# Electrical Engineering (EL ENG)

## Courses

Expand all course descriptions [+]Collapse all course descriptions [-]

### EL ENG 24 Freshman Seminar 1 Unit

Terms offered: Fall 2017, Spring 2017, Spring 2016
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.
Freshman Seminar: Read More [+]
**Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Freshman Seminar: Read Less [-]

### EL ENG 25 What Electrical Engineers Do--Feedback from Recent Graduates 1 Unit

Terms offered: Fall 2011
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?
What Electrical Engineers Do--Feedback from Recent Graduates: Read More [+]
**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

What Electrical Engineers Do--Feedback from Recent Graduates: Read Less [-]

### EL ENG 39 Freshman/Sophomore Seminar 2 - 4 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]
**Rules & Requirements**

**Prerequisites:** Priority given to freshmen and sophomores

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

**Hours & Format**

**Fall and/or spring:** 15 weeks - 2-4 hours 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.

Freshman/Sophomore Seminar: Read Less [-]

## EL ENG 42 Introduction to Digital Electronics 3 Units

Terms offered: Fall 2013, Summer 2013 8 Week Session, Spring 2013
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.
Introduction to Digital Electronics: Read More [+]

**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.

Introduction to Digital Electronics: Read Less [-]

## EL ENG 49 Electronics for the Internet of Things 4 Units

Terms offered: Spring 2020, Spring 2019, Fall 2018
Electronics has become pervasive in our lives as a powerful technology with applications in a wide range of fields including healthcare, environmental monitoring, robotics, or entertainment. This course teaches how to build electronic circuits that interact with the environment through sensors and actuators and how to communicate wirelessly with the internet to cooperate with other devices and with humans. In the laboratory students design and build representative samples such as solar harvesters, robots, that exchange information with or are controlled from the cloud.
Electronics for the Internet of Things: Read More [+]

**Objectives & Outcomes**

**Course Objectives:** Electronics has become a powerful and ubiquitous technology supporting solutions to a wide range of applications in fields ranging from science, engineering, healthcare, environmental monitoring, transportation, to entertainment. The objective of this course is to teach students majoring in these and related subjects how to use electronic devices to solve problems in their areas of expertise.
Through the lecture and laboratory, students gain insight into the possibilities and limitations of the technology and how to use electronics to help solve problems. Students learn to use electronics to interact with the environment through sound, light, temperature, motion using sensors and actuators, and how to use electronic computation to orchestrate the interactions and exchange information wirelessly over the internet.

**Student Learning Outcomes:** Deploy electronic sensors and interface them to microcontrollers through digital and analog channels as well as common protocols (I2C, SPI),
Design, build and test electronic devices leveraging these concepts.
Interact with the internet and cloud services using protocols such as http, MQTT, Blynk,
Interface DC motors, steppers and servos to microcontrollers,
Represent information with voltage, current, power, and energy and how to measure these quantities with laboratory equipment,
To use and program low-cost and low-power microcontrollers for sensing, actuation, and information processing, and find and use program libraries supporting these tasks
Understand and make basic low-pass and high-pass filters, Wheatstone bridge etc.
Use electronics to sense and actuate physical parameters such as temperature, humidity, sound, light, and motion,

**Rules & Requirements**

**Prerequisites:** ENGIN 7, COMPSCI 10, or equivalent background in computer programming (including COMPSCI 61A or COMPSCI C8 / INFO C8 / STAT C8); MATH 1A or equivalent background in Calculus

**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.

**Instructor:** Boser

Electronics for the Internet of Things: Read Less [-]

## EL ENG 84 Sophomore Seminar 1 or 2 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
Sophomore seminars are small interactive courses offered by faculty members in departments all across the campus. Sophomore seminars offer opportunity for close, regular intellectual contact between faculty members and students in the crucial second year. The topics vary from department to department and semester to semester. Enrollment limited to 15 sophomores.
Sophomore Seminar: Read More [+]
**Rules & Requirements**

**Prerequisites:** At discretion of instructor

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

**Hours & Format**

**Fall and/or spring:**
5 weeks - 3-6 hours of seminar per week
10 weeks - 1.5-3 hours of seminar per week
15 weeks - 1-2 hours of seminar per week

**Summer:**
6 weeks - 2.5-5 hours of seminar per week
8 weeks - 1.5-3.5 hours 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.

Sophomore Seminar: Read Less [-]

## EL ENG 97 Field Study 1 - 4 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015
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.
Field Study: Read More [+]
**Rules & Requirements**

**Prerequisites:** Consent of instructor (see department adviser)

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Field Study: Read Less [-]

## EL ENG 98 Directed Group Study for Undergraduates 1 - 4 Units

Terms offered: Fall 2020, Fall 2016, Spring 2016
Group study of selected topics in electrical engineering, usually relating to new developments.
Directed Group Study for Undergraduates: Read More [+]
**Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Directed Group Study for Undergraduates: Read Less [-]

## EL ENG 99 Individual Study and Research for Undergraduates 1 - 4 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015
Supervised independent study and research for students with fewer than 60 units completed.
Individual Study and Research for Undergraduates: Read More [+]
**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 without restriction.

**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.

Individual Study and Research for Undergraduates: Read Less [-]

## EL ENG 105 Microelectronic Devices and Circuits 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Microelectronic Devices and Circuits: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**Credit Restrictions:** Students will receive no credit for EL ENG 105 after completing EL ENG 240A, or EL ENG 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/Undergraduate

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

Microelectronic Devices and Circuits: Read Less [-]

## EL ENG C106A Introduction to Robotics 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
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.
Introduction to Robotics: Read More [+]
**Rules & Requirements**

**Prerequisites:** EL ENG 120 or 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

Introduction to Robotics: Read Less [-]

## EL ENG C106B Robotic Manipulation and Interaction 4 Units

Terms offered: Spring 2017, Spring 2016
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.
Robotic Manipulation and Interaction: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS C106A / BIO ENG 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 C125B

Robotic Manipulation and Interaction: Read Less [-]

## EL ENG 113 Power Electronics 4 Units

Terms offered: Fall 2020, Fall 2019, Spring 2019
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.
Power Electronics: Read More [+]
**Rules & Requirements**

**Prerequisites:** EL ENG 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.

Power Electronics: Read Less [-]

## EL ENG 117 Electromagnetic Fields and Waves 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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. Explanation of cellphone antennas, WiFi communication, and other wireless technologies.
Electromagnetic Fields and Waves: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16B, MATH 53, and MATH 54; PHYSICS 7B or equivalent that covers AC circuits and electromagnetics up to Maxwell's equations

**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/Undergraduate

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

**Instructor:** Yablonovitch

Electromagnetic Fields and Waves: Read Less [-]

## EL ENG 118 Introduction to Optical Engineering 4 Units

Terms offered: Fall 2020, Fall 2019, Spring 2019
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.
Introduction to Optical Engineering: Read More [+]
**Rules & Requirements**

**Prerequisites:** MATH 53; EECS 16A and EECS 16B, or MATH 54

**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.

**Instructors:** Waller, Kante

Introduction to Optical Engineering: Read Less [-]

## EL ENG 120 Signals and Systems 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Signals and Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**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.

Signals and Systems: Read Less [-]

## EL ENG 121 Introduction to Digital Communication Systems 4 Units

Terms offered: Spring 2016, Fall 2014, Fall 2013
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.
Introduction to Digital Communication Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A, EECS 16B, and COMPSCI 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.

Introduction to Digital Communication Systems: Read Less [-]

## EL ENG 122 Introduction to Communication Networks 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Introduction to Communication Networks: Read More [+]
**Rules & Requirements**

**Prerequisites:** COMPSCI 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.

Introduction to Communication Networks: Read Less [-]

## EL ENG 123 Digital Signal Processing 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Digital Signal Processing: Read More [+]
**Rules & Requirements**

**Prerequisites:** EL ENG 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.

Digital Signal Processing: Read Less [-]

## EL ENG 126 Probability and Random Processes 4 Units

Terms offered: Spring 2017, Fall 2016, Spring 2016
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.
Probability and Random Processes: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**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.

Probability and Random Processes: Read Less [-]

## EL ENG C128 Feedback Control Systems 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Feedback Control Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A or MEC ENG 100; MEC ENG 132 or EL ENG 120

**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

Feedback Control Systems: Read Less [-]

## EL ENG 130 Integrated-Circuit Devices 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Integrated-Circuit Devices: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**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.

Integrated-Circuit Devices: Read Less [-]

## EL ENG 134 Fundamentals of Photovoltaic Devices 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Fundamentals of Photovoltaic Devices: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**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

Fundamentals of Photovoltaic Devices: Read Less [-]

## EL ENG 137A Introduction to Electric Power Systems 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Introduction to Electric Power Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** Physics 7B; EECS 16A and EECS 16B, 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

Introduction to Electric Power Systems: Read Less [-]

## EL ENG 137B Introduction to Electric Power Systems 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Introduction to Electric Power Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** EL ENG 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

Introduction to Electric Power Systems: Read Less [-]

## EL ENG 140 Linear Integrated Circuits 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Linear Integrated Circuits: Read More [+]
**Rules & Requirements**

**Prerequisites:** EL ENG 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

Linear Integrated Circuits: Read Less [-]

## EL ENG 142 Integrated Circuits for Communications 4 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
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.
Integrated Circuits for Communications: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A, EECS 16B, and EL ENG 105

**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.

Integrated Circuits for Communications: Read Less [-]

## EL ENG 143 Microfabrication Technology 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Microfabrication Technology: Read More [+]
**Rules & Requirements**

**Prerequisites:** PHYSICS 7B

**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.

Microfabrication Technology: Read Less [-]

## EL ENG 144 Fundamental Algorithms for Systems Modeling, Analysis, and Optimization 4 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013
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.
Fundamental Algorithms for Systems Modeling, Analysis, and Optimization: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and COMPSCI 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

Fundamental Algorithms for Systems Modeling, Analysis, and Optimization: Read Less [-]

## EL ENG C145B Medical Imaging Signals and Systems 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Medical Imaging Signals and Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**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

Medical Imaging Signals and Systems: Read Less [-]

## EL ENG C145L Introductory Electronic Transducers Laboratory 3 Units

Terms offered: Fall 2014, Fall 2013, Fall 2012
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.
Introductory Electronic Transducers Laboratory: Read More [+]
**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

Introductory Electronic Transducers Laboratory: Read Less [-]

## EL ENG C145M Introductory Microcomputer Interfacing Laboratory 3 Units

Terms offered: Spring 2013, Spring 2012, Spring 2011
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.
Introductory Microcomputer Interfacing Laboratory: Read More [+]
**Rules & Requirements**

**Prerequisites:** EE 16A & 16B

**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

Introductory Microcomputer Interfacing Laboratory: Read Less [-]

## EL ENG C145O Laboratory in the Mechanics of Organisms 3 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013, Spring 2012
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.
Laboratory in the Mechanics of Organisms: Read More [+]
**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

Laboratory in the Mechanics of Organisms: Read Less [-]

## EL ENG 146L Application Specific Integrated Circuits Laboratory 2 Units

Terms offered: Spring 2015
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.
Application Specific Integrated Circuits Laboratory: Read More [+]
**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:** EECS 16B; EL ENG 105 recommended

**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

Application Specific Integrated Circuits Laboratory: Read Less [-]

## EL ENG 147 Introduction to Microelectromechanical Systems (MEMS) 3 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Introduction to Microelectromechanical Systems (MEMS): Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A and EECS 16B

**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

Introduction to Microelectromechanical Systems (MEMS): Read Less [-]

## EL ENG 192 Mechatronic Design Laboratory 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Mechatronic Design Laboratory: Read More [+]
**Rules & Requirements**

**Prerequisites:** EECS 16A, EECS 16B, COMPSCI 61A, COMPSCI 61B, COMPSCI 61C, and EL ENG 120

**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

Mechatronic Design Laboratory: Read Less [-]

## EL ENG 194 Special Topics 1 - 4 Units

Terms offered: Spring 2020, Fall 2018, Spring 2018
Topics will vary semester to semester. See the Electrical Engineering announcements.
Special Topics: Read More [+]
**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 - 1-4 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Electrical Engineering/Undergraduate

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

Special Topics: Read Less [-]

## EL ENG H196A Senior Honors Thesis Research 1 - 4 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015
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.
Senior Honors Thesis Research: Read More [+]
**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.

Senior Honors Thesis Research: Read Less [-]

## EL ENG H196B Senior Honors Thesis Research 1 - 4 Units

Terms offered: Spring 2016, Spring 2015, Spring 2014
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.
Senior Honors Thesis Research: Read More [+]
**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.

Senior Honors Thesis Research: Read Less [-]

## EL ENG 197 Field Study 1 - 4 Units

Terms offered: Spring 2018, Spring 2016, Fall 2015
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.
Field Study: Read More [+]
**Rules & Requirements**

**Prerequisites:** Consent of instructor (see department adviser)

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Field Study: Read Less [-]

## EL ENG 198 Directed Group Study for Advanced Undergraduates 1 - 4 Units

Terms offered: Fall 2020, Spring 2020, Spring 2019
Group study of selected topics in electrical engineering, usually relating to new developments.
Directed Group Study for Advanced Undergraduates: Read More [+]
**Rules & Requirements**

**Prerequisites:** 2.0 GPA or better; 60 units completed

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Directed Group Study for Advanced Undergraduates: Read Less [-]

## EL ENG 199 Supervised Independent Study 1 - 4 Units

Terms offered: Fall 2018, Spring 2018, Fall 2017
Supervised independent study. Enrollment restrictions apply.
Supervised Independent Study: Read More [+]
**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 without restriction.

**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.

Supervised Independent Study: Read Less [-]

## EL ENG 206A Introduction to Robotics 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
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.
Introduction to Robotics: Read More [+]
**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

Introduction to Robotics: Read Less [-]

## EL ENG 206B Robotic Manipulation and Interaction 4 Units

Terms offered: Spring 2018, Spring 2017
This course is a sequel to EECS 125/225, 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.
Robotic Manipulation and Interaction: Read More [+]
**Objectives & Outcomes**

**Course Objectives:** To teach students the connection between the geometry, physics of
manipulators with experimental setups that include sensors, control of large degrees of freedom
manipulators, mobile robots and different grippers.

**Student Learning Outcomes:** By the end of the course students will be able to build a complete
system composed of perceptual planning and autonomously controlled manipulators and /or
mobile systems, justified by predictive theoretical models of performance.

**Rules & Requirements**

**Prerequisites:** Electrical Engineering 206A/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/Graduate

**Grading:** Letter grade.

**Instructors:** Bajcsy, Sastry

Robotic Manipulation and Interaction: Read Less [-]

## EL ENG 210 Applied Electromagnetic Theory 3 Units

Terms offered: Spring 2011, Spring 2010, Fall 2006
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.
Applied Electromagnetic Theory: Read More [+]
**Rules & Requirements**

**Prerequisites:** 117, or Physics 110A, 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

Applied Electromagnetic Theory: Read Less [-]

## EL ENG 213A Power Electronics 4 Units

Terms offered: Fall 2020, Fall 2019, Spring 2019
Power conversion circuits and techniques. Characterization and design of magnetic devices including transformers, inductors, and electromagnetic actuators. Characteristics of power semiconductor devices, including power diodes, SCRs, MOSFETs, IGBTs, and emerging wide bandgap devices. Applications to renewable energy systems, high-efficiency lighting, power management in mobile electronics, and electric machine drives. Simulation based laboratory and design project.
Power Electronics: Read More [+]
**Rules & Requirements**

**Prerequisites:** EE105 or consent of instructor

**Credit Restrictions:** Students who have received credit for EE113 will not receive credit for EE213A.

**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.

**Instructor:** Sanders

Power Electronics: Read Less [-]

## EL ENG C213 X-rays and Extreme Ultraviolet Radiation 3 Units

Terms offered: Fall 2019, Fall 2017, Fall 2016
This course explores modern developments in the physics and applications of x-rays and extreme ultraviolet (EUV) radiation. 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 includes the generation of x-rays with synchrotron radiation, high harmonic generation, x-ray free electron lasers, laser-plasma sources. Spatial and temporal coherence concepts are explained. Optics appropriate for this spectral region are described. Applications include nanoscale and astrophysical imaging, femtosecond and attosecond probing of electron dynamics in molecules and solids, EUV lithography, and materials characteristics.
X-rays and Extreme Ultraviolet Radiation: Read More [+]
**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.

**Instructor:** Attwood

**Also listed as:** AST C210

X-rays and Extreme Ultraviolet Radiation: Read Less [-]

## EL ENG 218A Introduction to Optical Engineering 4 Units

Terms offered: Fall 2020, Fall 2019, Spring 2019
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.
Introduction to Optical Engineering: Read More [+]
**Rules & Requirements**

**Prerequisites:** MATH 53; EECS 16A and EECS 16B, or MATH 54

**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.

**Instructors:** Waller, Kante

Introduction to Optical Engineering: Read Less [-]

## EL ENG 219A Numerical Simulation and Modeling 4 Units

Terms offered: Fall 2019, Fall 2017, Fall 2015
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.
Numerical Simulation and Modeling: Read More [+]
**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

Numerical Simulation and Modeling: Read Less [-]

## EL ENG 219B Logic Synthesis 4 Units

Terms offered: Spring 2016, Spring 2015, Spring 2011
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.
Logic Synthesis: Read More [+]
**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.

Logic Synthesis: Read Less [-]

## EL ENG C220A Advanced Control Systems I 3 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Advanced Control Systems I: Read More [+]
**Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

**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

Advanced Control Systems I: Read Less [-]

## EL ENG C220B Experiential Advanced Control Design I 3 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Experiential Advanced Control Design I: Read More [+]
**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

Experiential Advanced Control Design I: Read Less [-]

## EL ENG C220C Experiential Advanced Control Design II 3 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Experiential Advanced Control Design II: Read More [+]
**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

Experiential Advanced Control Design II: Read Less [-]

## EL ENG C220D Input/Output Methods for Compositional System Analysis 2 Units

Terms offered: Prior to 2007
Introduction to input/output concepts from control theory, systems as operators in signal spaces, passivity and
small-gain theorems, dissipativity theory, integral quadratic constraints. Compositional stabilility and
performance certification for interconnected systems from subsystems input/output properties. Case studies in
multi-agent systems, biological networks, Internet congestion control, and adaptive control.
Input/Output Methods for Compositional System Analysis: Read More [+]
**Objectives & Outcomes**

**Course Objectives:** Standard computational tools for control synthesis and verification do not scale well to large-scale, networked
systems in emerging applications. This course presents a compositional methodology suitable when the
subsystems are amenable to analytical and computational methods but the interconnection, taken as a whole, is
beyond the reach of these methods. The main idea is to break up the task of certifying desired stability and
performance properties into subproblems of manageable size using input/output properties. Students learn about
the fundamental theory, as well as relevant algorithms and applications in several domains.

**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:** Arcak, Packard

**Also listed as:** MEC ENG C220D

Input/Output Methods for Compositional System Analysis: Read Less [-]

## EL ENG 221A Linear System Theory 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Linear System Theory: Read More [+]
**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.

Linear System Theory: Read Less [-]

## EL ENG 222 Nonlinear Systems--Analysis, Stability and Control 3 Units

Terms offered: Spring 2017, Spring 2016, Spring 2015
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.
Nonlinear Systems--Analysis, Stability and Control: Read More [+]
**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.

Nonlinear Systems--Analysis, Stability and Control: Read Less [-]

## EL ENG C222 Nonlinear Systems 3 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
Basic graduate course in nonlinear systems. Nonlinear phenomena, planar systems, bifurcations, center manifolds, existence and uniqueness theorems. Lyapunov's direct and indirect methods, Lyapunov-based feedback stabilization. Input-to-state and input-output stability, and dissipativity theory. Computation techniques for nonlinear system analysis and design. Feedback linearization and sliding mode control methods.
Nonlinear Systems: Read More [+]
**Rules & Requirements**

**Prerequisites:** Math 54, or equivalent (undergraduate level Ordinary Differential Equations and Linear Algebra)

**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:** Arcak, Tomlin, Kameshwar

**Also listed as:** MEC ENG C237

Nonlinear Systems: Read Less [-]

## EL ENG 223 Stochastic Systems: Estimation and Control 3 Units

Terms offered: Spring 2020, Spring 2018, Spring 2015
Parameter and state estimation. System identification. Nonlinear filtering. Stochastic control. Adaptive control.
Stochastic Systems: Estimation and Control: Read More [+]

**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.

Stochastic Systems: Estimation and Control: Read Less [-]

## EL ENG 224A Digital Communications 4 Units

Terms offered: Fall 2010, Fall 2009, Fall 2008
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.
Digital Communications: Read More [+]

**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

Digital Communications: Read Less [-]

## EL ENG 224B Fundamentals of Wireless Communication 3 Units

Terms offered: Spring 2013, Spring 2012, Spring 2010
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.
Fundamentals of Wireless Communication: Read More [+]

**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

Fundamentals of Wireless Communication: Read Less [-]

## EL ENG C225E Principles of Magnetic Resonance Imaging 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017, Spring 2016
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.
Principles of Magnetic Resonance Imaging: Read More [+]

**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.

**Repeat rules:** Course may be repeated for credit under special circumstances: Students can only receive credit for 1 of the 2 versions of the class,BioEc265 or EE c225e, not both

**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, Vandsburger

**Also listed as:** BIO ENG C265

Principles of Magnetic Resonance Imaging: Read Less [-]

## EL ENG 225D Audio Signal Processing in Humans and Machines 3 Units

Terms offered: Spring 2014, Spring 2012, Spring 2009
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.
Audio Signal Processing in Humans and Machines: Read More [+]

**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

Audio Signal Processing in Humans and Machines: Read Less [-]

## EL ENG 226A Random Processes in Systems 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Random Processes in Systems: Read More [+]

**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

Random Processes in Systems: Read Less [-]

## EL ENG 226B Applications of Stochastic Process Theory 2 Units

Terms offered: Spring 2017, Spring 2013, Spring 1997
Advanced topics such as: Martingale theory, stochastic calculus, random fields, queueing networks, stochastic control.
Applications of Stochastic Process Theory: Read More [+]
**Rules & Requirements**

**Prerequisites:** 226A

**Repeat rules:** Course may be repeated for credit without restriction.

**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

Applications of Stochastic Process Theory: Read Less [-]

## EL ENG 227BT Convex Optimization 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Convex Optimization: Read More [+]
**Rules & Requirements**

**Prerequisites:** Mathematics 54 and Statistics 2 or equivalents

**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:** El Ghaoui, Wainwright

Convex Optimization: Read Less [-]

## EL ENG C227C Convex Optimization and Approximation 3 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017
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.
Convex Optimization and Approximation: Read More [+]
**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

Convex Optimization and Approximation: Read Less [-]

## EL ENG C227T Introduction to Convex Optimization 4 Units

Terms offered: Prior to 2007
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.
Introduction to Convex Optimization: Read More [+]
**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

Introduction to Convex Optimization: Read Less [-]

## EL ENG 228A High Speed Communications Networks 3 Units

Terms offered: Fall 2014, Spring 2014, Fall 2011
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.
High Speed Communications Networks: Read More [+]
**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.

High Speed Communications Networks: Read Less [-]

## EL ENG 229A Information Theory and Coding 3 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Information Theory and Coding: Read More [+]
**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

Information Theory and Coding: Read Less [-]

## EL ENG 229B Error Control Coding 3 Units

Terms offered: Spring 2019, Spring 2016, Fall 2013
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.
Error Control Coding: Read More [+]
**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

Error Control Coding: Read Less [-]

## EL ENG 230A Integrated-Circuit Devices 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Integrated-Circuit Devices: Read More [+]
**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

Integrated-Circuit Devices: Read Less [-]

## EL ENG 230B Solid State Devices 4 Units

Terms offered: Fall 2020, Spring 2019, Spring 2018
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.
Solid State Devices: Read More [+]
**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

Solid State Devices: Read Less [-]

## EL ENG 230C Solid State Electronics 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
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.
Solid State Electronics: Read More [+]
**Rules & Requirements**

**Prerequisites:** 131; Physics 137B

**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

Solid State Electronics: Read Less [-]

## EL ENG W230A Integrated-Circuit Devices 4 Units

Terms offered: Spring 2019, Spring 2018, Spring 2017
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.
Integrated-Circuit Devices: Read More [+]
**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

Integrated-Circuit Devices: Read Less [-]

## EL ENG W230B Solid State Devices 4 Units

Terms offered: Fall 2015
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.
Solid State Devices: Read More [+]
**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

Solid State Devices: Read Less [-]

## EL ENG 232 Lightwave Devices 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Lightwave Devices: Read More [+]
**Rules & Requirements**

**Prerequisites:** Electrical Engineering 130 or equivalent; Physics 137A 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

Lightwave Devices: Read Less [-]

## EL ENG C235 Nanoscale Fabrication 4 Units

Terms offered: Spring 2016, Spring 2015, Spring 2013
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.
Nanoscale Fabrication: Read More [+]
**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

Nanoscale Fabrication: Read Less [-]

## EL ENG 236A Quantum and Optical Electronics 3 Units

Terms offered: Fall 2019, Fall 2017, Fall 2015
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.
Quantum and Optical Electronics: Read More [+]
**Rules & Requirements**

**Prerequisites:** 117A, Physics 137A 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.

Quantum and Optical Electronics: Read Less [-]

## EL ENG C239 Partially Ionized Plasmas 3 Units

Terms offered: Spring 2010, Spring 2009, Spring 2007
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.
Partially Ionized Plasmas: Read More [+]
**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

Partially Ionized Plasmas: Read Less [-]

## EL ENG 240A Analog Integrated Circuits 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
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.
Analog Integrated Circuits: Read More [+]
**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

Analog Integrated Circuits: Read Less [-]

## EL ENG 240B Advanced Analog Integrated Circuits 4 Units

Terms offered: Spring 2019, Spring 2018, Spring 2017
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.
Advanced Analog Integrated Circuits: Read More [+]
**Rules & Requirements**

**Prerequisites:** EE140/EE240A 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.

Advanced Analog Integrated Circuits: Read Less [-]

## EL ENG 240C Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits 3 Units

Terms offered: Fall 2019, Fall 2017, Fall 2015
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.
Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits: Read More [+]
**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

Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits: Read Less [-]

## EL ENG W240A Analog Integrated Circuits 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Analog Integrated Circuits: Read More [+]
**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

Analog Integrated Circuits: Read Less [-]

## EL ENG W240B Advanced Analog Integrated Circuits 3 Units

Terms offered: Spring 2020, Spring 2019, Fall 2015
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.
Advanced Analog Integrated Circuits: Read More [+]
**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

Advanced Analog Integrated Circuits: Read Less [-]

## EL ENG W240C Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits 3 Units

Terms offered: Spring 2017, Spring 2016
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.
Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits: Read More [+]
**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

Analysis and Design of VLSI Analog-Digital Interface Integrated Circuits: Read Less [-]

## EL ENG 241B Advanced Digital Integrated Circuits 3 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Advanced Digital Integrated Circuits: Read More [+]
**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

Advanced Digital Integrated Circuits: Read Less [-]

## EL ENG W241A Introduction to Digital Integrated Circuits 4 Units

Terms offered: Fall 2015, Fall 2014, Spring 2014
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.
Introduction to Digital Integrated Circuits: Read More [+]
**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

Introduction to Digital Integrated Circuits: Read Less [-]

## EL ENG W241B Advanced Digital Integrated Circuits 3 Units

Terms offered: Spring 2017, Spring 2016, Spring 2015
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.
Advanced Digital Integrated Circuits: Read More [+]
**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

Advanced Digital Integrated Circuits: Read Less [-]

## EL ENG 242A Integrated Circuits for Communications 4 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017
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.
Integrated Circuits for Communications: Read More [+]
**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

Integrated Circuits for Communications: Read Less [-]

## EL ENG 242B Advanced Integrated Circuits for Communications 3 Units

Terms offered: Fall 2020, Fall 2014
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.
Advanced Integrated Circuits for Communications: Read More [+]
**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

Advanced Integrated Circuits for Communications: Read Less [-]

## EL ENG W242A Integrated Circuits for Communications 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Integrated Circuits for Communications: Read More [+]
**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

Integrated Circuits for Communications: Read Less [-]

## EL ENG W242B Advanced Integrated Circuits for Communications 3 Units

Terms offered: Spring 2017, Spring 2016
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.
Advanced Integrated Circuits for Communications: Read More [+]
**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

Advanced Integrated Circuits for Communications: Read Less [-]

## EL ENG 243 Advanced IC Processing and Layout 3 Units

Terms offered: Spring 2014, Spring 2012, Spring 2011
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.
Advanced IC Processing and Layout: Read More [+]
**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.

Advanced IC Processing and Layout: Read Less [-]

## EL ENG 244 Fundamental Algorithms for Systems Modeling, Analysis, and Optimization 4 Units

Terms offered: Fall 2016, Fall 2015, Fall 2014
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.
Fundamental Algorithms for Systems Modeling, Analysis, and Optimization: Read More [+]
**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

Fundamental Algorithms for Systems Modeling, Analysis, and Optimization: Read Less [-]

## EL ENG W244 Fundamental Algorithms for System Modeling, Analysis, and Optimization 4 Units

Terms offered: Fall 2015
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.
Fundamental Algorithms for System Modeling, Analysis, and Optimization: Read More [+]
**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

Fundamental Algorithms for System Modeling, Analysis, and Optimization: Read Less [-]

## EL ENG C246 Parametric and Optimal Design of MEMS 3 Units

Terms offered: Spring 2013, Spring 2012, Spring 2011
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.
Parametric and Optimal Design of MEMS: Read More [+]
**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

Parametric and Optimal Design of MEMS: Read Less [-]

## EL ENG 247A Introduction to Microelectromechanical Systems (MEMS) 3 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Introduction to Microelectromechanical Systems (MEMS): Read More [+]

**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

Introduction to Microelectromechanical Systems (MEMS): Read Less [-]

## EL ENG C247B Introduction to MEMS Design 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2018
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.
Introduction to MEMS Design: Read More [+]

**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

**Formerly known as:** Electrical Engineering C245, Mechanical Engineering C218

**Also listed as:** MEC ENG C218

Introduction to MEMS Design: Read Less [-]

## EL ENG W247B Introduction to MEMS Design 4 Units

Terms offered: Prior to 2007
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.
Introduction to MEMS Design: Read More [+]

**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

Introduction to MEMS Design: Read Less [-]

## EL ENG 248C Numerical Modeling and Analysis: Nonlinear Systems and Noise 4 Units

Terms offered: Prior to 2007
Numerical modelling and analysis techniques are widely used in scientific and
engineering practice; they are also an excellent vehicle for understanding and
concretizing theory.
This course covers topics important for a proper understanding of nonlinearity
and noise: periodic steady state and envelope ("RF") analyses; oscillatory systems; nonstationary and phase noise; and homotopy/continuation techniques
for solving "difficult" equation systems. An underlying theme of the course is
relevance to different physical domains, from electronics (e.g., analog/RF/mixed-signal circuits, high-speed digital circuits, interconnect, etc.) to optics, nanotechnology, chemistry, biology and mechanics. Hands-on
coding using the MATLAB-based Berkeley Model
Numerical Modeling and Analysis: Nonlinear Systems and Noise: Read More [+]

**Objectives & Outcomes**

**Course Objectives:** Homotopy techniques for robust nonlinear equation solution
Modelling and analysis of oscillatory systems
- harmonic, ring and relaxation oscillators
- oscillator steady state analysis
- perturbation analysis of amplitude-stable oscillators
RF (nonlinear periodic steady state) analysis
- harmonic balance and shooting
- Multi-time PDE and envelope methods
- perturbation analysis of periodic systems (Floquet theory)
RF (nonlinear, nonstationary) noise concepts and their application
- cyclostationary noise analysis
- concepts of phase noise in oscillators
Using MAPP for fast/convenient modelling and analysis

**Student Learning Outcomes:** Students will develop a facility in the above topics and be able to apply them
widely across science and engineering.

**Rules & Requirements**

**Prerequisites:** Consent of Instructor

**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

Numerical Modeling and Analysis: Nonlinear Systems and Noise: Read Less [-]

## EL ENG C249A Introduction to Embedded Systems 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Introduction to Embedded Systems: Read More [+]

**Rules & Requirements**

**Credit Restrictions:** Students will receive no credit for Electrical Engineering/Computer Science C249A after completing Electrical Engineering/Computer Science 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

Introduction to Embedded Systems: Read Less [-]

## EL ENG C249B Embedded System Design: Modeling, Analysis, and Synthesis 4 Units

Terms offered: Spring 2020, Spring 2019, Spring 2016, Spring 2015
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.
Embedded System Design: Modeling, Analysis, and Synthesis: Read More [+]

**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

Embedded System Design: Modeling, Analysis, and Synthesis: Read Less [-]

## EL ENG C261 Medical Imaging Signals and Systems 4 Units

Terms offered: Fall 2020, Fall 2019, Fall 2018
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.
Medical Imaging Signals and Systems: Read More [+]
**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

## EL ENG 290 Advanced Topics in Electrical Engineering 1 - 4 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Advanced Topics in Electrical Engineering: Read More [+]
**Rules & Requirements**

**Prerequisites:** Consent of instructor

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

**Hours & Format**

**Fall and/or spring:**
4 weeks - 3-15 hours of lecture per week
6 weeks - 3-9 hours of lecture per week
8 weeks - 2-6 hours of lecture per week
10 weeks - 2-5 hours of lecture per week
15 weeks - 1-3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Electrical Engineering/Graduate

**Grading:** Letter grade.

Advanced Topics in Electrical Engineering: Read Less [-]

## EL ENG 290A Advanced Topics in Electrical Engineering: Advanced Topics in Computer-Aided Design 1 - 3 Units

Terms offered: Spring 2016, Spring 2015, Fall 2014
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Advanced Topics in Electrical Engineering: Advanced Topics in Computer-Aided Design: Read More [+]
**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Computer-Aided Design: Read Less [-]

## EL ENG 290B Advanced Topics in Electrical Engineering: Advanced Topics in Solid State Devices 1 - 3 Units

Terms offered: Spring 2020, Spring 2019, Fall 2018
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Solid State Devices: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Solid State Devices: Read Less [-]

## EL ENG 290C Advanced Topics in Electrical Engineering: Advanced Topics in Circuit Design 1 - 3 Units

Terms offered: Spring 2019, Fall 2018, Spring 2018
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Circuit Design: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Circuit Design: Read Less [-]

## EL ENG 290D Advanced Topics in Electrical Engineering: Advanced Topics in Semiconductor Technology 1 - 3 Units

Terms offered: Fall 2014, Fall 2013, Fall 2004
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Semiconductor Technology: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Semiconductor Technology: Read Less [-]

## EL ENG 290F Advanced Topics in Electrical Engineering: Advanced Topics in Photonics 1 - 3 Units

Terms offered: Spring 2014, Fall 2013, Fall 2012
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Photonics: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Photonics: Read Less [-]

## EL ENG 290G Advanced Topics in Electrical Engineering: Advanced Topics in Mems, Microsensors, and Microactuators 1 - 3 Units

Terms offered: Fall 2017, Fall 2016, Spring 2002
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Mems, Microsensors, and Microactuators: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

**Formerly known as:** Engineering 210

Advanced Topics in Electrical Engineering: Advanced Topics in Mems, Microsensors, and Microactuators: Read Less [-]

## EL ENG 290N Advanced Topics in Electrical Engineering: Advanced Topics in System Theory 1 - 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2015
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in System Theory: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in System Theory: Read Less [-]

## EL ENG 290O Advanced Topics in Electrical Engineering: Advanced Topics in Control 1 - 3 Units

Terms offered: Spring 2019, Fall 2018, Fall 2017
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Control: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Control: Read Less [-]

## EL ENG 290P Advanced Topics in Electrical Engineering: Advanced Topics in Bioelectronics 1 - 3 Units

Terms offered: Spring 2019, Spring 2018, Fall 2017
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester. Advanced Topics in Electrical Engineering: Advanced Topics in Bioelectronics: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Bioelectronics: Read Less [-]

## EL ENG 290Q Advanced Topics in Electrical Engineering: Advanced Topics in Communication Networks 1 - 3 Units

Terms offered: Spring 2017, Spring 2016, Fall 2014
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Advanced Topics in Electrical Engineering: Advanced Topics in Communication Networks: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Communication Networks: Read Less [-]

## EL ENG 290S Advanced Topics in Electrical Engineering: Advanced Topics in Communications and Information Theory 1 - 3 Units

Terms offered: Fall 2018, Fall 2016, Fall 2009
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Advanced Topics in Electrical Engineering: Advanced Topics in Communications and Information Theory: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Communications and Information Theory: Read Less [-]

## EL ENG 290T Advanced Topics in Electrical Engineering: Advanced Topics in Signal Processing 1 - 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016
The 290 courses cover current topics of research interest in electrical engineering. The course content may vary from semester to semester.
Advanced Topics in Electrical Engineering: Advanced Topics in Signal Processing: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Advanced Topics in Electrical Engineering: Advanced Topics in Signal Processing: Read Less [-]

## EL ENG W290C Advanced Topics in Circuit Design 3 Units

Terms offered: Prior to 2007
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.
Advanced Topics in Circuit Design: Read More [+]

**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 without restriction.

**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.

Advanced Topics in Circuit Design: Read Less [-]

## EL ENG 290Y Advanced Topics in Electrical Engineering: Organic Materials in Electronics 3 Units

Terms offered: Spring 2014, Spring 2013, Fall 2009
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.
Advanced Topics in Electrical Engineering: Organic Materials in Electronics: Read More [+]

**Rules & Requirements**

**Prerequisites:** 130; undergraduate general chemistry

**Repeat rules:** Course may be repeated for credit without restriction.

**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

Advanced Topics in Electrical Engineering: Organic Materials in Electronics: Read Less [-]

## EL ENG C291 Control and Optimization of Distributed Parameters Systems 3 Units

Terms offered: Fall 2017, Spring 2016, Spring 2015, Spring 2014
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.
Control and Optimization of Distributed Parameters Systems: Read More [+]

**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

Control and Optimization of Distributed Parameters Systems: Read Less [-]

## EL ENG C291E Hybrid Systems and Intelligent Control 3 Units

Terms offered: Spring 2020, Spring 2018, Spring 2016
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).
Hybrid Systems and Intelligent Control: Read More [+]

**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

Hybrid Systems and Intelligent Control: Read Less [-]

## EL ENG 297 Field Studies in Electrical Engineering 12 Units

Terms offered: Summer 2018 8 Week Session, Fall 2011, Fall 2010
Supervised experience in off-campus companies relevant to specific aspects and applications of electrical engineering. Written report required at the end of the semester.
Field Studies in Electrical Engineering: Read More [+]

**Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**

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

**Summer:** 8 weeks - 1-12 hours of independent study per week

**Additional Details**

**Subject/Course Level:** Electrical Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Field Studies in Electrical Engineering: Read Less [-]

## EL ENG 298 Group Studies, Seminars, or Group Research 1 - 4 Units

Terms offered: Spring 2020, Spring 2019, Fall 2018
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.
Group Studies, Seminars, or Group Research: Read More [+]

**Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Group Studies, Seminars, or Group Research: Read Less [-]

## EL ENG 299 Individual Research 1 - 12 Units

Terms offered: Spring 2019, Summer 2016 10 Week Session, Summer 2016 8 Week Session
Investigation of problems in electrical engineering.
Individual Research: Read More [+]

**Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Individual Research: Read Less [-]

## EL ENG 375 Teaching Techniques for Electrical Engineering 2 Units

Terms offered: Fall 2020, Spring 2020, Fall 2019
Discussion of effective teaching techniques. Use of educational objectives, alternative forms of instruction, and proven techniques to enhance student learning. This course is intended to orient new student instructors to more effectively teach courses offered by the Department of Electrical Engineering and Computer Sciences at UC Berkeley.
Teaching Techniques for Electrical Engineering: Read More [+]

**Rules & Requirements**

**Prerequisites:** Teaching assistant or graduate student

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Teaching Techniques for Electrical Engineering: Read Less [-]

## EL ENG 602 Individual Study for Doctoral Students 1 - 8 Units

Terms offered: Fall 2016, Fall 2015, Fall 2014
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).
Individual Study for Doctoral Students: Read More [+]
**Rules & Requirements**

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

**Repeat rules:** Course may be repeated for credit without restriction.

**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.

Individual Study for Doctoral Students: Read Less [-]