

EL ENG 129 Neural and Nonlinear Information Processing 3 Units
Principles of massively parallel real-time computation, optimization, and information processing via nonlinear dynamics and analog VLSI neural networks, applications selected from image processing, pattern recognition, feature extraction, motion detection, data compression, secure communication, bionic eye, auto waves, and Turing patterns.
Rules & Requirements

Prerequisites: 120 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Instructor: Chua

EL ENG 130 Integrated-Circuit Devices 4 Units
Overview of electronic properties of semiconductor. Metal-semiconductor contacts, pn junctions, bipolar transistors, and MOS field-effect transistors. Properties that are significant to device operation for integrated circuits. Silicon device fabrication technology.
Rules & Requirements

Prerequisites: 40 or 100

Credit Restrictions: Students will receive no credit for El Eng 130 after taking El Eng 230A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 134 Fundamentals of Photovoltaic Devices 4 Units
This course is designed to give an introduction to, and overview of, the fundamentals of photovoltaic devices. Students will learn how solar cells work, understand the concepts and models of solar cell device physics, and formulate and solve relevant physical problems related to photovoltaic devices. Monocrystalline, thin film and third generation solar cells will be discussed and analyzed. Light management and economic considerations in a solar cell system will also be covered.
Rules & Requirements

Prerequisites: 40 or 100 or Engineering 45

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Arias

EL ENG 137A Introduction to Electric Power Systems 4 Units
Overview of conventional electric power conversion and delivery, emphasizing a systemic understanding of the electric grid with primary focus at the transmission level, aimed toward recognizing needs and opportunities for technological innovation. Topics include aspects of a.c. system design, electric generators, components of transmission and distribution systems, power flow analysis, system planning and operation, performance measures, and limitations of legacy technologies.
Rules & Requirements

Prerequisites: PHYSICS 7B (http://guide.berkeley.edu/search/?P=PHYSICS%207B); Electrical Engineering 40, 100, or Engineering 45; or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: von Meier

EL ENG 137B Introduction to Electric Power Systems 4 Units
Overview of recent and potential future evolution of electric power systems with focus on new and emerging technologies for power conversion and delivery, primarily at the distribution level. Topics include power electronics applications, solar and wind generation, distribution system design and operation, electric energy storage, information management and communications, demand response, and microgrids.
Rules & Requirements

Prerequisites: Electrical Engineering 137A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: von Meier

EL ENG 140 Linear Integrated Circuits 4 Units
Single and multiple stage transistor amplifiers. Operational amplifiers. Feedback amplifiers, 2-port formulation, source, load, and feedback network loading. Frequency response of cascaded amplifiers, gain-bandwidth exchange, compensation, dominant pole techniques, root locus. Supply and temperature independent biasing and references. Selected applications of analog circuits such as analog-to-digital converters, switched capacitor filters, and comparators. Hardware laboratory and design project.
Rules & Requirements

Prerequisites: Electrical Engineering 105

Credit Restrictions: Students will receive no credit for El Eng 140 after taking El Eng 240A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Alon, Sanders

EL ENG 141 Introduction to Digital Integrated Circuits 4 Units
CMOS devices and deep sub-micron manufacturing technology. CMOS inverters and complex gates. Modeling of interconnect wires. Optimization of designs with respect to a number of metrics: cost, reliability, performance, and power dissipation. Sequential circuits, timing considerations, and clocking approaches. Design of large system blocks, including arithmetic, interconnect, memories, and programmable logic arrays. Introduction to design methodologies, including hands-on experience.
Rules & Requirements

Prerequisites: Electrical Engineering 40; Electrical Engineering 105 and Computer Science 150 recommended

Credit Restrictions: Students will receive no credit for Electrical Engineering 141 after taking Electrical Engineering 241A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Alon, Rabaey

EL ENG 142 Integrated Circuits for Communications 4 Units
Analysis and design of electronic circuits for communication systems, with an emphasis on integrated circuits for wireless communication systems. Analysis of noise and distortion in amplifiers with application to radio receiver design. Power amplifier design with application to wireless radio transmitters. Radio-frequency mixers, oscillators, phase-locked loops, modulators, and demodulators.
Rules & Requirements

Prerequisites: EL ENG 20 (http://guide.berkeley.edu/search/?P=EL%20ENG%2020) and El Eng 140

Credit Restrictions: Students will receive no credit for El Eng 142 after taking El Eng 242A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 143 Microfabrication Technology 4 Units
Integrated circuit device fabrication and surface micromachining technology. Thermal oxidation, ion implantation, impurity diffusion, film deposition, expitaxy, lithography, etching, contacts and interconnections, and process integration issues. Device design and mask layout, relation between physical structure and electrical/mechanical performance. MOS transistors and poly-Si surface microstructures will be fabricated in the laboratory and evaluated.
Rules & Requirements

Prerequisites: 40 and PHYSICS 7B (http://guide.berkeley.edu/search/?P=PHYSICS%207B)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG 144 Fundamental Algorithms for Systems Modeling, Analysis, and Optimization 4 Units
The modeling, analysis, and optimization of complex systems requires a range of algorithms and design software. This course reviews the fundamental techniques underlying the design methodology for complex systems, using integrated circuit design as example. Topics include design flows, discrete and continuous models and algorithms, and strategies for implementing algorithms efficiently and correctly in software. Laboratory assignments and a class project will expose students to state-of-the-art tools.
Rules & Requirements

Prerequisites: 20; Computer Science 70 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Keutzer, Lee, Roychowdhury, Seshia

EL ENG C145B Medical Imaging Signals and Systems 4 Units
Biomedical imaging is a clinically important application of engineering, applied mathematics, physics, and medicine. In this course, we apply linear systems theory and basic physics to analyze X-ray imaging, computerized tomography, nuclear medicine, and MRI. We cover the basic physics and instrumentation that characterizes medical image as an ideal perfect-resolution image blurred by an impulse response. This material could prepare the student for a career in designing new medical imaging systems that reliably detect small tumors or infarcts.
Rules & Requirements

Prerequisites: Electrical Engineering 20 and Engineering 7 or equivalent; Knowledge of Matlab or linear algebra assumed

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Conolly

Also listed as: BIO ENG C165

EL ENG C145L Introductory Electronic Transducers Laboratory 3 Units
Laboratory exercises exploring a variety of electronic transducers for measuring physical quantities such as temperature, force, displacement, sound, light, ionic potential; the use of circuits for low-level differential amplification and analog signal processing; and the use of microcomputers for digital sampling and display. Lectures cover principles explored in the laboratory exercises; construction, response and signal to noise of electronic transducers and actuators; and design of circuits for sensing and controlling physical quantities.
Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Derenzo

Also listed as: BIO ENG C145L

EL ENG C145M Introductory Microcomputer Interfacing Laboratory 3 Units
Laboratory exercises constructing basic interfacing circuits and writing 20-100 line C programs for data acquisition, storage, analysis, display, and control. Use of the IBM PC with microprogrammable digital counter/timer, parallel I/O port. Circuit components include anti-aliasing filters, the S/H amplifier, A/D and D/A converters. Exercises include effects of aliasing in periodic sampling, fast Fourier transforms of basic waveforms, the use of the Hanning filter for leakage reduction, Fourier analysis of the human voice, digital filters, and control using Fourier deconvolution. Lectures cover principles explored in the lab exercises and design of microcomputer-based systems for data acquisitions, analysis and control.
Rules & Requirements

Prerequisites: 40, COMPSCI 61B (http://guide.berkeley.edu/search/?P=COMPSCI%2061B) or a working knowledge of ANSI C programming or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Derenzo

Also listed as: BIO ENG C145M

EL ENG C145O Laboratory in the Mechanics of Organisms 3 Units
Introduction to laboratory and field study of the biomechanics of animals and plants using fundamental biomechanical techniques and equipment. Course has a series of rotations involving students in experiments demonstrating how solid and fluid mechanics can be used to discover the way in which diverse organisms move and interact with their physical environment. The laboratories emphasize sampling methodology, experimental design, and statistical interpretation of results. Latter third of course devoted to independent research projects. Written reports and class presentation of project results are required.
Rules & Requirements

Prerequisites: Integrative Biology 135 or consent of instructor; for Electrical Engineering and Computer Science students, Electrical Engineering 105, 120 or Computer Science 184

Credit Restrictions: Students will receive no credit for C135L after taking 135L.

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory, 1 hour of discussion, and 1 hour of fieldwork per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Formerly known as: Integrative Biology 135L

Also listed as: BIO ENG C136L/INTEGBI C135L

EL ENG 146L Application Specific Integrated Circuits Laboratory 2 Units
This is a lab course that covers the design of modern Application-Specific Integrated Circuits (ASICs). The labs lay the foundation of modern digital design by first setting-up the scripting and hardware description language base for specification of digital systems and interactions with tool flows. Software testing of digital designs is covered leading into a set of labs that cover the design flow. Digital synthesis, floorplanning, placement and routing are covered, as well as tools to evaluate design timing and power. Chip-level assembly is covered, instantiation of custom IP blocks: I/O pads, memories, PLLs, etc. The labs culminate with a project design – implementation of a 3-stage RISC-V processor with register file and caches.
Objectives Outcomes

Course Objectives: This course is a one-time offering to supplement the CS150 course offered in the Fall 2014, with a lab and project section that cover the Application-Specific Integrated Circuit Design. The CS150 lectures in the Fall 2014 already covered the necessary lecture material, so students who took the CS150 lab in the Fall of 2014 will have a chance to expand their skills into the area of Application-Specific Integrated Circuit design.
Hence the pre-requisite for this course is that a student has taken the CS150 course in the Fall 2014.

Rules & Requirements

Prerequisites: Electrical Engineering 40; Electrical Engineering 105 recommended and Computer Science 150 (taken Fall 2014) - mandatory

Credit Restrictions: Students will receive no credit for Electrical Engineering 146L after taking Fall 2014 version of Electrical Engineering 141/241A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of laboratory and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Instructor: Stojanovic

EL ENG 147 Introduction to Microelectromechanical Systems (MEMS) 3 Units
This course will teach fundamentals of micromachining and microfabrication techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are central to MEMS fabrication. It will pay special attention to teaching of fundamentals necessary for the design and analysis of devices and systems in mechanical, electrical, fluidic, and thermal energy/signal domains, and will teach basic techniques for multi-domain analysis. Fundamentals of sensing and transduction mechanisms including capacitive and piezoresistive techniques, and design and analysis of micmicromachined miniature sensors and actuators using these techniques will be covered.
Rules & Requirements

Prerequisites: Electrical Engineering 40 or 100 or consent of instructor

Credit Restrictions: Students will receive no credit for El Eng 147 after taking El Eng 247A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Maharbiz, Nguyen, Pister

EL ENG C149 Introduction to Embedded Systems 4 Units
This course introduces students to the basics of models, analysis tools, and control for embedded systems operating in real time. Students learn how to combine physical processes with computation. Topics include models of computation, control, analysis and verification, interfacing with the physical world, mapping to platforms, and distributed embedded systems. The course has a strong laboratory component, with emphasis on a semester-long sequence of projects.
Rules & Requirements

Prerequisites: 20N; Computer Science 61C; Computer Science 70 or Math 55

Credit Restrictions: Students will receive no credit for Electrical Engineering C149/Computer Science C149 after
taking Electrical Engineering C249M/Computer Science C249M. Students may remove a deficient grade in Electrical Engineering C149/Computer Science C149 after taking Electrical Engineering 124.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Lee, Seshia

Also listed as: COMPSCI C149

EL ENG 192 Mechatronic Design Laboratory 4 Units
Design project course, focusing on application of theoretical principles in electrical engineering to control of a small-scale system, such as a mobile robot. Small teams of students will design and construct a mechatronic system incorporating sensors, actuators, and intelligence.
Rules & Requirements

Prerequisites: 120, Computer Science 61B or 61C, 150 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 1.5 hours of lecture and 10 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Fearing

EL ENG 194 Special Topics 1 - 4 Units
Topics will vary semester to semester. See the Electrical Engineering announcements.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit as topic varies. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

EL ENG H196A Senior Honors Thesis Research 1 - 4 Units
Thesis work under the supervision of a faculty member. A minimum of four units must be taken; the units may be distributed between one and two semesters in any way. To obtain credit a satisfactory thesis must be submitted at the end of the two semesters to the Electrical and Engineering and Computer Science Department archive. Students who complete four units and a thesis in one semester receive a letter grade at the end of H196A. Students who do not, receive an IP in H196A and must enroll in H196B.
Rules & Requirements

Prerequisites: Open only to students in the Electrical Engineering and Computer Science honors program

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. This is part one of a year long series course. A provisional grade of IP (in progress) will be applied and later replaced with the final grade after completing part two of the series. Final exam required.

EL ENG H196B Senior Honors Thesis Research 1 - 4 Units
Thesis work under the supervision of a faculty member. A minimum of four units must be taken; the units may be distributed between one and two semesters in any way. To obtain credit a satisfactory thesis must be submitted at the end of the two semesters to the Electrical and Engineering and Computer Science Department archive. Students who complete four units and a thesis in one semester receive a letter grade at the end of H196A. Students who do not, receive an IP in H196A and must enroll in H196B.
Rules & Requirements

Prerequisites: Open only to students in the Electrical Engineering and Computer Science honors program

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Letter grade. This is part two of a year long series course. Upon completion, the final grade will be applied to both parts of the series. Final exam required.

EL ENG 197 Field Study 1 - 4 Units
Students take part in organized individual field sponsored programs with off-campus companies or tutoring/mentoring relevant to specific aspects and applications of computer science on or off campus. Note Summer CPT or OPT students: written report required. Course does not count toward major requirements, but will be counted in the cumulative units toward graduation.
Rules & Requirements

Prerequisites: Consent of instructor (see department adviser)

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of fieldwork per week

Summer:
6 weeks - 2.5-10 hours of fieldwork per week
8 weeks - 2-7.5 hours of fieldwork per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 198 Directed Group Study for Advanced Undergraduates 1 - 4 Units
Group study of selected topics in electrical engineering, usually relating to new developments.
Rules & Requirements

Prerequisites: 2.0 GPA or better; 60 units completed

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 199 Supervised Independent Study 1 - 4 Units
Supervised independent study. Enrollment restrictions apply.
Rules & Requirements

Prerequisites: Consent of instructor and major adviser

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG 206A Introduction to Robotics 4 Units
An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course will cover forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics and control-position, and force control. Proximity, tactile, and force sensing. Network modeling, stability, and fidelity in teleoperation and medical applications of robotics.
Rules & Requirements

Prerequisites: 120 or equivalent, or consent of instructor

Credit Restrictions: Students will receive no credit for 206A after taking C125/Bioengineering C125 or EE C106A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Bajcsy

Formerly known as: Electrical Engineering 215A

EL ENG 210 Applied Electromagnetic Theory 3 Units
Advanced treatment of classical electromagnetic theory with engineering applications. Boundary value problems in electrostatics. Applications of Maxwell's Equations to the study of waveguides, resonant cavities, optical fiber guides, Gaussian optics, diffraction, scattering, and antennas.
Rules & Requirements

Prerequisites: 117, or PHYSICS 110A (http://guide.berkeley.edu/search/?P=PHYSICS%20110A), 110B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 210A-210B

EL ENG C213 Soft X-rays and Extreme Ultraviolet Radiation 3 Units
This course will explore modern developments in the physics and applications of soft x-rays. It begins with a review of electromagnetic radiation at short wavelengths including dipole radiation, scattering and refractive index, using a semi-classical atomic model. Subject matter will include the generation of x-rays with laboratory tubes, synchrotron radiation, laser-plasma sources, x-ray lasers, and black body radiation. Concepts of spatial and temporal coherence will be discussed.
Rules & Requirements

Prerequisites: Physics 110, 137, and Mathematics 53, 54 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: El Engineering 290G

Also listed as: AST C210

EL ENG 218A Introduction to Optical Engineering 3 Units
Fundamental principles of optical systems. Geometrical optics and aberration theory. Stops and apertures, prisms, and mirrors. Diffraction and interference. Optical materials and coatings. Radiometry and photometry. Basic optical devices and the human eye. The design of optical systems. Lasers, fiber optics, and holography.
Rules & Requirements

Credit Restrictions: Students will receive no credit for Electrical Engineering 218A after taking Electrical Engineering 118 or 119.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Waller

EL ENG 219A Numerical Simulation and Modeling 4 Units
Numerical simulation and modeling are enabling technologies that pervade science and engineering. This course provides a detailed introduction to the fundamental principles of these technologies and their translation to engineering practice. The course emphasizes hands-on programming in MATLAB and application to several domains, including circuits, nanotechnology, and biology.
Rules & Requirements

Prerequisites: Consent of instructor; a course in linear algebra and on circuits is very useful

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Roychowdhury

EL ENG 219B Logic Synthesis 4 Units
The course covers the fundamental techniques for the design and analysis of digital circuits. The goal is to provide a detailed understanding of basic logic synthesis and analysis algorithms, and to enable students to apply this knowledge in the design of digital systems and EDA tools. The course will present combinational circuit optimization (two-level and multi-level synthesis), sequential circuit optimization (state encoding, retiming), timing analysis, testing, and logic verification.
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 219C Computer-Aided Verification 3 Units
Introduction to the theory and practice of formal methods for the design and analysis of systems, with a focus on automated algorithmic techniques. Covers selected topics in computational logic and automata theory including formal models of reactive systems, temporal logic, model checking, and automated theorem proving. Applications in hardware and software verification, analysis of embedded, real-time, and hybrid systems, computer security, synthesis, planning, constraint solving, and other areas will be explored as time permits.
Rules & Requirements

Prerequisites: Consent of instructor; Computer Science 170 is recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Seshia

EL ENG C219D Concurrent Models of Computation 3 Units
Theory and practice of concurrent models of computation (MoCs) with applications to software systems, embedded systems, and cyber-physical systems. Analysis for boundedness, deadlock, and determinacy; formal semantics (fixed point semantics and metric-space models); composition; heterogeneity; and model-based design. MoCs covered may include process networks, threads, message passing, synchronous/reactive, dataflow, rendezvous, time-triggered, discrete events, and continuous time.
Rules & Requirements

Repeat rules: Course may be repeated for credit with consent of instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Lee

Also listed as: COMPSCI C219D

EL ENG C220A Advanced Control Systems I 3 Units
Input-output and state space representation of linear continuous and discrete time dynamic systems. Controllability, observability, and stability. Modeling and identification. Design and analysis of single and multi-variable feedback control systems in transform and time domain. State observer. Feedforward/preview control. Application to engineering systems.
Rules & Requirements

Repeat rules: Students will receive no credit for Electrical Engineering C220A after taking Mechanical Engineering 232. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Borrelli, Horowitz, Tomizuka, Tomlin

Also listed as: MEC ENG C232

EL ENG C220B Experiential Advanced Control Design I 3 Units
Experience-based learning in the design of SISO and MIMO feedback controllers for linear systems. The student will master skills needed to apply linear control design and analysis tools to classical and modern control problems. In particular, the participant will be exposed to and develop expertise in two key control design technologies: frequency-domain control synthesis and time-domain optimization-based approach.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C231A

EL ENG C220C Experiential Advanced Control Design II 3 Units
Experience-based learning in the design, analysis, and verification of automatic control systems. The course emphasizes the use of computer-aided design techniques through case studies and design tasks. The student will master skills needed to apply advanced model-based control analysis, design, and estimation to a variety of industrial applications. The role of these specific design methodologies within the larger endeavor of control design is also addressed.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C231B

EL ENG 221A Linear System Theory 4 Units
Basic system concepts; state-space and I/O representation. Properties of linear systems. Controllability, observability, minimality, state and output-feedback. Stability. Observers. Characteristic polynomial. Nyquist test.
Rules & Requirements

Prerequisites: 120; Mathematics 110 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of recitation per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 222 Nonlinear Systems--Analysis, Stability and Control 3 Units
Basic graduate course in non-linear systems. Second Order systems. Numerical solution methods, the describing function method, linearization. Stability - direct and indirect methods of Lyapunov. Applications to the Lure problem - Popov, circle criterion. Input-Output stability. Additional topics include: bifurcations of dynamical systems, introduction to the "geometric" theory of control for nonlinear systems, passivity concepts and dissipative dynamical systems.
Rules & Requirements

Prerequisites: 221A (may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 223 Stochastic Systems: Estimation and Control 3 Units
Parameter and state estimation. System identification. Nonlinear filtering. Stochastic control. Adaptive control.
Rules & Requirements

Prerequisites: 226A (which students are encouraged to take concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 224A Digital Communications 4 Units
Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding; channel coding; baseband and passband modulation techniques; receiver design; channel equalization; information theoretic techniques; block, convolutional, and trellis coding techniques; multiuser communications and spread spectrum; multi-carrier techniques and FDM; carrier and symbol synchronization. Applications to design of digital telephone modems, compact disks, and digital wireless communication systems are illustrated. The concepts are illustrated by a sequence of MATLAB exercises.
Rules & Requirements

Prerequisites: 120 and 126, or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 224

EL ENG 224B Fundamentals of Wireless Communication 3 Units
Introduction of the fundamentals of wireless communication. Modeling of the wireless multipath fading channel and its basic physical parameters. Coherent and noncoherent reception. Diversity techniques over time, frequency, and space. Spread spectrum communication. Multiple access and interference management in wireless networks. Frequency re-use, sectorization. Multiple access techniques: TDMA, CDMA, OFDM. Capacity of wireless channels. Opportunistic communication. Multiple antenna systems: spatial multiplexing, space-time codes. Examples from existing wireless standards.
Rules & Requirements

Prerequisites: 121, 226A, or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Tse

EL ENG 225A Digital Signal Processing 3 Units
Advanced techniques in signal processing. Stochastic signal processing, parametric statistical signal models, and adaptive filterings. Application to spectral estimation, speech and audio coding, adaptive equalization, noise cancellation, echo cancellation, and linear prediction.
Rules & Requirements

Prerequisites: 123 and 126 or solid background in stochastic processes

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Gastpar, Bahai

EL ENG 225B Digital Image Processing 3 Units
2-D sequences and systems, separable systems, projection slice thm, reconstruction from projections and partial Fourier information, Z transform, different equations, recursive computability, 2D DFT and FFT, 2D FIR filter design; human eye, perception, psychophysical vision properties, photometry and colorimetry, optics and image systems; image enhancement, image restoration, geometrical image modification, morphological image processing, halftoning, edge detection, image compression: scalar quantization, lossless coding, huffman coding, arithmetic coding dictionary techniques, waveform and transform coding DCT, KLT, Hadammard, multiresolution coding pyramid, subband coding, Fractal coding, vector quantization, motion estimation and compensation, standards: JPEG, MPEG, H.xxx, pre- and post-processing, scalable image and video coding, image and video communication over noisy channels.
Rules & Requirements

Prerequisites: 123

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Zakhor

EL ENG C225E Principles of Magnetic Resonance Imaging 4 Units
Fundamentals of MRI including signal-to-noise ratio, resolution, and contrast as dictated by physics, pulse sequences, and instrumentation. Image reconstruction via 2D FFT methods. Fast imaging reconstruction via convolution-back projection and gridding methods and FFTs. Hardware for modern MRI scanners including main field, gradient fields, RF coils, and shim supplies. Software for MRI including imaging methods such as 2D FT, RARE, SSFP, spiral and echo planar imaging methods.
Objectives Outcomes

Course Objectives: Graduate level understanding of physics, hardware, and systems engineering description of image formation, and image reconstruction in MRI. Experience in Imaging with different MR Imaging systems. This course should enable students to begin graduate level research at Berkeley (Neuroscience labs, EECS and Bioengineering), LBNL or at UCSF (Radiology and Bioengineering) at an advanced level and make research-level contribution

Rules & Requirements

Prerequisites: Either Electrical Engineering 120 or Bioengineering C165/ Electrical Engineering C145B or consent of instructor

Credit Restrictions: Students will receive no credit for Bioengineering C265/El Engineering C225E after taking El Engineering 265.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Lustig, Conolly

Also listed as: BIO ENG C265

EL ENG 225D Audio Signal Processing in Humans and Machines 3 Units
Introduction to relevant signal processing and basics of pattern recognition. Introduction to coding, synthesis, and recognition. Models of speech and music production and perception. Signal processing for speech analysis. Pitch perception and auditory spectral analysis with applications to speech and music. Vocoders and music synthesizers. Statistical speech recognition, including introduction to Hidden Markov Model and Neural Network approaches.
Rules & Requirements

Prerequisites: 123 or equivalent; Statistics 200A or equivalent; or graduate standing and consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Morgan

EL ENG 226A Random Processes in Systems 4 Units
Probability, random variables and their convergence, random processes. Filtering of wide sense stationary processes, spectral density, Wiener and Kalman filters. Markov processes and Markov chains. Gaussian, birth and death, poisson and shot noise processes. Elementary queueing analysis. Detection of signals in Gaussian and shot noise, elementary parameter estimation.
Rules & Requirements

Prerequisites: 120 and Statistics 200A or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Anantharam

Formerly known as: 226

EL ENG 226B Applications of Stochastic Process Theory 2 Units
Advanced topics such as: Martingale theory, stochastic calculus, random fields, queueing networks, stochastic control.
Rules & Requirements

Prerequisites: 226A

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Anantharam, Varaiya

EL ENG 227AT Optimization Models in Engineering 4 Units
This course offers an introduction to optimization models and their applications, ranging from machine learning and statistics to decision-making and control, with emphasis on numerically tractable problems, such as linear or constrained least-squares optimization.
Rules & Requirements

Prerequisites: Mathematics 54 or equivalent or consent of instructor

Credit Restrictions: Students will receive no credit for Electrical Engineering 227AT after taking Electrical Engineering 127.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: El Ghaoui

EL ENG 227BT Convex Optimization 4 Units
Convex optimization is a class of nonlinear optimization problems where the objective to be minimized, and the constraints, are both convex. The course covers some convex optimization theory and algorithms, and describes various applications arising in engineering design, machine learning and statistics, finance, and operations research. The course includes laboratory assignments, which consist of hands-on experiments with the optimization software CVX, and a discussion section.
Rules & Requirements

Prerequisites: Mathematics 54 and Statistics 2 or equivalents

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: El Ghaoui, Wainwright

Formerly known as: Electrical Engineering 227A

EL ENG C227C Convex Optimization and Approximation 3 Units
Convex optimization as a systematic approximation tool for hard decision problems. Approximations of combinatorial optimization problems, of stochastic programming problems, of robust optimization problems (i.e., with optimization problems with unknown but bounded data), of optimal control problems. Quality estimates of the resulting approximation. Applications in robust engineering design, statistics, control, finance, data mining, operations research.
Rules & Requirements

Prerequisites: 227A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: El Ghaoui

Also listed as: IND ENG C227B

EL ENG C227T Introduction to Convex Optimization 4 Units
The course covers some convex optimization theory and algorithms, and describes various applications arising in engineering design, machine learning and statistics, finance, and operations research. The course includes laboratory assignments, which consist of hands-on experience.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: El Ghaoui, Wainwright

Formerly known as: Electrical Engineering C227A/Industrial Engin and Oper Research C227A

Also listed as: IND ENG C227A

EL ENG 228A High Speed Communications Networks 3 Units
Descriptions, models, and approaches to the design and management of networks. Optical transmission and switching technologies are described and analyzed using deterministic, stochastic, and simulation models. FDDI, DQDB, SMDS, Frame Relay, ATM, networks, and SONET. Applications demanding high-speed communication.
Rules & Requirements

Prerequisites: 122, 226A (may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 229A Information Theory and Coding 3 Units
Fundamental bounds of Shannon theory and their application. Source and channel coding theorems. Galois field theory, algebraic error-correction codes. Private and public-key cryptographic systems.
Rules & Requirements

Prerequisites: 226 recommended, Statistics 200A or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Anantharam, Tse

Formerly known as: 229

EL ENG 229B Error Control Coding 3 Units
Error control codes are an integral part of most communication and recording systems where they are primarily used to provide resiliency to noise. In this course, we will cover the basics of error control coding for reliable digital transmission and storage. We will discuss the major classes of codes that are important in practice, including Reed Muller codes, cyclic codes, Reed Solomon codes, convolutional codes, concatenated codes, turbo codes, and low density parity check codes. The relevant background material from finite field and polynomial algebra will be developed as part of the course. Overview of topics: binary linear block codes; Reed Muller codes; Galois fields; linear block codes over a finite field; cyclic codes; BCH and Reed Solomon codes; convolutional codes and trellis based decoding, message passing decoding algorithms; trellis based soft decision decoding of block codes; turbo codes; low density parity check codes.
Rules & Requirements

Prerequisites: 126 or equivalent (some familiarity with basic probability). Prior exposure to information theory not necessary

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Anatharam

EL ENG 230A Integrated-Circuit Devices 4 Units
Overview of electronic properties of semiconductors. Metal-semiconductor contacts, pn junctions, bipolar transistors, and MOS field-effect transistors. Properties that are significant to device operation for integrated circuits. Silicon device fabrication technology.
Rules & Requirements

Prerequisites: 40 or 100

Credit Restrictions: Students will receive no credit for Electrical Engineering 230A after taking Electrical Engineering 130.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering 230M

EL ENG 230B Solid State Devices 4 Units
Physical principles and operational characteristics of semiconductor devices. Emphasis is on MOS field-effect transistors and their behaviors dictated by present and probable future technologies. Metal-oxide-semiconductor systems, short-channel and high field effects, device modeling, and impact on analog, digital circuits.
Rules & Requirements

Prerequisites: 130 or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Subramanian, King Liu, Salahuddin

Formerly known as: Electrical Engineering 231

EL ENG 230C Solid State Electronics 3 Units
Crystal structure and symmetries. Energy-band theory. Cyclotron resonance. Tensor effective mass. Statistics of electronic state population. Recombination theory. Carrier transport theory. Interface properties. Optical processes and properties.
Rules & Requirements

Prerequisites: 131; PHYSICS 137B (http://guide.berkeley.edu/search/?P=PHYSICS%20137B)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Bokor, Salahuddin

Formerly known as: Electrical Engineering 230

EL ENG W230A Integrated-Circuit Devices 4 Units
Overview of electronic properties of semiconductors. Metal-semiconductor contacts, pn junctions, bipolar transistors, and MOS field-effect transistors. Properties that are significant to device operation for integrated circuits. Silicon device fabrication technology.
Rules & Requirements

Prerequisites: MAS-IC students only

Credit Restrictions: Students will receive no credit for Electrical Engineering W230A after taking Electrical Engineering 130, Electrical Engineering W130 or Electrical Engineering 230A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

Summer: 10 weeks - 4.5 hours of web-based lecture and 1.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Javey, Subramanian, King Liu

Formerly known as: Electrical Engineering W130

EL ENG W230B Solid State Devices 4 Units
Physical principles and operational characteristics of semiconductor devices. Emphasis is on MOS field-effect transistors and their behaviors dictated by present and probable future technologies. Metal-oxide-semiconductor systems, short-channel and high field effects, device modeling, and impact on analog, digital circuits.
Rules & Requirements

Prerequisites: EE W230A or equivalent; MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W230B after taking EE 230B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

Summer: 10 weeks - 4.5 hours of web-based lecture and 1.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Subramanian, King Liu, Salahuddin

Formerly known as: Electrical Engineering W231

EL ENG 232 Lightwave Devices 4 Units
This course is designed to give an introduction and overview of the fundamentals of optoelectronic devices. Topics such as optical gain and absorption spectra, quantization effects, strained quantum wells, optical waveguiding and coupling, and hetero p-n junction will be covered. This course will focus on basic physics and design principles of semiconductor diode lasers, light emitting diodes, photodetectors and integrated optics. Practical applications of the devices will be also discussed.
Rules & Requirements

Prerequisites: Electrical Engineering 130 or equivalent; PHYSICS 137A (http://guide.berkeley.edu/search/?P=PHYSICS%20137A) and Electrical Engineering 117 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Wu

EL ENG C235 Nanoscale Fabrication 4 Units
This course discusses various top-down and bottom-up approaches to synthesizing and processing nanostructured materials. The topics include fundamentals of self assembly, nano-imprint lithography, electron beam lithography, nanowire and nanotube synthesis, quantum dot synthesis (strain patterned and colloidal), postsynthesis modification (oxidation, doping, diffusion, surface interactions, and etching techniques). In addition, techniques to bridging length scales such as heterogeneous integration will be discussed. We will discuss new electronic, optical, thermal, mechanical, and chemical properties brought forth by the very small sizes.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Chang-Hasnain

Also listed as: NSE C203

EL ENG 236A Quantum and Optical Electronics 3 Units
Interaction of radiation with atomic and semiconductor systems, density matrix treatment, semiclassical laser theory (Lamb's), laser resonators, specific laser systems, laser dynamics, Q-switching and mode-locking, noise in lasers and optical amplifiers. Nonlinear optics, phase-conjugation, electrooptics, acoustooptics and magnetooptics, coherent optics, stimulated Raman and Brillouin scattering.
Rules & Requirements

Prerequisites: 117A, PHYSICS 137A (http://guide.berkeley.edu/search/?P=PHYSICS%20137A) or equivalent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG C239 Partially Ionized Plasmas 3 Units
Introduction to partially ionized, chemically reactive plasmas, including collisional processes, diffusion, sources, sheaths, boundaries, and diagnostics. DC, RF, and microwave discharges. Applications to plasma-assisted materials processing and to plasma wall interactions.
Rules & Requirements

Prerequisites: An upper division course in electromagnetics or fluid dynamics

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 239

Also listed as: AST C239

EL ENG 240A Analog Integrated Circuits 4 Units
Single and multiple stage transistor amplifiers. Operational amplifiers. Feedback amplifiers, 2-port formulation, source, load, and feedback network loading. Frequency response of cascaded amplifiers, gain-bandwidth exchange, compensation, dominant pole techniques, root locus. Supply and temperature independent biasing and references. Selected applications of analog circuits such as analog-to-digital converters, switched capacitor filters, and comparators. Hardware laboratory and design project.
Rules & Requirements

Prerequisites: Electrical Engineering 105

Credit Restrictions: Students will receive no credit for Electrical Engineering 240A after taking El ectrical Engineering 140.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Sanders, Nguyen

EL ENG 240B Advanced Analog Integrated Circuits 3 Units
Analysis and optimized design of monolithic operational amplifiers and wide-band amplifiers; methods of achieving wide-band amplification, gain-bandwidth considerations; analysis of noise in integrated circuits and low noise design. Precision passive elements, analog switches, amplifiers and comparators, voltage reference in NMOS and CMOS circuits, Serial, successive-approximation, and parallel analog-to-digital converters. Switched-capacitor and CCD filters. Applications to codecs, modems.
Rules & Requirements

Prerequisites: 140

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering 240

EL ENG 240C Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits 3 Units
Architectural and circuit level design and analysis of integrated analog-to-digital and digital-to-analog interfaces in CMOS and BiCMOS VLSI technology. Analog-digital converters, digital-analog converters, sample/hold amplifiers, continuous and switched-capacitor filters. RF integrated electronics including synthesizers, LNA's, and baseband processing. Low power mixed signal design. Data communications functions including clock recovery. CAD tools for analog design including simulation and synthesis.
Rules & Requirements

Prerequisites: Electrical Engineering 140

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Boser

Formerly known as: Electrical Engineering 247

EL ENG W240A Analog Integrated Circuits 4 Units
Single and multiple stage transistor amplifiers. Operational amplifiers. Feedback amplifiers, 2-port formulation, source, load, and feedback network loading. Frequency response of cascaded amplifiers, gain-bandwidth exchange, compensation, dominant pole techniques, root locus. Supply and temperature independent biasing and references. Selected applications of analog circuits such as analog-to-digital converters, switched capacitor filters, and comparators.
Rules & Requirements

Prerequisites: MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W240A after taking EE 140 or EE 240A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

Summer: 10 weeks - 4.5 hours of web-based lecture and 1.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Alon, Sanders, Nguyen

EL ENG W240B Advanced Analog Integrated Circuits 3 Units
Analysis and optimized design of monolithic operational amplifiers and wide-band amplifiers; methods of achieving wide-band amplification, gain-bandwidth considerations; analysis of noise in integrated circuits and low noise design. Precision passive elements, analog switches, amplifiers and comparators, voltage reference in NMOS and CMOS circuits, Serial, successive-approximation, and parallel analog-to-digital converts. Switched-capacitor and CCD filters. Applications to codecs, modems.
Rules & Requirements

Prerequisites: EE W240A; MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W240B after taking EE 240B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week

Summer: 10 weeks - 4.5 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering W240

EL ENG W240C Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits 3 Units
Architectural and circuit level design and analysis of integrated analog-to-digital and digital-to-analog interfaces in modern CMOS and BiCMOS VLSI technology. Analog-digital converters, digital-analog converters, sample/hold amplifiers, continuous and switched-capacitor filters. Low power mixed signal design techniques. Data communications systems including interface circuity. CAD tools for analog design for simulation and synthesis.
Rules & Requirements

Prerequisites: EE W240A; MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W240C after taking EE 240C.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week

Summer: 10 weeks - 4.5 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Boser

Formerly known as: Electrical Engineering W247

EL ENG 241A Introduction to Digital Integrated Circuits 4 Units
CMOS devices and deep sub-micron manufacturing technology. CMOS inverters and complex gates. Modeling of interconnect wires. Optimization of designs with respect to a number of metrics: cost, reliability, performance, and power dissipation. Sequential circuits, timing considerations, and clocking approaches. Design of large system blocks, including arithmetic, interconnect, memories, and programmable logic arrays. Introduction to design methodologies, including hands-on laboratory experience.
Rules & Requirements

Prerequisites: Electrical Engineering 40; Electrical Engineering 105 and Computer Science 150 recommended

Credit Restrictions: Students will receive no credit for Electrical Engineering 241A after taking Electrical Engineering 141.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Alon, Rabaey, Nikolic

EL ENG 241B Advanced Digital Integrated Circuits 3 Units
Analysis and design of MOS and bipolar large-scale integrated circuits at the circuit level. Fabrication processes, device characteristics, parasitic effects static and dynamic digital circuits for logic and memory functions. Calculation of speed and power consumption from layout and fabrication parameters. ROM, RAM, EEPROM circuit design. Use of SPICE and other computer aids.
Rules & Requirements

Prerequisites: 141

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nikolic, Rabaey

Formerly known as: Electrical Engineering 241

EL ENG W241A Introduction to Digital Integrated Circuits 4 Units
CMOS devices and deep sub-micron manufacturing technology. CMOS inverters and complex gates. Modeling of interconnect wires. Optimization of designs with respect to a number of metrics: cost, reliability, performance, and power dissipation. Sequential circuits, timing considerations, and clocking approaches. Design of large system blocks, including arithmetic, interconnect, memories, and programmable logic arrays. Introduction to design methodologies, including laboratory experience.
Rules & Requirements

Prerequisites: MAS-IC students only

Credit Restrictions: Students will receive no credit for W241A after taking EE 141 or EE 241A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 4 hours of web-based discussion per week

Summer: 10 weeks - 4.5 hours of web-based lecture and 6 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Alon, Rabaey, Nikolic

EL ENG W241B Advanced Digital Integrated Circuits 3 Units
Analysis and design of MOS and bipolar large-scale integrated circuits at the circuit level. Fabrication processes, device characteristics, parasitic effects static and dynamic digital circuits for logic and memory functions. Calculation of speed and power consumption from layout and fabrication parameters. ROM, RAM, EEPROM circuit design. Use of SPICE and other computer aids.
Rules & Requirements

Prerequisites: EE W241A; MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W241B after taking EE 241B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week

Summer: 10 weeks - 4.5 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nikolic, Rabaey

Formerly known as: Electrical Engineering W241

EL ENG 242A Integrated Circuits for Communications 4 Units
Analysis and design of electronic circuits for communication systems, with an emphasis on integrated circuits for wireless communication systems. Analysis of noise and distortion in amplifiers with application to radio receiver design. Power amplifier design with application to wireless radio transmitters. Radio-frequency mixers, oscillators, phase-locked loops, modulators, and demodulators.

Rules & Requirements

Prerequisites: 20N and 140 or equivalent

Credit Restrictions: Students will receive no credit for Electrical Engineering 242A after taking Electrical Engineering 142.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering 242M

EL ENG 242B Advanced Integrated Circuits for Communications 3 Units
Analysis, evaluation and design of present-day integrated circuits for communications application, particularly those for which nonlinear response must be included. MOS, bipolar and BICMOS circuits, audio and video power amplifiers, optimum performance of near-sinusoidal oscillators and frequency-translation circuits. Phase-locked loop ICs, analog multipliers and voltage-controlled oscillators; advanced components for telecommunication circuits. Use of new CAD tools and systems.

Rules & Requirements

Prerequisites: 142, 240

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Niknejad

Formerly known as: Electrical Engineering 242

EL ENG W242A Integrated Circuits for Communications 4 Units
Analysis and design of electronic circuits for communication systems, with an emphasis on integrated circuits for wireless communication systems. Analysis of noise and distortion in amplifiers with application to radio receiver design. Power amplifier design with application to wireless radio transmitters. Radio-frequency mixers, oscillators, phase-locked loops, modulators, and demodulators.

Rules & Requirements

Prerequisites: EE W240A; MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W242A after taking EE 142, EE 242A, or EE 242B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

Summer: 10 weeks - 4.5 hours of web-based lecture and 1.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Niknejad

Formerly known as: Electrical Engineering W142

EL ENG W242B Advanced Integrated Circuits for Communications 3 Units
Analysis, evaluation, and design of present-day integrated circuits for communications application, particularly those for which nonlinear response must be included. MOS, bipolar and BICMOS circuits, audio and video power amplifiers, optimum performance of near-sinusoidal oscillators and frequency-translation circuits. Phase-locked loop ICs, analog multipliers and voltage-controlled oscillators; advanced components for telecommunication circuits. Use of new CAD tools and systems.
Rules & Requirements

Prerequisites: EE W240A, EE W242A; MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W242B after taking EE 242B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week

Summer: 10 weeks - 4.5 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Niknejad

Formerly known as: Electrical Engineering W242

EL ENG 243 Advanced IC Processing and Layout 3 Units
The key processes for the fabrication of integrated circuits. Optical, X-ray, and e-beam lithography, ion implantation, oxidation and diffusion. Thin film deposition. Wet and dry etching and ion milling. Effect of phase and defect equilibria on process control.
Rules & Requirements

Prerequisites: 143 and either 140 or 141

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 244 Fundamental Algorithms for Systems Modeling, Analysis, and Optimization 4 Units
The modeling, analysis, and optimization of complex systems requires a range of algorithms and design software. This course reviews the fundamental techniques underlying the design methodology for complex systems, using integrated circuit design as example. Topics include design flows, discrete and continuous models and algorithms, and strategies for implementing algorithms efficiently and correctly in software. Laboratory assignments and a class project will expose students to state-of-the-art.
Rules & Requirements

Prerequisites: Graduate standing

Hours & Format

Fall and/or spring: 15 weeks - 4 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Keutzer, Lee, Roychowdhury, Seshia

EL ENG W244 Fundamental Algorithms for System Modeling, Analysis, and Optimization 4 Units
The modeling, analysis, and optimization of complex systems require a range of algorithms and design tools. This course reviews the fundamental techniques underlying the design methodology for complex systems, using integrated circuit design as an example. Topics include design flows, discrete and continuous models and algorithms, and strategies for implementing algorithms efficiently and correctly in software.
Rules & Requirements

Prerequisites: MAS-IC students only

Credit Restrictions: Students will receive no credit for W244 after taking 144 and 244.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week

Summer: 10 weeks - 4.5 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Keutzer, Lee, Roychowdhury, Seshia

EL ENG C246 Parametric and Optimal Design of MEMS 3 Units
Parametric design and optimal design of MEMS. Emphasis on design, not fabrication. Analytic solution of MEMS design problems to determine the dimensions of MEMS structures for specified function. Trade-off of various performance requirements despite conflicting design requirements. Structures include flexure systems, accelerometers, and rate sensors.
Rules & Requirements

Prerequisites: Graduate standing or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Lin, Pisano

Formerly known as: 219

Also listed as: MEC ENG C219

EL ENG 247A Introduction to Microelectromechanical Systems (MEMS) 3 Units
This course will teach fundamentals of micromachining and microfabrication techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are central to MEMS fabrication. It will pay special attention to teaching of fundamentals necessary for the design and analysis of devices and systems in mechanical, electrical, fluidic, and thermal energy/signal domains, and will teach basic techniques for multi-domain analysis. Fundamentals of sensing and transduction mechanisms including capacitive and piezoresistive techniques, and design and analysis of micmicromachined miniature sensors and actuators using these techniques will be covered.
Rules & Requirements

Prerequisites: Electrical Engineering 40 or 100 or consent of instructor required

Credit Restrictions: Students will receive no credit for EE 247A after taking EE 147.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Maharbiz, Nguyen, Pister

EL ENG C247B Introduction to MEMS Design 4 Units
Physics, fabrication, and design of micro-electromechanical systems (MEMS). Micro and nanofabrication processes, including silicon surface and bulk micromachining and non-silicon micromachining. Integration strategies and assembly processes. Microsensor and microactuator devices: electrostatic, piezoresistive, piezoelectric, thermal, magnetic transduction. Electronic position-sensing circuits and electrical and mechanical noise. CAD for MEMS. Design project is required.
Rules & Requirements

Prerequisites: Graduate standing in engineering or science; undergraduates with consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nguyen, Pister

Also listed as: MEC ENG C218

EL ENG W247B Introduction to MEMS Design 4 Units
Physics, fabrication and design of micro electromechanical systems (MEMS). Micro and nano-fabrication processes, including silicon surface and bulk micromachining and non-silicon micromachining. Integration strategies and assembly processes. Microsensor and microactuator devices: electrostatic, piezoresistive, piezoelectric, thermal, and magnetic transduction. Electronic position-sensing circuits and electrical and mechanical noise. CAD for MEMS. Design project is required.
Rules & Requirements

Prerequisites: MAS-IC students only

Credit Restrictions: Students will receive no credit for EE W247B after taking EE C247B or Mechanical Engineering C218.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

Summer: 10 weeks - 4.5 hours of web-based lecture and 1.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nguyen, Pister

Formerly known as: Electrical Engineering W245

EL ENG C249A Introduction to Embedded Systems 4 Units
This course introduces students to the basics of models, analysis tools, and control for embedded systems operating in real time. Students learn how to combine physical processes with computation. Topics include models of computation, control, analysis and verification, interfacing with the physical world, mapping to platforms, and distributed embedded systems. The course has a strong laboratory component, with emphasis on a semester-long sequence of projects.
Rules & Requirements

Credit Restrictions: Students will receive no credit for El Eng/Comp Sci C249A after taking El Eng/Comp Sci C149.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Lee, Seshia

Formerly known as: Electrical Engineering C249M/Computer Science C249M

Also listed as: COMPSCI C249A

EL ENG C249B Embedded System Design: Modeling, Analysis, and Synthesis 4 Units
Principles of embedded system design. Focus on design methodologies and foundations. Platform-based design and communication-based design and their relationship with design time, re-use, and performance. Models of computation and their use in design capture, manipulation, verification, and synthesis. Mapping into architecture and systems platforms. Performance estimation. Scheduling and real-time requirements. Synchronous languages and time-triggered protocols to simplify the design process.
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Sangiovanni-Vincentelli

Formerly known as: Electrical Engineering C249/Civil and Environmental Engineering C289

Also listed as: CIV ENG C289

EL ENG C261 Medical Imaging Signals and Systems 4 Units
Biomedical imaging is a clinically important application of engineering, applied mathematics, physics, and medicine. In this course, we apply linear systems theory and basic physics to analyze X-ray imaging, computerized tomography, nuclear medicine, and MRI. We cover the basic physics and instrumentation that characterizes medical image as an ideal perfect-resolution image blurred by an impulse response. This material could prepare the student for a career in designing new medical imaging systems that reliably detect small tumors or infarcts.
Objectives Outcomes

Course Objectives: • understand how 2D impulse response or 2D spatial frequency transfer function (or Modulation Transfer Function) allow one to quantify the spatial resolution of an imaging system.
• understand 2D sampling requirements to avoid aliasing
• understand 2D filtered backprojection reconstruction from projections based on the projection-slice theorem of Fourier Transforms
• understand the concept of image reconstruction as solving a mathematical inverse problem.
• understand the limitations of poorly conditioned inverse problems and noise amplification
• understand how diffraction can limit resolution---but not for the imaging systems in this class
• understand the hardware components of an X-ray imaging scanner
•
• understand the physics and hardware limits to spatial resolution of an X-ray imaging system
• understand tradeoffs between depth, contrast, and dose for X-ray sources
• understand resolution limits for CT scanners
• understand how to reconstruct a 2D CT image from projection data using the filtered backprojection algorithm
• understand the hardware and physics of Nuclear Medicine scanners
• understand how PET and SPECT images are created using filtered backprojection
• understand resolution limits of nuclear medicine scanners
• understand MRI hardware components, resolution limits and image reconstruction via a 2D FFT
• understand how to construct a medical imaging scanner that will achieve a desired spatial resolution specification.

Student Learning Outcomes: • students will be tested for their understanding of the key concepts above
• undergraduate students will apply to graduate programs and be admitted
• students will apply this knowledge to their research at Berkeley, UCSF, the national labs or elsewhere
• students will be hired by companies that create, sell, operate or consult in biomedical imaging

Rules & Requirements

Prerequisites: El Eng 20N and Engineering 7 or equivalent. Knowledge of Matlab or linear algebra assumed

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Conolly

Also listed as: BIO ENG C261

EL ENG 290A Advanced Topics in Electrical Engineering: Advanced Topics in Computer-Aided Design 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290B Advanced Topics in Electrical Engineering: Advanced Topics in Solid State Devices 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290C Advanced Topics in Electrical Engineering: Advanced Topics in Circuit Design 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290D Advanced Topics in Electrical Engineering: Advanced Topics in Semiconductor Technology 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290F Advanced Topics in Electrical Engineering: Advanced Topics in Photonics 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290N Advanced Topics in Electrical Engineering: Advanced Topics in System Theory 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290O Advanced Topics in Electrical Engineering: Advanced Topics in Control 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290P Advanced Topics in Electrical Engineering: Advanced Topics in Bioelectronics 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290Q Advanced Topics in Electrical Engineering: Advanced Topics in Communication Networks 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290S Advanced Topics in Electrical Engineering: Advanced Topics in Communications and Information Theory 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290T Advanced Topics in Electrical Engineering: Advanced Topics in Signal Processing 1 - 3 Units
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG W290C Advanced Topics in Circuit Design 3 Units
Seminar-style course presenting an in-depth perspective on one specific domain of integrated circuit design. Most often, this will address an application space that has become particularly relevant in recent times. Examples are serial links, ultra low-power design, wireless transceiver design, etc.
Rules & Requirements

Prerequisites: MAS-IC students only

Credit Restrictions: Students will receive no credit for W290C after taking 290C.

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture per week

Summer: 10 weeks - 4.5 hours of web-based lecture per week

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

EL ENG 290Y Advanced Topics in Electrical Engineering: Organic Materials in Electronics 3 Units
Organic materials are seeing increasing application in electronics applications. This course will provide an overview of the properties of the major classes of organic materials with relevance to electronics. Students will study the technology, physics, and chemistry of their use in the three most rapidly growing major applications--energy conversion/generation devices (fuel cells and photovoltaics), organic light-emitting diodes, and organic transistors.
Rules & Requirements

Prerequisites: 130; undergraduate general chemistry

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Subramanian

EL ENG C291 Control and Optimization of Distributed Parameters Systems 3 Units
Distributed systems and PDE models of physical phenomena (propagation of waves, network traffic, water distribution, fluid mechanics, electromagnetism, blood vessels, beams, road pavement, structures, etc.). Fundamental solution methods for PDEs: separation of variables, self-similar solutions, characteristics, numerical methods, spectral methods. Stability analysis. Adjoint-based optimization. Lyapunov stabilization. Differential flatness. Viability control. Hamilton-Jacobi-based control.
Rules & Requirements

Prerequisites: Engineering 77, Mathematics 54 (or equivalent), or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Also listed as: CIV ENG C291F/MEC ENG C236

EL ENG C291E Hybrid Systems and Intelligent Control 3 Units
Analysis of hybrid systems formed by the interaction of continuous time dynamics and discrete-event controllers. Discrete-event systems models and language descriptions. Finite-state machines and automata. Model verification and control of hybrid systems. Signal-to-symbol conversion and logic controllers. Adaptive, neural, and fuzzy-control systems. Applications to robotics and Intelligent Vehicle and Highway Systems (IVHS).
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 291E

Also listed as: MEC ENG C290S

EL ENG 298 Group Studies, Seminars, or Group Research 1 - 4 Units
Advanced study in various subjects through special seminars on topics to be selected each year, informal group studies of special problems, group participation in comprehensive design problems, or group research on complete problems for analysis and experimentation.
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of lecture per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: The grading option will be decided by the instructor when the class is offered.

EL ENG 299 Individual Research 1 - 12 Units
Investigation of problems in electrical engineering.
Rules & Requirements

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1-12 hours of independent study per week

Summer:
6 weeks - 2.5-30 hours of independent study per week
8 weeks - 1.5-22.5 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

EL ENG 375 Teaching Techniques for Electrical Engineering 1 Unit
Weekly seminars and discussions of effective teaching techniques. Use of educational objectives, alternative forms of instruction, and special techniques for teaching key concepts and techniques in electrical engineering. Student and self-evaluation. Course is intended to orient new graduate student instructors to teaching in the Electrical Engineering Department at Berkeley.
Rules & Requirements

Prerequisites: Graduate standing

Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1.5 hours of seminar per week

Additional Details

Subject/Course Level: Electrical Engineering/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: Electrical Engineering 301

EL ENG 602 Individual Study for Doctoral Students 1 - 8 Units
Individual study in consultation with the major field adviser, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D. (and other doctoral degrees).
Rules & Requirements

Credit Restrictions: Course does not satisfy unit or residence requirements for doctoral degree.

Repeat rules: Course may be repeated for credit. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Summer: 8 weeks - 6-45 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.