Electrical Engineering and Computer Sciences

The Department of Electrical Engineering and Computer Sciences offers four graduate programs in Electrical Engineering: the Master of Engineering (MEng) in Electrical Engineering and Computer Sciences, the Master of Advanced Study in Integrated Circuits (MAS-IC), the Master of Science (MS), and the Doctor of Philosophy (PhD).

For information regarding the MAS-IC program, please see the Integrated Circuits program page (http://guide.berkeley.edu/archive/2014-15/graduate/degree-programs/integrated-circuits) in this Bulletin.

Master of Engineering (MEng)

The Master of Engineering (MEng) in Electrical Engineering & Computer Sciences, first offered by the EECS Department in the 2011-2012 academic year, is a professional master's with a larger tuition than our other programs and is designed for students who plan to join the engineering profession immediately following graduation. The accelerated program is designed to develop professional engineering leaders who understand the technical, economic, and social issues of technology. This single academic year, interdisciplinary experience includes three major components: an area of technical concentration, courses in leadership skills, and a rigorous capstone project experience.

Master of Science (MS)

The Master of Science (MS) emphasizes research preparation and experience and, for most students, is a chance to lay the groundwork for pursuing a PhD.

Doctor of Philosophy (PhD)

The Berkeley PhD in EECS combines coursework and original research with some of the finest EECS faculty in the U.S. preparing for careers in academia or industry. Our alumni (http://www.eecs.berkeley.edu/alumni/distinguished.shtml) have gone on to hold amazing positions around the world.

Admission to the University

Uniform minimum requirements for admission

The following minimum requirements apply to all programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A minimum grade-point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g. Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 570 on the paper-and-pencil test, 230 on the computer-based test, 90 on the iBT test, or an IELTS Band score of at least 7 (note that individual programs may set higher levels for any of these); and
4. Enough undergraduate training to do graduate work in the given field.

Applicants who already hold a graduate degree

The Graduate Council views academic degrees as evidence of broad research training, not as vocational training certificates; therefore, applicants who already have academic graduate degrees should be able to take up new subject matter on a serious level without undertaking a graduate program, unless the fields are completely dissimilar.

Programs may consider students for an additional academic master's or professional master's degree if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may only apply to one single degree program or one concurrent degree program per admission cycle.

Any applicant who was previously registered at Berkeley as a graduate student, no matter how briefly, must apply for readmission, not admission, even if the new application is to a different program.

Required documents for admissions applications

1. **Transcripts:** Upload unofficial transcripts with the application for the departmental initial review. Official transcripts of all college-level work will be required **if admitted**. Official transcripts must be in sealed envelopes as issued by the school(s) you have attended. Request a current transcript from every post-secondary school that you have attended, including community colleges, summer sessions, and extension programs.
   If you have attended Berkeley, upload unofficial transcript with the application for the departmental initial review. Official transcript with evidence of degree conferral ***will not*** be required if admitted.
2. **Letters of recommendation:** Applicants can request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.
3. **Evidence of English language proficiency:** All applicants from countries in which the official language is not English are required to submit official evidence of English language proficiency. This requirement applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, and most European countries. However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a U.S. university

may submit an official transcript from the U.S. university to fulfill this requirement. The following courses will not fulfill this requirement: 1) courses in English as a Second Language, 2) courses conducted in a language other than English, 3) courses that will be completed after the application is submitted, and 4) courses of a non-academic nature. If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests.

Admission to the MS/PhD Program

The following items are required for admission to the Berkeley EECS MS/PhD program in addition to the University's general graduate admission requirements:

1. **GRE Scores:** All three sections of the GRE are required. Send your scores electronically to Institution Code 4833. (scores must be from the last five years)
2. **Statement of Purpose:** Why are you applying for this program? What will you do during this degree program? What do you want to do after and how will this help you?
3. **Personal History Statement:** What from your past made you decide to go into this field? And how will your personal history help you succeed in this program and your future goals?
4. **GPA:** If you attended a university outside of the USA, please leave the GPA section blank.
5. **Resume:** Please also include a full resume/CV listing your experience and education.

Complete the online UC Berkeley graduate application:

1. Start your application through this link (http://www.grad.berkeley.edu) and fill in each relevant page.
2. Upload the materials above, and send the recommender links several weeks prior to the application deadline to give your recommenders time to submit their letters

Normative Time Requirements

Total Normative Time

Normative Time in the EECS department is between 5.5-6 years for the doctoral program.

Time to Advancement

Curriculum

The Faculty of the College of Engineering recommends a minimum number of courses taken while in graduate standing. The total minimum is 24 units of coursework, taken for a letter grade and not including 298, 299, 301, and 602. Students entering prior to Fall 2009 have the option of completing 32 units of coursework with a reduced teaching requirement.

Approved study list per student's research interests to include:		
12 units in one major field within EECS, with a 3.5 GPA		
6 units in one minor field within EECS, with a 3.0 GPA		
6 units in one minor field outside EECS, with a 3.0 GPA		
EL ENG 375	Teaching Techniques for Electrical Engineering	1

Preliminary Exams

The EECS Preliminary Requirement consists of two components:

Oral examination

The oral exam serves an advisory role in a student's graduate studies program with official feedback from the exam committee of faculty members. Students must be able to demonstrate an integrated grasp of the exam area's body of knowledge in an unstructured framework. Students must pass the oral portion of the preliminary exam within their first two attempts. A third attempt is possible with a petition of support from the student's faculty advisor and final approval by the Prelim Committee chair. Failure to pass the oral portion of the preliminary exam will result in the student being ineligible to complete the PhD program. The examining committee awards a score in the range of 0-10. The minimum passing score is 6.0.

Breadth courses

The prelim breadth courses ensure that students have an exposure to areas outside of their concentration.

EE students are expected to complete two courses of at least three units each in two areas of EECS outside their oral exam area. These courses must be graduate or advanced undergraduate courses, and students must receive a grade of A- or better.

QE

The Qualifying Examination is an important checkpoint meant to show that a student is on a promising research track toward the PhD degree. It is a University examination, administered by the Graduate Council, with the specific purpose of demonstrating that "the student is clearly an expert in those areas of the discipline that have been specified for the examination, and that he or she can, in all likelihood, design and produce an acceptable dissertation." Despite such rigid criteria, faculty examiners recognize that the level of expertise expected is that appropriate for a 3rd year graduate student who may be only in the early stages of a research project.

The EECS Departments offers the Qualifying exam in two formats A or B. Students may choose the exam type of their choice after consultation with their advisor.

Format A

1. Students prepare a write-up and presentation summarizing a specific research area, preferably the one in which they intend to do their dissertation work. Their summary surveys that area and describes open and interesting research problems.
2. They describe why they chose these problems and indicate what direction their research may take in the future.
3. They prepare to display expertise on both the topic presented and on any related material that the committee thinks is relevant.
4. The student should talk (at least briefly) about any research progress to date (e.g. MS project, PhD research, class project etc.). Some evidence of the ability to do research is expected.
5. The committee shall evaluate students on the basis of their comprehension of the fundamental facts and principles that apply within their research area and the student's ability to think incisively and critically about the theoretical and practical aspects of this field.
6. Students must demonstrate command of the content and the ability to design and produce an acceptable dissertation.

Format B

This option includes the presentation and defense of a thesis proposal in addition to the requirements of option A. It will include a summary of research to date and plans for future work (or at least the next stage thereof). The committee shall not only evaluate the student's thesis proposal and his/her progress to date, but shall also evaluate according to option A. As in option A, the student should prepare a single document and presentation, but in this case additional emphasis must be placed on research completed to date, and plans for the remainder of the dissertation research.

Thesis Proposal Defense

Students not presenting a satisfactory thesis proposal defense, either because they took option A for the QE, or because the material presented in an option B exam was not deemed a satisfactory proposal defense (although it may have sufficed to pass the QE), must write up and present a thesis proposal, which should include a summary of the research to date and plans for the remainder of the dissertation research. They should be prepared to discuss background and related areas, but the focus of the proposal should be on the progress made so far, and detailed plans for completing the thesis. The standard for continuing on with PhD research is that the proposal has sufficient merit to lead to a satisfactory dissertation. Another purpose of this presentation is for faculty to provide feedback on the quality of work to date. For this step, the committee should consist of at least 3 members from EECS familiar with the research area, preferably including those on the dissertation committee.

Normative Time in Candidacy

Advancement to Candidacy

Students must file the advancement form in the Graduate Office no later than the end of the semester following the one in which the Qualifying Exam was passed. In approving this application, Graduate Division approves the dissertation committee and will send a Certificate of Candidacy.

Dissertation Talk

As part of the requirements for the doctoral degree, students must give a public talk on the research covered by their dissertation. The dissertation talk is to be given a few months before the signing of the final submission of the dissertation. The talk should cover all the major components of the dissertation work in a substantial manner; in particular, the dissertation talk should not omit topics that will appear in the dissertation but are incomplete at the time of the talk.

The dissertation talk is to be attended by the whole dissertation committee, or, if this is not possible, by at least a majority of the members. Attendance at this talk is part of the committee's responsibility. It is, however, the responsibility of the student to schedule a time for the talk that is convenient for members of the committee.

Required Professional Development

Graduate Student Instructor Teaching Requirement

The Department requires all PhD candidates to serve as Graduate Student Instructors (GSIs) within the EECS department. The GSI teaching requirement not only helps to develop a student's communication skills, but it also makes a great contribution to the department's academic community. Students must fulfill this requirement by working as a GSI (excluding EL ENG 301, COMPSCI 301, EL ENG 375, or COMPSCI 375) for a total of 30 hours minimum prior to graduation. At least 20 of those hours must be for an EE or CS undergraduate course.

Unit requirements

A minimum of 24 units is required.

Curriculum

All courses must be taken for a letter grade, except courses numbered 299s, which are only offered for *S/U* credit.

Students must maintain a minimum cumulative GPA of 3.0. No credit will be given for courses in which the student earns a grade of D+ or below.

Transfer credit may be awarded for a maximum of 4 semester or 6 quarter units of graduate coursework from another institution.

Plan I

10 units of courses, selected from the 200-series (excluding 298 and 299) in EECS		
EL ENG 299	Individual Research	4-10
or COMPSCI 299	Individual Research	
Upper-division or graduate courses to reach the minimum of 24 units		

Plan II

10 units of courses, selected from the 200-series (excluding 298 and 299) in EECS		
EL ENG 299	Individual Research	3-6
or COMPSCI 299	Individual Research	
Upper-division or graduate courses to reach the minimum of 24 units		

Advancement to Candidacy

For both Plan I and Plan II MS students, students need to complete the departmental Advance to Candidacy form, have their research adviser sign it, and submit the form to the Department. Once a student is advanced to candidacy, candidacy is valid for 3 years.

Capstone/Thesis (Plan I)

Students planning to use Plan I for their MS Degree will need to follow the Graduate Division's "Thesis Filing Guidelines." They will also need to complete the "Graduate Division Advance to Candidacy" form and submit this to the department no later than the end of the 2nd week of classes of their final semester.

Capstone/Master's Project (Plan II)

Students planning to use Plan II for their MS Degree will need to produce an MS Plan II Title/Signature Page. There is no special formatting required for the body of the Plan II MS report unlike the Plan I MS thesis which must follow strict Graduate Division guidelines.

Unit requirements

The minimum number of units to complete the degree is 25 semester units.

Curriculum

Technical courses		
12 units, two courses per semester, of approved technical courses		12
Leadership courses		
ENGIN 271	Engineering Leadership I	3
ENGIN 272	Engineering Leadership II	3
ENGIN 295	Master of Engineering Capstone Integration (2 semesters required)	1
ENGIN 296MA	Master of Engineering Capstone Project	2
ENGIN 296MB	Master of Engineering Capstone Project	3

Capstone/Master's Project (Plan II)

Students will join a team of three to five students and address a specific problem or opportunity that can be addressed by technology, gaining direct experience in applying the skills learned in leadership courses.

The Fung Institute (http://funginstitute.berkeley.edu/programs/curriculum-model) is offering optional coursework during the summer for incoming students in computational analytics. This will help MEng students to improve their success in technical electives, capstone projects, and the job search.

Computation and data have become fundamental to engineering and business. Today's professional engineer often needs to master a specific discipline – be it Mechanical, or Civil, or Industrial Engineering – and a set of computational tools and abilities to analyze data. The Berkeley MEng program provides a unique opportunity to accomplish both of these objectives, by providing an **optional and unofficial Area of Emphasis in Computational Analytics**. Earning the professional Masters Degree and fulfilling the requirements for the emphasis makes for a challenging year, though students can even out the workload by attending a course during summer session. This guide contains advice on appropriate elective courses and extracurricular activities.

If you would like to indicate an *"Emphasis in Computational Analytics"* on your resume, you should be taking at least TWO of the recommended or other possible courses from the list below.

One of these course may be counted towards other M.Eng. course requirements, only if it is offered in your degree-granting department and approved as accepted towards your concentration.

We also recommend being involved in at least one activity or workshop (hackathon, speaker series, etc.); see the following list for details.

More information and a list of recommended electives can be found on their website (http://funginstitute.berkeley.edu/programs-centers-master-engineering/emphasis-computational-analytics) .

Select a subject to view courses

Computer Science

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

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Lee

Also listed as: EL ENG C219D

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

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Lee, Seshia

Formerly known as: Electrical Engineering C249M/Computer Science C249M

Also listed as: EL ENG C249A

COMPSCI 250 VLSI Systems Design 4 Units
Unified top-down and bottom-up design of integrated circuits and systems concentrating on architectural and topological issues. VLSI architectures, systolic arrays, self-timed systems. Trends in VLSI development. Physical limits. Tradeoffs in custom-design, standard cells, gate arrays. VLSI design tools.
Rules & Requirements

Prerequisites: 150

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Wawrzynek

COMPSCI 252 Graduate Computer Architecture 4 Units
Graduate survey of contemporary computer organizations covering: early systems, CPU design, instruction sets, control, processors, busses, ALU, memory, I/O interfaces, connection networks, virtual memory, pipelined computers, multiprocessors, and case studies. Term paper or project is required.
Rules & Requirements

Prerequisites: 152

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Culler, Kubiatowicz, Patterson

COMPSCI 260A User Interface Design and Development 4 Units
The design, implementation, and evaluation of user interfaces. User-centered design and task analysis. Conceptual models and interface metaphors. Usability inspection and evaluation methods. Analysis of user study data. Input methods (keyboard, pointing, touch, tangible) and input models. Visual design principles. Interface prototyping and implementation methodologies and tools. Students will develop a user interface for a specific task and target user group in teams.
Rules & Requirements

Prerequisites: Computer Science 61B, 61BL, or consent of instructor

Credit Restrictions: Students will receive no credit for Computer Science 260A after taking Computer Science 160.

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Agrawala, Canny, Hartmann

COMPSCI 260B Human-Computer Interaction Research 3 Units
This course is a broad introduction to conducting research in Human-Computer Interaction. Students will become familiar with seminal and recent literature; learn to review and critique research papers; re-implement and evaluate important existing systems; and gain experience in conducting research. Topics include input devices, computer-supported cooperative work, crowdsourcing, design tools, evaluation methods, search and mobile interfaces, usable security, help and tutorial systems.
Rules & Requirements

Prerequisites: Computer Science 160 recommended, or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Hartmann

COMPSCI 261 Security in Computer Systems 3 Units
Graduate survey of modern topics in computer security, including protection, access control, distributed access security, firewalls, secure coding practices, safe languages, mobile code, and case studies from real-world systems. May also cover cryptographic protocols, privacy and anonymity, and/or other topics as time permits.
Rules & Requirements

Prerequisites: 162

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: D. Song, Wagner

COMPSCI 261N Internet and Network Security 4 Units
Develops a thorough grounding in Internet and network security suitable for those interested in conducting research in the area or those more broadly interested in security or networking. Potential topics include denial-of-service; capabilities; network intrusion detection/prevention; worms; forensics; scanning; traffic analysis; legal issues; web attacks; anonymity; wireless and networked devices; honeypots; botnets; scams; underground economy; attacker infrastructure; research pitfalls.
Rules & Requirements

Prerequisites: Electrical Engineering 122 or equivalent; Computer Science 161 or familiarity with basic security concepts

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Paxson

COMPSCI 262A Advanced Topics in Computer Systems 4 Units
Graduate survey of systems for managing computation and information, covering a breadth of topics: early systems; volatile memory management, including virtual memory and buffer management; persistent memory systems, including both file systems and transactional storage managers; storage metadata, physical vs. logical naming, schemas, process scheduling, threading and concurrency control; system support for networking, including remote procedure calls, transactional RPC, TCP, and active messages; security infrastructure; extensible systems and APIs; performance analysis and engineering of large software systems. Homework assignments, exam, and term paper or project required.
Rules & Requirements

Prerequisites: 162 and entrance exam

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Brewer, Hellerstein

Formerly known as: 262

COMPSCI 262B Advanced Topics in Computer Systems 3 Units
Continued graduate survey of large-scale systems for managing information and computation. Topics include basic performance measurement; extensibility, with attention to protection, security, and management of abstract data types; index structures, including support for concurrency and recovery; parallelism, including parallel architectures, query processing and scheduling; distributed data management, including distributed and mobile file systems and databases; distributed caching; large-scale data analysis and search. Homework assignments, exam, and term paper or project required.
Rules & Requirements

Prerequisites: 262A

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Brewer, Culler, Hellerstein, Joseph

COMPSCI 263 Design of Programming Languages 3 Units
Selected topics from: analysis, comparison, and design of programming languages, formal description of syntax and semantics, advanced programming techniques, structured programming, debugging, verification of programs and compilers, and proofs of correctness.
Rules & Requirements

Prerequisites: 164

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Necula

COMPSCI 264 Implementation of Programming Languages 4 Units
Compiler construction. Lexical analysis, syntax analysis. Semantic analysis code generation and optimization. Storage management. Run-time organization.
Rules & Requirements

Prerequisites: 164, 263 recommended

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 6 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Bodik

COMPSCI 265 Compiler Optimization and Code Generation 3 Units
Table-driven and retargetable code generators. Register management. Flow analysis and global optimization methods. Code optimization for advanced languages and architectures. Local code improvement. Optimization by program transformation. Selected additional topics. A term paper or project is required.
Rules & Requirements

Prerequisites: 164

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Sen

COMPSCI C267 Applications of Parallel Computers 3 Units
Models for parallel programming. Fundamental algorithms for linear algebra, sorting, FFT, etc. Survey of parallel machines and machine structures. Exiting parallel programming languages, vectorizing compilers, environments, libraries and toolboxes. Data partitioning techniques. Techniques for synchronization and load balancing. Detailed study and algorithm/program development of medium sized applications.
Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Demmel, Yelick

Also listed as: ENGIN C233

COMPSCI 268 Computer Networks 3 Units
Distributed systems, their notivations, applications, and organization. The network component. Network architectures. Local and long-haul networks, technologies, and topologies. Data link, network, and transport protocols. Point-to-point and broadcast networks. Routing and congestion control. Higher-level protocols. Naming. Internetworking. Examples and case studies.
Rules & Requirements

Prerequisites: 162

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Joseph, Katz, Stoica

Formerly known as: 292V

COMPSCI 270 Combinatorial Algorithms and Data Structures 3 Units
Design and analysis of efficient algorithms for combinatorial problems. Network flow theory, matching theory, matroid theory; augmenting-path algorithms; branch-and-bound algorithms; data structure techniques for efficient implementation of combinatorial algorithms; analysis of data structures; applications of data structure techniques to sorting, searching, and geometric problems.

Rules & Requirements

Prerequisites: 170

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Papadimitriou, Rao, Sinclair, Vazirani

COMPSCI 271 Randomness and Computation 3 Units
Computational applications of randomness and computational theories of randomness. Approximate counting and uniform generation of combinatorial objects, rapid convergence of random walks on expander graphs, explicit construction of expander graphs, randomized reductions, Kolmogorov complexity, pseudo-random number generation, semi-random sources.

Rules & Requirements

Prerequisites: 170 and at least one course numbered 270-279

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Sinclair

COMPSCI 273 Foundations of Parallel Computation 3 Units
. Fundamental theoretical issues in designing parallel algorithms and architectures. Shared memory models of parallel computation. Parallel algorithms for linear algegra, sorting, Fourier Transform, recurrence evaluation, and graph problems. Interconnection network based models. Algorithm design techniques for networks like hypercubes, shuffle-exchanges, threes, meshes and butterfly networks. Systolic arrays and techniques for generating them. Message routing.

Rules & Requirements

Prerequisites: 170, or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Rao

COMPSCI 274 Computational Geometry 3 Units
. Constructive problems in computational geometry: convex hulls, triangulations, Voronoi diagrams, arrangements of hyperplanes; relationships among these problems. Search problems: advanced data structures; subdivision search; various kinds of range searches. Models of computation; lower bounds.

Rules & Requirements

Prerequisites: 170 or equivalent

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Shewchuk

COMPSCI 276 Cryptography 3 Units
Graduate survey of modern topics on theory, foundations, and applications of modern cryptography. One-way functions; pseudorandomness; encryption; authentication; public-key cryptosystems; notions of security. May also cover zero-knowledge proofs, multi-party cryptographic protocols, practical applications, and/or other topics, as time permits.
Rules & Requirements

Prerequisites: 170

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Trevisan, Wagner

COMPSCI C280 Computer Vision 3 Units
Paradigms for computational vision. Relation to human visual perception. Mathematical techniques for representing and reasoning, with curves, surfaces and volumes. Illumination and reflectance models. Color perception. Image segmentation and aggregation. Methods for bottom-up three dimensional shape recovery: Line drawing analysis, stereo, shading, motion, texture. Use of object models for prediction and recognition.
Rules & Requirements

Prerequisites: Knowledge of linear algebra and calculus. Mathematics 1A-1B, 53, 54 or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Malik

Also listed as: VIS SCI C280

COMPSCI C281A Statistical Learning Theory 3 Units
Classification regression, clustering, dimensionality, reduction, and density estimation. Mixture models, hierarchical models, factorial models, hidden Markov, and state space models, Markov properties, and recursive algorithms for general probabilistic inference nonparametric methods including decision trees, kernal methods, neural networks, and wavelets. Ensemble methods.
Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Bartlett, Jordan, Wainwright

Also listed as: STAT C241A

COMPSCI C281B Advanced Topics in Learning and Decision Making 3 Units
Recent topics include: Graphical models and approximate inference algorithms. Markov chain Monte Carlo, mean field and probability propagation methods. Model selection and stochastic realization. Bayesian information theoretic and structural risk minimization approaches. Markov decision processes and partially observable Markov decision processes. Reinforcement learning.
Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Bartlett, Jordan, Wainwright

Also listed as: STAT C241B

COMPSCI 284A Foundations of Computer Graphics 4 Units
Techniques of modeling objects for the purpose of computer rendering: boundary representations, constructive solids geometry, hierarchical scene descriptions. Mathematical techniques for curve and surface representation. Basic elements of a computer graphics rendering pipeline; architecture of modern graphics display devices. Geometrical transformations such as rotation, scaling, translation, and their matrix representations. Homogeneous coordinates, projective and perspective transformations.
Rules & Requirements

Prerequisites: Computer Science 61B or 61BL; programming skills in C, C++, or Java; linear algebra and calculus; or consent of instructor

Credit Restrictions: Students will receive no credit for Computer Science 284A after taking 184.

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Agrawala, Barsky, O'Brien, Ramamoorthi, Sequin

COMPSCI 284B Advanced Computer Graphics Algorithms and Techniques 4 Units
This course provides a graduate-level introduction to advanced computer graphics algorithms and techniques. Students should already be familiar with basic concepts such as transformations, scan-conversion, scene graphs, shading, and light transport. Topics covered in this course include global illumination, mesh processing, subdivision surfaces, basic differential geometry, physically based animation, inverse kinematics, imaging and computational photography, and precomputed light transport.
Rules & Requirements

Prerequisites: 184 or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: O'Brien, Ramamoorthi

Formerly known as: Computer Science 283

COMPSCI 286A Introduction to Database Systems 4 Units
Access methods and file systems to facilitate data access. Hierarchical, network, relational, and object-oriented data models. Query languages for models. Embedding query languages in programming languages. Database services including protection, integrity control, and alternative views of data. High-level interfaces including application generators, browsers, and report writers. Introduction to transaction processing. Database system implementation to be done as term project.
Rules & Requirements

Prerequisites: Computer Science 61B and 61C

Credit Restrictions: Students will receive no credit for CS 286A after taking CS 186.

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Franklin, Hellerstein

COMPSCI 286B Implementation of Data Base Systems 3 Units
Implementation of data base systems on modern hardware systems. Considerations concerning operating system design, including buffering, page size, prefetching, etc. Query processing algorithms, design of crash recovery and concurrency control systems. Implementation of distributed data bases and data base machines.
Rules & Requirements

Prerequisites: Computer Science 162 and 186 or 286A

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Franklin, Hellerstein

COMPSCI 287 Advanced Robotics 3 Units
Advanced topics related to current research in robotics. Planning and control issues for realistic robot systems, taking into account: dynamic constraints, control and sensing uncertainty, and non-holonomic motion constraints. Analysis of friction for assembly and grasping tasks. Sensing systems for hands including tactile and force sensing. Environmental perception from sparse sensors for dextrous hands. Grasp planning and manipulation.
Rules & Requirements

Prerequisites: Electrical Engineering 125

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Abbeel

COMPSCI 288 Natural Language Processing 4 Units
Methods and models for the analysis of natural (human) language data. Topics include: language modeling, speech recognition, linguistic analysis (syntactic parsing, semantic analysis, reference resolution, discourse modeling), machine translation, information extraction, question answering, and computational linguistics techniques.
Rules & Requirements

Prerequisites: CS188 required, CS170 recommended

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructor: Klein

COMPSCI 289A Introduction to Machine Learning 4 Units
This course provides an introduction to theoretical foundations, algorithms, and methodologies for machine learning, emphasizing the role of probability and optimization and exploring a variety of real-world applications. Students are expected to have a solid foundation in calculus and linear algebra as well as exposure to the basic tools of logic and probability, and should be familiar with at least one modern, high-level programming language.
Rules & Requirements

Prerequisites: Mathematics 53, 54; Computer Science 70; Computer Science 188 or consent of instructor

Credit Restrictions: Students will receive no credit for Comp Sci 289A after taking Comp Sci 189.

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Letter grade.

Instructors: Abbeel, Bartlett, Darrell, El Ghaoui, Jordan, Klein, Malik, Russell

COMPSCI 294 Special Topics 1 - 4 Units
Topics will vary from semester to semester. See Computer Science Division announcements.
Rules & Requirements

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

Hours & Format

Fall and/or spring:
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: Computer Science/Graduate

Grading: Letter grade.

COMPSCI 297 Field Studies in Computer Science 1 - 12 Units
Supervised experience in off-campus companies relevant to specific aspects and applications of electrical engineering and/or computer science. Written report required at the end of the semester.
Rules & Requirements

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

Hours & Format

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

Summer:
6 weeks - 2.5-30 hours of independent study per week
8 weeks - 1.5-22.5 hours of independent study per week
10 weeks - 1.5-18 hours of independent study per week

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Graduate

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

COMPSCI 299 Individual Research 1 - 12 Units
Investigations of problems in computer science.
Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 0-1 hours of independent study per week

Summer:
6 weeks - 8-30 hours of independent study per week
8 weeks - 6-22.5 hours of independent study per week
10 weeks - 1.5-18 hours of independent study per week

Additional Details

Subject/Course Level: Computer Science/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

COMPSCI 300 Teaching Practice 1 - 6 Units
Supervised teaching practice, in either a one-on-one tutorial or classroom discussion setting.
Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of 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: Computer Science/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

COMPSCI 302 Designing Computer Science Education 3 Units
Discussion and review of research and practice relating to the teaching of computer science: knowledge organization and misconceptions, curriculum and topic organization, evaluation, collaborative learning, technology use, and administrative issues. As part of a semester-long project to design a computer science course, participants invent and refine a variety of homework and exam activities, and evaluate alternatives for textbooks, grading and other administrative policies, and innovative uses of technology.
Rules & Requirements

Prerequisites: Computer Science 301 and two semesters of GSI experience

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Professional course for teachers or prospective teachers

Grading: Letter grade.

Instructor: Garcia

COMPSCI 375 Teaching Techniques for Computer Science 2 Units
Discussion and practice of techniques for effective teaching, focusing on issues most relevant to teaching assistants in computer science courses.
Rules & Requirements

Prerequisites: Consent of instructor

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

Hours & Format

Fall and/or spring: 10 weeks - 3 hours of discussion per week

Summer: 8 weeks - 4 hours of discussion per week

Additional Details

Subject/Course Level: Computer Science/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructors: Barsky, Garcia, Harvey

COMPSCI 399 Professional Preparation: Supervised Teaching of Computer Science 1 or 2 Units
Discussion, problem review and development, guidance of computer science laboratory sections, course development, supervised practice teaching.
Rules & Requirements

Prerequisites: Appointment as graduate student instructor

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

Hours & Format

Fall and/or spring: 15 weeks - 1-2 hours of independent study per week

Summer: 8 weeks - 1-2 hours of independent study per week

Additional Details

Subject/Course Level: Computer Science/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

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

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

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

Hours & Format

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

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

Additional Details

Subject/Course Level: Computer Science/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.

Electrical Engineering and Computer Sciences

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

Prerequisites: 120 or equivalent, or consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Bajcsy

Formerly known as: Electrical Engineering 215A

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

Prerequisites: 117, or PHYSICS 110A, 110B

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 210A-210B

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: El Engineering 290G

Also listed as: AST C210

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Waller

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Roychowdhury

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

Prerequisites: Consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor; Computer Science 170 is recommended

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Seshia

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Lee

Also listed as: COMPSCI C219D

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Borrelli, Horowitz, Tomizuka, Tomlin

Also listed as: MEC ENG C232

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C231A

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Also listed as: MEC ENG C231B

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

Prerequisites: 120; Mathematics 110 recommended

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: 221A (may be taken concurrently)

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: 120 and 126, or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 224

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

Prerequisites: 121, 226A, or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Tse

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

Prerequisites: 123 and 126 or solid background in stochastic processes

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Gastpar, Bahai

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

Prerequisites: 123

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Zakhor

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Morgan

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

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

Rules & Requirements

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Lustig, Conolly

Also listed as: BIO ENG C265

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

Prerequisites: 120 and Statistics 200A or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Anantharam

Formerly known as: 226

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

Prerequisites: 226A

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Anantharam, Varaiya

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

Prerequisites: Mathematics 54 or equivalent or consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: El Ghaoui

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

Prerequisites: Mathematics 54 and Statistics 2 or equivalents

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: El Ghaoui, Wainwright

Formerly known as: Electrical Engineering 227A

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

Prerequisites: 227A or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: El Ghaoui

Also listed as: IND ENG C227B

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: El Ghaoui, Wainwright

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

Also listed as: IND ENG C227A

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: 226 recommended, Statistics 200A or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Anantharam, Tse

Formerly known as: 229

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Anatharam

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

Prerequisites: 40 or 100

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering 230M

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

Prerequisites: 130 or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Subramanian, King Liu, Salahuddin

Formerly known as: Electrical Engineering 231

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

Prerequisites: 131; PHYSICS 137B

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Bokor, Salahuddin

Formerly known as: Electrical Engineering 230

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

Prerequisites: MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Javey, Subramanian, King Liu

Formerly known as: Electrical Engineering W130

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

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

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Subramanian, King Liu, Salahuddin

Formerly known as: Electrical Engineering W231

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

Prerequisites: Electrical Engineering 130 or equivalent; PHYSICS 137A and Electrical Engineering 117 recommended

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Wu

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Chang-Hasnain

Also listed as: NSE C203

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

Prerequisites: 117A, PHYSICS 137A or equivalent

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: An upper division course in electromagnetics or fluid dynamics

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 239

Also listed as: AST C239

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

Prerequisites: Electrical Engineering 105

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Sanders, Nguyen

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

Prerequisites: 140

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering 240

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

Prerequisites: Electrical Engineering 140

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Boser

Formerly known as: Electrical Engineering 247

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

Prerequisites: MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Alon, Sanders, Nguyen

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

Prerequisites: EE W240A; MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering W240

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

Prerequisites: EE W240A; MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Boser

Formerly known as: Electrical Engineering W247

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

Rules & Requirements

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Alon, Rabaey, Nikolic

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

Rules & Requirements

Prerequisites: 141

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nikolic, Rabaey

Formerly known as: Electrical Engineering 241

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

Rules & Requirements

Prerequisites: MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Alon, Rabaey, Nikolic

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

Rules & Requirements

Prerequisites: EE W241A; MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nikolic, Rabaey

Formerly known as: Electrical Engineering W241

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

Prerequisites: 20N and 140 or equivalent

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: Electrical Engineering 242M

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

Prerequisites: 142, 240

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Niknejad

Formerly known as: Electrical Engineering 242

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

Prerequisites: EE W240A; MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Niknejad

Formerly known as: Electrical Engineering W142

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

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

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Niknejad

Formerly known as: Electrical Engineering W242

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

Prerequisites: 143 and either 140 or 141

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Graduate standing

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Keutzer, Lee, Roychowdhury, Seshia

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

Prerequisites: MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Keutzer, Lee, Roychowdhury, Seshia

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

Prerequisites: Graduate standing or consent of instructor

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Lin, Pisano

Formerly known as: 219

Also listed as: MEC ENG C219

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

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Maharbiz, Nguyen, Pister

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nguyen, Pister

Also listed as: MEC ENG C218

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

Prerequisites: MAS-IC students only

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Nguyen, Pister

Formerly known as: Electrical Engineering W245

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

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructors: Lee, Seshia

Formerly known as: Electrical Engineering C249M/Computer Science C249M

Also listed as: COMPSCI C249A

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Sangiovanni-Vincentelli

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

Also listed as: CIV ENG C289

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

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

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

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Conolly

Also listed as: BIO ENG C261

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Prerequisites: 130; undergraduate general chemistry

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Instructor: Subramanian

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

Rules & Requirements

Prerequisites: MAS-IC students only

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

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

Hours & Format

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

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

Online: This is an online course.

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

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

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Also listed as: CIV ENG C291F/MEC ENG C236

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Letter grade.

Formerly known as: 291E

Also listed as: MEC ENG C290S

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

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

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

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

Rules & Requirements

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

Hours & Format

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

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

Rules & Requirements

Prerequisites: Graduate standing

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

Hours & Format

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

Additional Details

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

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: Electrical Engineering 301

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

Rules & Requirements

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

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

Hours & Format

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.