Abstract data types, together with methods for specifying them. Implementations and proofs of implementation using recursion schemes to reason about program. Parameterized types. Constructing good formal specifications. Offered in alternate years.—II. Levitt

262. Distributed Database Systems (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 165A. Concepts of distributed database systems and architectures, distributed database design, distributed query processing and optimization, transaction processing, concurrency control, heterogeneous and multidatabase systems.—I, III. (III.) Gertz, Ludaescher

266. Spatial Databases (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 158B or 165A. Wide-area distributed information system design, broadcast, multicast, publish/subscribe, service differentiation, information retrieval, Web caching. Offered in alternate years.—III. Askoy

268. Scientific Data And Workflow Management (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 165A. Scientific data integration, metadata, knowledge representation, ontologies, scientific workflows, design and management. Offered in alternate years.—II. (II.) Davidson, Levitt


271. Machine Learning and Discovery (4) Lecture—3 hours; project—1 hour. Prerequisite: course 170. Artificial intelligence techniques for knowledge acquisition by computers. Fundamental problems in machine learning and discovery. Systems that learn from examples, analogies, and solved problems. Systems that discover numerical laws and qualitative relationships. Projects centering on implementation and evaluation.—III. Levitt, Vemuri

272. Information Visualization (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: course 163 or 175 recommended. Advanced topics in information visualization: perceptually effective display methods, color design and selection, interaction models and techniques, focus-context techniques, distortion methods, large visualization techniques, visual data mining methods, and evaluation methods.—II. (II.) Ma

273. Applied Visual Computing (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: graduate standing. Visual computing paradigms, current visualization technologies, principles of 3D graphics, user interface designs, and exploratory visualization. Offered in alternate years.—I. Hamann, Joy, Ma, Max

274. Automated Deduction (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Mathematics 125 or Philosophy 112 or familiarity with first-order logic. Techniques of mechanical theorem proving. Methods based on resolution and term-rewriting. Decidability procedures. Induction. Applications to program verification, question/answering and plan generation. Study existing mechanical theorem provers. Offered in alternate years.—III. Levitt

275A. Advanced Computer Graphics (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: courses 157 or 178. Advanced topics in computer graphics. Hidden surface models, rendering of various surface types, subdivision methods, shading techniques, anti-aliasing, modeling techniques.—II. (II.) Joy, Hamann

275B. Advanced Computer Graphics (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: course 175 or 177 or 178. Advanced topics in computer graphics and geometric modeling. Topics taken from advanced research papers in computer graphics, image-based visualization and geometric modeling. Discussion of current research in the field. Offered in alternate years.—II. (II.) Joy, Hamann, Ma

276. Advanced Volume Visualization (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 177. Applications, available tools and techniques, the challenges confronting the field of volume visualization, and some of the advanced topics in the field. Primary emphasis on advanced software and hardware techniques to achieve interactive visualization.—III. (III.) Hamann, Joy, Hamann, Ma

277. Computer-Aided Geometric Design (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: course 175. Mathematical techniques for the definition and manipulation of curves and surfaces. Bezier curves and surfaces, B-spline curves and surfaces, subdivision surfaces, wavelets. Integration into various computer graphics rendering models, visualization systems and computer-aided design systems. Offered in alternate years.—III. (III.) Joy, Hamann

279. Computer Animation (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 175 or 177. Course surveys current research and fundamental techniques that lie behind character animation tools. Emphasis on improving expressive aspects of movement and how physics, motion capture data, the arts and psychology literature, and interactive techniques can be used towards this goal. Offered in alternate years.—II. Neff

280. Virtual Reality Technology (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 175. Fundamentals and principles of Virtual Reality (VR) technology. Potential and limits for its useful application. Developing a complete virtual reality application. Offered in alternate years.—III. Joy


290. Seminar in Computer Science (1) Seminar—1 hour. Participating seminar; discussion and presentation of current research and development in computer science. (S/U grading only.—I, II, III, I, II, III

290C. Graduate Research Group Conference (1) Discussion—1 hour. Research problems, progress and techniques in computer science. May be repeated for credit. (S/U grading only.—I, II, III, I, II, III

293A. Research in Computer Science (1) Lecture—1 hour. Prerequisite: graduate standing in computer science. Study of research topics in computer science. Ph.D. level research methodologies (experimental, applied and theoretical). Study skills necessary to successfully find/solve significant research problems. Finding and successful interacting with a research advisor. Ethical issues in research/collaborative work. (S/U grading only.—I, II.) Martel

293B. Research in Computer Science (1) Lecture—1 hour. Prerequisite: graduate standing in computer science; course 293A recommended. Study of Ph.D. level research methodologies (experimental, applied and theoretical), presenting research results for the computer science community. Study skills necessary to successfully find/solve significant research problems. (S/U grading only.—II.) Martel

298. Group Study (1-5) Lecture, laboratory, or combination. Prerequisite: consent of instructor. (S/U grading only)

299. Research (1-12) (S/U grading only)

Professional

390. The Teaching of Computer Science (1) Discussion—1 hour. Prerequisite: meet qualifications for teaching assistant and/or associate-in in Computer Science. Participation as a teaching assistant or associate-in in a designated course offers. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports. May be repeated for credit. (S/U grading only.—I, II, III. I, II, III)

396. Teaching Assistant Training Practicum (1-4) Prerequisite: graduate standing. May be repeated for credit. (S/U grading only)

Engineering: Electrical and Computer Engineering

(College of Engineering)

Kent Willen, Ph.D., Chairperson of the Department
Charles Hunt, Ph.D., Vice Chairperson for Undergraduate Studies
Rajeev Amirtharajah, Ph.D., Vice Chairperson for Graduate Studies

Department Office. 2064 Kemper Hall
530-752-0583; http://www.ece.ucdavis.edu

Faculty

Khaled Abdel-Ghaffar, Ph.D., Professor
Venkatesh Akella, Ph.D., Professor
Hussain Al-Assad, Ph.D., Assistant Professor
Razan Alammari, Ph.D., Associate Professor
Bevan Baas, Ph.D., Associate Professor
G. R. Branner, Ph.D., Professor
Tao-Shuan Chang, Ph.D., Professor
Chen-Nee Chuah, Ph.D., Professor
Zhi Ding, Ph.D., Professor
Saeheil Ghiasi, Ph.D., Associate Professor
Gane Giu, Ph.D., Assistant Professor
A. Nazli Gündes, Ph.D., Professor
Joshua Hihath, Ph.D., Assistant Professor
Charles E. Hunt, Ph.D., Professor
Paul J. Hurst, Ph.D., Professor
Sail Islam, Ph.D., Associate Professor
Academic Senate Distinguished Teaching Award
Richard A. Kiehl, Ph.D., Professor
Andre Krause, Ph.D., Professor
H. Brian Kolner, Ph.D., Professor
Bernard C. Levy, Ph.D., Professor
Stephen H. Lewis, Ph.D., Professor
Xiaoqiang "Leo" Liu, Ph.D., Assistant Professor
Neville C. Luhmann, Jr., Ph.D., Professor
Omeed Momeni, Ph.D., Assistant Professor
Stephen D. O’Driscoll, Assistant Professor
John Owens, Ph.D., Associate Professor

Quarter Offered: I-Fall, II-Winter, III-Spring, IV-Summer; 2015-2016 offering in parentheses

Pre-Fall 2011 General Education (GE): AH=Arts and Humanities; SC=Science and Engineering; SS=Social Sciences; ACGH=American Cultures; DD=Domestic Diversity; Div=Dominant Diversity; Wrt=Writing Experience

Fall 2011 and on Revised General Education (GE): AH=Arts and Humanities; SC=Science and Engineering; SS=Social Sciences; ACGH=American Cultures; DD=Domestic Diversity; OL=Oral Skills; QL=Quantitative; SL=Scientific; VL=Visual; WC=World Cultures; WRT=Writing Experience
leaders in industry or to do meaningful research in industry, government or academia. Research—To develop and support research programs that produce useful technological advances while simultaneously training the next generation of researchers and leaders; to update and/or shift the focus of these programs frequently in response to the needs of our constituency and the nation; to provide a stimulating environment that encourages our graduate students to develop their abilities as far as possible.

### Electrical Engineering Undergraduate Program

The Electrical Engineering program is accredited by the Engineering Accreditation Commission of ABET; see http://www.abet.org.

Electrical engineering involves the design, analysis, and effective use of electrical systems including electronic computers. Electrical systems and computers play a central role in nearly all aspects of modern life, including communication, transportation, education, environmental protection, space exploration, defense, and home entertainment.

Students who complete the Electrical Engineering curriculum will obtain a Bachelor of Science in Electrical Engineering. One of the engineering degrees recognized in all fifty states as eligible for registration as a Professional Engineer.

### Objectives.

The Electrical Engineering program has adopted the following objectives to serve the long-term interests of our students and the industries of Northern California and the nation. Foundation—To provide our graduates with a solid foundation in engineering science, including mathematics, physical science, and the fundamentals of electrical engineering. This foundation is necessary to succeed in more advanced engineering courses and to be able to continue learning throughout a career. Breadth—To provide our graduates the sufficient breadth in electrical engineering in order to understand engineering tradeoffs that cross disciplines, to contribute effectively to multidisciplinary projects and to make an informed decision about their area of specialization. Depth—To provide our graduates with sufficient depth in a specific area of electrical engineering necessary to solve complex real-world engineering problems and to contribute to a specific discipline within electrical engineering. Ethics—To provide our graduates with a basic understanding of, and ability to handle correctly, ethical problems that may arise during their careers and to provide them with an understanding of their obligations to society at large.

Exclusive of General Education units, the minimum number of units for the Electrical Engineering major is 145 (70 units in the lower division and 75 in the upper division).

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed.

### Lower Division Required Courses

| Mathematics 21A-21B 21C 21D ........................................ 16 |
| Mathematics 22A-22B ................................................. 6 |
| Physics 9A-9B 9C-9D .................................................. 19 |
| Chemistry 2A .......................................................... 5 |
| Computer Science 10 ................................................... 4 |
| Engineering 6 ........................................................... 4 |
| Electrical and Computer Engineering 10 ........................ 3 |
| Electrical and Computer Engineering 10 ........................ 3 |

### Suggested Advisers.

R. Amirtharajah, Q. Gu, P.J. Hurst, S.H. Lewis, O. Momeni, S.D. O’Driscoll

Digital Electronics: transistors- and system-level analog circuit design.

### Recommended elective courses.

- Core electives: Electrical and Computer Engineering 130B, 140B
- Design Electives with Lab: Electrical and Computer Engineering 132A, 132B. Select remaining upper division design electives from Electrical and Computer Engineering 110B, 132C, 135

### Suggested Advisers.

G.R. Branner, A. Knoesen, X. Liu, N. Luhmann, O. Momeni, A. Pham, B. Yoo

Analog Electronics: transistor- and system-level digital circuit design.

### Recommended elective courses.

- Core electives: Electrical and Computer Engineering 110B, 130B, 130C

### Suggested Advisers.

R. Amirtharajah, Q. Gu, P.J. Hurst, S.H. Lewis, O. Momeni, S.D. O’Driscoll

Communication Controls and Signal Processing: digital communication, robotics, classical controls and communication, wireless and cellular digital communication systems, signal and image processing, and computer vision.

### Recommended elective courses.

- Core electives: Electrical and Computer Engineering, 1508, 1808
Design Electives with lab: Electrical and Computer Engineering 151, 157A and 157B or 155
Select remaining upper division design electives from Electrical and Computer Engineering 158 or 160

Technical Electives: Open only to Electrical and Computer Engineering 112, 195A-195B


Upper Division Required Courses
Electrical and Computer Engineering 100, 110A, 130A, 140A, 150A, 161, 180A, 196

Computer Engineering 160, 190 or Computer Science Engineering 188

Upper-division electives** 3-4

Three upper division courses, including one from the following:

- Computer Science Engineering 154B may be substituted for Electrical and Computer Engineering 170.

** After completion of the upper division elective requirement (at least 8 courses, 2 core, 2 with labs,
1 project) any units in excess of 32 will count toward the technical elective requirement.

Computer Engineering Undergraduate Program

The Computer Engineering program is accredited by the Engineering Accreditation Commission of ABET; see http://www.abet.org

Exclusions of General Education units, the minimum number of units required for the Computer Engineering undergraduate major is 148 (79 units in the lower division and 69 units in the upper division). Students are encouraged to adhere carefully to all prerequisite requirements. This instructor is authorized to drop students from a course for which stated prerequisites have not been completed.

Lower Division Required Courses

<table>
<thead>
<tr>
<th>UNITS</th>
<th>REQUIREMENTS</th>
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</thead>
<tbody>
<tr>
<td>16</td>
<td>Mathematics 21A-21B-21C-21D</td>
</tr>
<tr>
<td>7</td>
<td>Physics 22A-22AL-22B</td>
</tr>
<tr>
<td>19</td>
<td>Chemistry 2A</td>
</tr>
<tr>
<td>5</td>
<td>Computer Science Engineering 20, 30, 40, 60</td>
</tr>
<tr>
<td>1</td>
<td>Electrical and Computer Engineering 110A, 110B</td>
</tr>
<tr>
<td>40</td>
<td>Engineering 100, 102, 103, 122, 140</td>
</tr>
<tr>
<td>8</td>
<td>English 3 or University Writing Program 1, 1Y</td>
</tr>
<tr>
<td>8</td>
<td>Computer Science Engineering 110A, 122, 122P</td>
</tr>
<tr>
<td>1</td>
<td>Native American Studies 5</td>
</tr>
</tbody>
</table>

Communication 1 or 3

Upper Division Required Courses


Computer Science Engineering 122A, 150C, 150D, 150E, 154A & 154B

Computer Engineering 160, 190, or Computer Science Engineering 188*

Upper Division Elective Courses: 9-11

One design project course: Electrical and Computer Engineering 119B, 134AB, 136AB, 181AB, 193AB, 195AB

At least one design project course**: Electrical and Computer Engineering 119B, 134AB, 136AB, 181AB, 193AB, 195AB

The remaining electives may be any letter-graded upper division Electrical and Computer Engineering course not used to satisfy another major requirement;

Computer Science and Engineering 40, 150, 152B, 163, 175, 177, or 17B

Technical electives*** 9

A maximum of 6 units of any combination of engineering courses numbered 190C, 192, 198, and 199 may be used.

Chemistry 28, 2C & 2D, any upper division except Chemistry 195 & 197

Engineering 132, 135, 157, 188, 154A, & 154B (154 courses may be used by EEE majors who did not take EEC 170)

Any upper-division Mathematics course except Mathematics 135A & 1977C

Any upper-division Physics course except 116, 137, 160 (restricted to one unit of technical elective), 195, 1977T

Any upper-division Statistics course except Statistics 100, 102, 103, 104, 106, 108, 120, 130A


Economics 100, 101, 102, 123, 140, 150A, 150B

Management 11A, 11B, 120, 120C, 150, 160, 170, 180

Upper Division Composition Requirement:

One course from the following (a grade of C- or better is required): University Writing Program 101, 102A, 102AT or passing the Upper Division Composition Exam offered by the College of Letters and Science

* Computer Science Engineering 154B may be substituted for Electrical and Computer Engineering 170.

** All design project courses are also considered elective lab courses and may be counted in both categories simultaneously.

*** Computer Science Engineering 154B may be substituted for Electrical and Computer Engineering 170.

One course from the following [a grade of C- or better is required]: University Writing Program 101, 102A, 102AT or passing the Upper Division Composition Exam

Computer Science Engineering 154B may be substituted for the Electrical and Computer Engineering 170 requirement.

Electrical Engineering Minor

There has been an increasing need for professionals in most engineering disciplines to understand the fundamentals of electronic circuits, electronic signals, semiconductor devices, applied electromagnetics, control systems, computer systems, and communication systems.

The objective of this minor program is to prepare students with the necessary theoretical and practical training in one or many of the above mentioned fields. The minor program curriculum is designed to allow flexibility while ensuring a solid foundation of fundamental electrical engineering concepts. The program is expected to accommodate students of diverse backgrounds.

The minor must be outside the department or program of your major and no more than one course may be counted toward both your minor and your major. The courses you take to satisfy the requirements of a minor, including those completed elsewhere, must be approved by an advisor in the Department of Electrical and Computer Engineering. You must have a minimum overall GPA of 2.0 and satisfy the minor course requirements, listed below. To receive notification of this minor program, you must obtain a minor petition and file it no later than the deadline for filing for graduation.

Minor Requirements

<table>
<thead>
<tr>
<th>UNITS</th>
<th>REQUIREMENTS</th>
</tr>
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<tbody>
<tr>
<td>21</td>
<td>Electrical and Computer Engineering 100</td>
</tr>
</tbody>
</table>

At least one of the following combination

Analog circuits: Electrical and Computer Engineering 110A and 110B

Electromagnetics: Electrical and Computer Engineering 130A and 130B

Physical Electronics: Electrical and Computer Engineering 140A and 140B

Signals and Systems: Electrical and Computer Engineering 150A and 150B

Control Systems: Electrical and Computer Engineering 150A and 157A

Digital Systems: Electrical and Computer Engineering 180A and 180B

The Graduate Program in Electrical and Computer Engineering

M.S. and Ph.D.

http://www.ece.ucdavis.edu

The Department of Electrical and Computer Engineering prepares graduate students to do meaningful research and acquire skills and insights vital to solving some of the world’s most complex technological problems. Our graduate program offers a challenging and stimulating environment in areas such as optical, wireless and telecommunication networks, computer engineering, circuits, electromagnetics, physical electronics, optoelectronics, control, and signal processing. The depth of resources in the study of circuit design alone, with one of the largest faculty groups in the field in the UC system, distinguishes us from other...
programs, while our program in microwave communications and devices is unique.

The Electrical and Computer Engineering Graduate Program benefits from the highly interdisciplinary culture at UC Davis and attracts faculty from biomedical, chemical, electrical, computer, civil, and mechanical engineering, as well as computer science and mathematics. Many of our graduates go on to leadership and technology management roles in industry, returning each year for our industrial affiliates meeting to network with other industry representatives, current students and faculty.

Generous financial support is available in the form of research assistantships, teaching assistantships, fellowships and financial aid.

Research Highlights:
- Communications, control, networking, and signal processing
- Computer engineering
- Electronic circuits
- Optoelectronics
- RF, micro- and millimeter waves
- Physical electronics

Research Facilities and Partnerships:
- Center for Information Technology in the Interest of Society
- Northern California Center for Nanotechnology
- Center on Polymer Interfaces and Macromolecular Assemblies
- Lawrence Livermore National Laboratory
- Lawrence Berkeley National Laboratory
- Los Alamos National Laboratory
- California Lighting Technology Center
- PlanetLab Consortium
- Sandia National Laboratory

Complete information on our website.

Courses in Engineering: Electrical and Computer Engineering (EEC)

Lower Division

1. Introduction to Electrical and Computer Engineering (1)
   Lecture—1 hour. Electrical and Computer Engineering as a professional activity. What Electrical and Computer Engineering is (and is not) and why you should pursue your knowledge. (P/NP grading only.) GE credit: SE.—I. (I)

10. Introduction to Digital and Analog Systems (3)
   Lecture—1 hour; laboratory—3 hours. Prerequisite: Engineering 6 or Mathematics 22AL, Computer Science Engineering 30, Physics 9C and Engineering 17 (concurrent enrollment in Engineering 17 is allowed). Open to Electrical and Computer Engineering sophomores. Interactive and practical introduction to fundamental concepts of electrical and computer engineering by implementing electronic systems, which can be digitally controlled and interrogated, with a programmable microcontroller with the ability to program the electrical connections between analog and digital components. GE credit: SciEng | SE.—II. (II)

70. Computer Structure and Assembly Language (4)
   Lecture—3 hours; workshop—1 hour. Prerequisite: Computer Science Engineering 30, Computer architecture, machine language and assembly language, and hardware and software fundamentals. GE credit: SciEng | SE.—II. (II)

89A-F. Special Topics in Electromagnetics (1-5)
   Prerequisite: consent of instructor. Special Topics in (A) Electromagnetics, (B) Physical Electronics, (C) Active and Passive Circuits, (E) Computer Systems and Software, (F) Digital System Design for freshmen and sophomore level students. May be repeated for credit if topic differs. Offered irregularly. GE credit: SciEng | SE

90C. Research Group Conference in Electrical and Computer Engineering (1)
   Discussion—1 hour. Prerequisite: consent of instructor; course enrollment during semester, Research group conference meets. May be repeated for credit. (P/NP grading only).—I, II, III. (I, II, III)

90X. Lower Division Seminar (1-4)
   Seminar—1-4 hours. Prerequisite: consent of instructor. Examination of a special topic in a small group setting. May be repeated for credit.

92. Internship in Electrical and Computer Engineering (1-5)
   Internship—3-15 hours. Prerequisite: lower division standing, project approval prior to period of internship. Supervised work experience in Electrical and Computer Engineering. May be repeated for credit. (P/NP grading only)

98. Directed Group Study (1-5)
   Prerequisite: consent of instructor. (P/NP grading only)

99. Special Study for Lower Division Students (1-5)
   (P/NP grading only)

Upper Division

100. Circuits II (5)
   Laboratory—3 hours; lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 17, C- or better. Restricted to the following majors: Electrical Engineering, Computer Engineering, Computer Science & Engineering, Electronic Materials Engineering, Electrical Engineering/Materials Science, Optical Science & Engineering, Biomedical Engineering, Applied Physics, Electrical & Computer Engineering graduate students. Theory, application, and design of analog circuits. Methods of analysis including frequency response, SPICE simulation, and Laplace transform. Operational amplifiers and design of active filters. Students who have completed Engineering 100 may receive 3.5 units of credit. GE credit: SciEng | QL, SE.—I, III. (I, III)

110A. Electronic Circuits I (4)
   Lecture—3 hours; discussion—1 hour. Prerequisite: course 100; course 140A recommended. Use and modeling of nonlinear solid-state devices with emphasis on basic analog and digital circuits. Introduction to the design of transistor amplifiers and logic gates. GE credit: SciEng | SE.—I, III. (I, III)

110B. Electrical Circuits II (4)
   Lecture—3 hours; laboratory—3 hours. Prerequisite: course 110A. Analysis and design of integrated circuits. Single-stage amplifiers, cascaded amplifier stages, differential amplifiers, current sources, frequency response, and return-ratio analysis of feedback amplifiers. GE credit: SciEng | SE.—II. (II)

112. Communication Electronics (4)
   Lecture—3 hours; laboratory—3 hours. Prerequisite: course 110A and 150A; course 110B recommended. Electronic circuits for analog and digital communication, including oscillators, mixers, tuned amplifiers, modulators, demodulators, and phase-locked loops. Circuits for amplitude modulation (AM) and frequency modulation (FM) are emphasized. GE credit: SciEng | SE.—I, II. (I, II)

116. VLSI Design (4)
   Lecture—3 hours; laboratory—3 hours. Prerequisite: course 110A; course 180A recommended. CMOS devices, layout, circuits, and functional units; VLSI fabrication and design methodologies. GE credit: SciEng | SE.—I. (I)

118. Digital Integrated Circuits (4)
   Lecture—3 hours; laboratory—3 hours. Prerequisite: course 110A, 180A. Analysis and design of digital integrated circuits. Emphasis on digital logic families. Logic gate construction, voltage transfer characteristics, propagation delay, and power consumption. Register transfer circuits, sequential elements, interconnect, RAMs, ROMs, and PLAs. GE credit: SciEng | SE.—II. (II)

119A. Integrated Circuit Design Project (3)
   Workshop—1 hour; laboratory—6 hours. Prerequisite: course 116 or 118. Design course involving architecture, circuit design, physical design, and validation through extensive simulation of a digital or mixed-signal integrated circuit of substantial complexity under given design constraints. Team project that includes a final report. (Deferral grading only, pending completion of sequence.) GE credit: SciEng | SE.—II. (II)

119B. Integrated Circuit Design Project (3)
   Workshop—1 hour; laboratory—6 hours. Prerequisite: course 119A. Design of digital logic and memory architectures, circuit design, physical design, and validation through extensive simulation of a digital or mixed-signal integrated circuit of substantial complexity under given design constraints. Team project that includes a final report. (Deferral grading only, pending completion of sequence.) GE credit: SciEng | SE.—II. (II)

130A. Electromagnetics I (4)

130B. Introductory Electromagnetics II (4)
   Lecture—3 hours; discussion—1 hour. Prerequisite: course 130A. Plane wave propagation in lossy media, reflections, guided waves, simple modulated waves and dispersion, and basic antennas. GE credit: SciEng | SE.—II. (II)

132A. RF and Microwave in Wireless Communication (5)
   Lecture—3 hours; laboratory—3 hours; discussion—1 hour. Prerequisite: course 110B, 130B, 140B. The study of Radio Frequency and Microwave theory and practice for design of wireless electronic systems. Transmission lines, microwave integrated circuits, circuit analysis of electromagnetic energy transfer systems, the scattering parameters. GE credit: SciEng | SE.—I. (I)

132B. RF and Microwave in Wireless Communication (5)
   Lecture—3 hours; laboratory—3 hours; discussion—1 hour. Prerequisite: course 132A. Passive RF and microwave device analysis and design, fabrication, and testing for wireless applications. RF and microwave filter and coupler design. Introductory analysis and design of RF and microwave transistor amplifiers. GE credit: SciEng | SE.—II. (II)

132C. RF and Microwave in Wireless Communications (5)
   Lecture—3 hours; laboratory—3 hours; discussion—1 hour. Prerequisite: course 132B. RF and microwave amplifier theory and design, including transistor circuit models, stability considerations, noise models and low noise design. Theory and design of microwave transistor oscillators and mixers. Wireline system design and analysis. GE credit: SciEng | SE.—III. (III)

133. Electromagnetic Radiation and Antenna Analysis (4)
   Lecture—3 hours; discussion—1 hour. Prerequisite: course 130B. Properties of electromagnetic radiation; analysis and design of antennas: ideal cylindrical, small loop, aperture, and arrays; antenna field measurements. GE credit: SciEng | SE.—I. (I)
134A. RF/Microwave Systems Design (3)
Workshop—3 hours; laboratory—6 hours. Prerequisite: course 130B, 130D, 110A or 150A. Class size limited to 24 students. Board-level RF design, fabrication, and characterization of an RF/micro- wave system, including the antenna, RF front-end, baseband, and digital signal-processing models. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE—II. (II.) Liu, Momeni

134B. RF/Microwave Systems Design (3)
Workshop—3 hours; laboratory—6 hours. Prerequisite: course 134A. Class size limited to 24 students. Board-level RF design, fabrication, and characterization of an RF/microwave system, including the antenna, RF front-end, baseband, and digital signal-processing models. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE—II. (II.) Liu, Momeni

135. Optical Communications I: Fibers (4)

136A. Electronic Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequi- site: Computer Science Engineering 30; courses 110A, 110B, 110C, 120A. Pass One restricted to major. Optical, electronic and communication-engineering design of an opto-electronic system operating under performance and economic constraints. Measure- ment techniques will be designed and implemented, and the system will be characterized. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE—II. (II.)

136B. Electronic Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequi- site: course 136A. Optical, electronic and communi- cation-engineering design of an opto-electronic system operating under performance and economic constraints. Measurement techniques will be designed and implemented, and the system will be characterized. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE—II. (II.)

140A. Principles of Device Physics I (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 17; Physics 9D. Semiconductor device fundamentals, equilibrium and non-equilibrium statis- tical mechanics of charge, diffusion, recombination, and holes, p-n and Schottky junctions. Fundamentals of material science and technology. GE credit: SciEng | SE—I. (I.)

140B. Principles of Device Physics II (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 140A. Electrical properties, designs, models and advanced concepts for MOS, Bipolar, and Junc- tion FETs. Intrinsic and extrinsic devices including minority-carrier distributions, non-ideal effects, and device fabrication methods. MESFET and heterojunction bipolar transistor (HBTs). Fundamentals of solar cells. Photovoltaics. Semiconductors, diodes, transistors, lasers, and thinfilm electronics. GE credit: SciEng | SE—III. (III.)

145. Electronic Materials (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 140B, Engineering 43. Electronic and physi- cal properties of materials used in electronics, ICs, optoelectronics and MEMS. Semiconductors, dielec- trics, metals, optical materials, organic semiconduc- tor, optical and nonlinear properties, as well as their synthesis and deposition methods. GE credit: SciEng | SE—III. (III.)

146A. Integrated Circuits Fabrication (3)
Lecture—2 hours; laboratory—3 hours. Prerequisite: course 140A. Basic fabrication processes for Metal Oxide Semiconductor (MOS) integrated circuits. Laboratory assignments covering oxidation, photolith-ography, impurity diffusion, metallization, wet chemical etching, and characterization work together in producing metal-gate PMOS test chips which will undergo parametric and functional test- ing. GE credit: SciEng | SE—II. (II.)

146B. Advanced Integrated Circuits Fabrication (3)
Lecture—2 hours; laboratory—3 hours. Prerequisite: course 146A. Restricted to Electrical, Computer, and Electrical/Materials Engineering Engineering graduate students. Non-majors accommodated when space available. Fabrication pro- cesses for CMOS VLSI. Laboratory projects examine deposition of oxide, nitride, polysilicon, etching, p-type and n-type implantation, and chemical-mechanical planarization. GE credit: SciEng | SE—II. (II.)

147. Micro electromechanical Systems (4)
Lecture—2 hours; laboratory—3 hours. Prerequisite: Chemistry 2A, Engineering 100 or course 100. Restricted to undergraduate students. Introduction to College of Engineering. Introduction to the theory and practice of micro-electromechanical systems (MEMS), including fundamentals of micro-nanofabrication, microscale sensing and actuation, self assembly, microfluidics and lab-on-a-chip. Weekly hands-on laboratory sections are emphasized on implementa- tion and utilization of MEMS technologies. [Same course as Biomedical Engineering 118] GE credit: SciEng | QL, SE—II. (II.)

150A. Introduction to Signals and Systems I (4)
Lecture—4 hours. Prerequisite: Engineering 6 or Mathematics 22A (may be taken concurrently). course 100. Characterization and analysis of continu- ous-time linear systems. Fourier series and transforms with applications. Introduction to communicati- on systems. Elements of feedback systems. Stability of linear systems. GE credit: SciEng | QL, SE—II. (II.)

150B. Introduction to Signals and Systems II (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 150A. Characterization and analysis of dis- crete time systems. Difference equation models. Ztransform analysis methods. Discrete and fast Fourier transforms. Introduction to digital filter design. GE credit: SciEng | QL, SE—II. (II.)

152. Digital Signal Processing (4)
Lecture—2 hours; laboratory—6 hours. Prerequisite: course 150B; course 70 or Computer Science Engi- neering 50. The design and implementation of real-time digital signal processing. Fundamentals of real-time sys- tems. Programmable architectures including I/O, memory, peripherals, interrupts, DMA. Interfacing issues with A/D and D/A interfaces. Mapping to a program- mable DSP. Specification driven design and imple- mentation of simple DSP applications. GE credit: SciEng | QL, SE—III. (III.)

157A. Control Systems (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 100. Analysis and design of feedback control sys- tems. Examples are drawn from electrical and mechanical systems as well as other engineering fields. Mathematical models of linear systems, stability criteria, root-locus and frequency domain design methods. GE credit: SciEng | SE—II. (II.)

157B. Control Systems (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 157A. Design of feedback control systems; transfer-func- tion and state-space methods; sampled-data imple- mentation, digital control. Laboratory includes feedback system experiments and simulation studies. GE credit: SciEng | SE—II. (II.)

160. Signal Analysis and Communications (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 150A. Signal analysis based on Fourier methods. Fourier series; time-sam- pling, convolution, and filtering; spectral density; modulation: carrier-amplitude, carrier-frequency, and pulse-amplitude. GE credit: SciEng | SE—II. (II.)
180A. Digital Systems I (5)
Lecture—3 hours; laboratory—6 hours. Prerequisite: Physics 9C or 9HD. Introduction to digital system design including combinational logic design, sequential and asynchronous circuits, computer arithmetic, memory systems and algorithmic state machine design; computer aided design (CAD) methodologies and tools. GE credit: SciEng | SE.—I, II, III.

180B. Digital Systems II (5)
Lecture—3 hours; laboratory—6 hours. Prerequisite: course 150A. Computer-aided design of digital systems with emphasis on hardware description language (VHDL), logic synthesis, and field-programmable gate arrays (FPGA). May cover advanced topics in system design such as static timing analysis, pipelining, memory system design, testing digital circuits. GE credit: SciEng | SE.—II, III.

181A. Digital Systems Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequisite: courses 110A and either course 170 or Computer Science 122A. Digital-system and computer-engineering design course involving architecture, design, implementation and testing of a prototype application-specific processor under given design constraints. This is a team project that includes a final presentation and report. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE.—II, III.

181B. Digital Systems Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequisite: course 181A. Digital-system and computer-engineering design course involving architecture, design, implementation and testing of a prototype application-specific processor under given design constraints. This is a team project that includes a final presentation and report. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE.—II, III.

183. Testing and Verification of Digital Systems (5)
Lecture—4 hours; laboratory—4 hours. Prerequisite: courses 170 and 180B. Computer-aided testing and design verification techniques for digital systems; physical fault testing; simulation-based design verification and formal verification. GE credit: SciEng | SE.—II.

189A-V. Special Topics in Electrical Engineering and Computer Science (1-5)

190C. Research Group Conferences in Electrical and Computer Engineering (1)
Discussion—1 hour. Prerequisite: upper division standing in Electrical and Computer Engineering; consent of instructor. Research group conferences. May be repeated for credit (P/NC grading only). GE credit: SciEng | SE.—II, III, IV.

190R. Internship in Electrical and Computer Engineering (1-5)
Internship—1 to 4 hours. Prerequisite: completion of a minimum of 84 units with approval before period of internship; consent of instructor. Supervised work experience in electrical and computer engineering. May be repeated for credit if project is different. (P/NC grading only.) GE credit: SciEng | SE.—II, III, IV.

193A. Senior Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequisite: course 195A (may be taken concurrently); consent of instructor. Restricted to senior standing in Electrical or Computer Engineering. Team design project for seniors in Electrical or Computer Engineering. Project involves analysis, design, implementation and evaluation of an Electrical Engineering or Computer Engineering system. Project is supervised by faculty member. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE.—II, III, IV.

193B. Senior Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequisite: course 193A. Team design project for seniors in Electrical Engineering or Computer Engineering. Team design project for seniors in Electrical Engineering or Computer Engineering. Project involves analysis, design, implementation and evaluation of an Electrical Engineering or Computer Engineering system. Project supervised by a faculty member. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | SE.—II, III, IV.

195A. Autonomous Vehicle Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequisite: course 180A, Computer Science and Engineering 50, and one of 110B, 157A, 180B, or Computer Science and Engineering 150. Pass One restricted to major. Design and construct an autonomous race car. Work in groups to design, build and test a speed control circuit, and a steering control loop. (Deferred grading only pending completion of sequence.) GE credit: SciEng | SE.—II, III.

195B. Autonomous Vehicle Design Project (3)
Workshop—1 hour; laboratory—6 hours. Prerequisite: course 195A. Design and construct an autonomous race car. Students work in groups to design, build and test speed control circuit, track sensor circuits, and a steering control loop. (Deferred grading only pending completion of sequence.) GE credit: SciEng | SE.—II, III.

196. Issues in Engineering Design (1)
Seminar—1 hour. Prerequisite: senior standing in Electrical or Computer Engineering. The course covers various electrical and computer engineering standards and realistic design constraints including economics, manufacturability, sustainability, health and safety, environmental, social, and political. GE credit: SciEng | SE.—I, II, III.

197. Tutoring in Electrical and Computer Engineering (1-3)
Discussion—1 hour; discussion/laboratory—2-8 hours. Prerequisite: upper division standing; consent of instructor. Tutoring in Electrical and Computer Engineering courses, especially introductory courses. For upper-division students to facilitate students who will provide tutorial assistance. (P/NC grading only.) I, II, III, IV.

198. Directed Group Study (1-5)
Prerequisite: consent of instructor. May be repeated three times for credit (P/NC grading only). GE credit: SE.

199. Special Study for Advanced Undergraduates (1-5)
Prerequisite: consent of instructor. (P/NC grading only.)

Graduate
201. Digital Signal Processing (4)
Lecture—4 hours. Prerequisite: course 150B, Statistics 120 or Mathematics 167 recommended. Theory and design of digital filters. Classification of digital filters, linear phase systems, allpass functions, FIR and IIR filter design methods and optimally approximated robust structures for digital filters. (II, II)

202. Advanced Digital Signal Processing (4)
Lecture—4 hours. Prerequisite: courses 201, 260, and 265, and Mathematics 167 are recommended. Multirate DSP theory and wavelets, optimal transforms and subband coders in data compression, advanced sampling theory and oversampled A/D converters, transmultiplexers and precoders in digital communication systems, genomic signal processing. Offered in alternate years. (II)

205. Computational Methods in Biomedical Imaging (4)
Lecture—4 hours. Prerequisite: Biomedical Engineering 105 or Statistics 120; Biomedical Engineering 108 or course 150A. Analytic and geometric reconstruction from projections in 2D and 3D; model-based image reconstruction methods; maximum like- lihood and Bayesian methods; applications to CT, PET, and SPECT. (Same course as Biomedical Engineering 252.) (II)

206. Digital Image Processing (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: course 150B. Two-dimensional systems theory, image perception, sampling issues, quantization, motion transform theory and applications, enhancement, filtering and restoration, image analysis, and image processing systems. (II)

210. MOS Analog Circuit Design (3)
Lecture—3 hours. Prerequisite: courses 110B, 111B and 140B. Analysis and design of MOS amplifiers, bias circuits, voltage references and other analog circuits. Stability and compensation of feedback amplifiers. Introduction to noise analysis in MOS circuits. (I)

211. Advanced Analog Circuit Design (3)
Lecture—3 hours. Prerequisite: course 210; Statistics 131A and course 112 recommended. Noise and distortion in electronic circuit systems, application to communication circuits. Specific applications include mixers, low-noise amplifiers, power amplifiers, phase-locked loops, oscillators and receiver architectures. (II)

212. Analog MOS IC Design for Signal Processing (3)
Lecture—3 hours. Prerequisite: course 210. Analysis and design of analog MOS integrated circuits. Passive components, single-ended and fully differential op amps, sampled-data and continuous-time filters. (II, III)

213. Data-Conversion Techniques and Circuits (3)
Lecture—3 hours. Prerequisites: course 210. Digital-to-analog and analog-to-digital conversion; component characteristics and matching; sample-and-hold, comparator, amplifier, and reference circuits. (III)

214. Computer-Aided Circuit Analysis and Design (3)
Lecture—3 hours. Prerequisites: courses 110A, 110B and knowledge of FORTRAN or C. Network equation formulations. Nonlinear DC, linear AC, time-domain analysis (both linear and nonlinear), optimal and harmonic analysis. DC, AC, and time-domain sensitivities of linear and nonlinear circuits. Gradient-based design optimization. Behavioral simulations. Extensive CAD project. (II, II)

215. Circuits for Digital Communications (3)
Lecture—3 hours. Prerequisites: courses 150B and 210 (may be taken concurrently); course 165, 166 or 265 recommended. Analog, digital, and mixed-signal CMOS implementations of communication circuit blocks; gain control, adaptive equalizers, sampling detectors, clock recovery. Offered in alternate years. (II)

216. Low Power Digital Integrated Circuit Design (3)
Lecture—3 hours. Prerequisite: course 118B. IC design for low power and energy consumption. Low power architectures, logic styles and circuit design. Variable supply and threshold voltages. Leakage minimization, low power design, design for low leakage and low energy consumption. Power estimation. Energy sources, power electronics, and energy recovery. Applications in portable electronics and sensors. thermodynamic limits. (II, II)

217. Biomedical Electronics (4)
Lecture—3 hours; project. Prerequisite: course 210 or consent of instructor. Special consideration and accommodation will be made for biomedical or signal processing majors who have not taken 210. (II, II, II)

Quarter Offered: I-Fall, II-Winter, III-Spring, IV-Summer. 2015-2016 offering in parentheses.
Pre-Fall 2011 General Education (GE): AH—Arts and Humanities; SciEng—Science and Engineering; SS—Social Sciences; Div—Diversity; Dom—Domestic; Writ—Writing Experience
Fall 2011 and on Revised General Education (GE): AH—Arts and Humanities; SE—Science and Engineering; SS—Social Sciences; ACCH—American Cultures, DD—Domestic Diversity, OL—Oral Skills, G—Quantitative, SL—Scientific, VL—Visual, WC—World Cultures; Writ—Writing Experience
237A. Lasers (3)  
Lecture—3 hours. Prerequisite: course 130B or the equivalent and course 235. Theoretical and practical description of generation, amplification, and oscillation using semiconductors and laser materials and rate equations. Description and design of real laser system. Not open for credit to students who have completed course 226A. Offered in alternate years. —(I.)

237B. Laser Physics II (4)  
Lecture—3 hours; extensive problem solving. Prerequisite: course 237A or Applied Science Engineering 265A. Optical resonator design, stability, and excitation. Not open for credit to students who have completed course 226C. Offered in alternate years. —II. Herkal, Kolner

238. Semiconductor Diode Lasers (3)  
Lecture—3 hours. Prerequisite: course 245A. Understanding of fundamental optical transitions in semiconductor and quantum-confined systems are applied to diode lasers and selected photonic devices. The importance of radiative and non-radiative recombination, stimulated emission, excitons in quantum wells, and strained quantum layers are considered. Offered in alternate years. —III.

239A. Optical Fiber Communications Technologies (4)  

239B. Optical Fiber Communications Systems and Networking (4)  
Lecture—4 hours. Prerequisite: course 239A. Physical layer optical communications systems in network architectures and protocols. Optical systems design and integration using optical component technologies. Comparison of wavelength routed WDM, TDM, and NGN systems and networks. Case studies of next generation technologies. Offered in alternate years. —II.

240. Semiconductor Device Physics (3)  
Lecture—3 hours. Prerequisite: course 140B. Physical principles, characteristics and models of fundamental semiconductor devices, including P-N and Schottky diodes, MOSFETs and MESFETs Bipolar Junction Transistors, and light emitters/detectors. —I.

242. Advanced Nanostructured Devices (3)  
Lecture—3 hours. Prerequisite: courses 130A and 140B. Physics of nanostructures and device operation. Overview of new devices enabled by nanotechnology; fabrication and characterization methods; applications of nanostructures and devices. Offered in alternate years. —II.

244A. Design of Microelectromechanical Systems (MEMS) (3)  
Lecture—3 hours. Prerequisite: course 140A, 140B or consent of instructor. Theory and practice of MEMS design fundamentals, CAD tools, and case studies. A MEMS design project is required. The designs will be fabricated in a commercial foundry and tested in course 244B. Offered in alternate years. —I.

244B. Microsystems (4)  
Lecture/discussion—4 hours. Introduction to the theory of physical and chemical principles at the microscale. Scale effects, surface tension, microfluidic mechanical properties, intermolecular interactions and micro tribology. [Same course as Biomedical Engineering 218]. —I.
280 Engineering: Electrical and Computer Engineering

tion and spectral density, ergodicity and duality between time averages and expected values, filters and dynamical systems. Applications. — (I, II.)

261. Signal Processing for Communications (4)
Lecture—4 hours. Prerequisite: course 165, 260 or consent of instructor. Signal processing in wireless and wireline communication systems. Characterization and distortion of wireless and wireline channels. Channel equalization and maximum likelihood sequence estimation. Channel precoding and pre-equalization. OFDM and transmit diversity. Array processing. Offered in alternate years. — III.

262. Multi-Access Communications Theory (4)
Lecture—3 hours; project. Prerequisite: Statistics 120 or equivalent; course 173A or Engineering Computer Science 152A. Maximum stable throughput of Poisson collision channels. Classic collision resolution algorithms. Carrier sensing multiple access and its performance analysis. System stability analysis. Joint design of the physical/medium access control layers. Capacity region of multi-access channels. Multi-access with correlated sources. Offered in alternate years. — III.

263. Optimal and Adaptive Filtering (4)

264. Estimation and Detection of Signals in Noise (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 260. Introduction to parameter estimation and detections of signals in noise. Bayes and Neyman-Pearson likelihood-ratio tests for signal detection. Maximum-likelihood parameter estimation. Detection of known and Gaussian signals in white or colored noise. Applications to communications, radar, signal processing. — II. (II.)

265. Principles of Digital Communications (4)
Lecture—4 hours; courses 165 and 260, or consent of instructor. Introduction to digital communications. Coding for analog sources. Characterization of signals and systems. Modulation and demodulation for the additive Gaussian channel. Digital signaling over bandwidth constrained linear filter channels and over fading multipath channels. Spread spectrum signals. — II. (II.)

266. Information Theory and Coding (3)
Lecture—3 hours. Prerequisite: Statistics 120. Information theory; measure of information. Redundancy reduction encoding of an information source. Capacity of a communication channel, error-free communications. Offered in alternate years. — III.

267. Mobile Communications (4)
Lecture/laboratory—3 hours. Prerequisite: courses 260 and 265 [can be taken concurrently]. Time-varying multi-path fading channel models and receivers performing in fading channels; multiple access techniques and multiple access receivers design and performance; optimum design and the capacity of wireless channels. Offered in alternate years. — III.

269A. Error Correcting Codes I (3)
Lecture—3 hours. Prerequisite: Mathematics 22A and course 160. Introduction to the theory and practice of block codes, linear block codes, cyclic codes, decoding algorithms. — I. (I.)

269B. Error Correcting Codes II (3)
Lecture—3 hours. Prerequisite: course 165 and 269A. Introduction to convolutional codes, turbo codes, trellis and block coded modulation codes, soft-decision decoding algorithms, the Viterbi algo-
rithm, reliability-based decoding, trellis-based decoding, multistage decoding. Offered in alternate years. — II.

270. Computer Architecture (3)
Lecture—3 hours. Prerequisite: course 170 or Computer Science Engineering 154B. Introduction to modern techniques for high-performance single and multiple processor systems. Topics include advanced pipeline design, advanced memory hierarchy design, optimizing pipeline and memory use, and memory sharing among multiprocessors. Case studies of recent single and multiple processor systems. — II. (II.)

272. High-Performance Computer Architecture and Implementation (3)
Lecture—3 hours. Prerequisite: course 170 or Computer Science Engineering 254B and course 270 or Computer Science Engineering 250A. Architectural issues in achieving high-performance via concurrent execution of instructions and associated problems and solutions. Specialized architectures. Offered in alternate years. — 150A. Mechanical Design III. — III.

273. Networking Architecture and Resource Management (4)
Lecture—3 hours; project. Prerequisite: Computer Science Engineering 152A or course 173A; Computer Science Engineering 252 recommended. Design and implementation principles of networking architecture systems. Internet, ATM and telephony case studies. Topics: Internet technology; application and services; resource management; Quality of Service (QoS) provisioning; traffic engineering; performance evaluation and future research issues. [Same course as Computer Science Engineering 258.] — II. (II.)

274. Internet Measurements, Modeling and Analysis (4)
Lecture—3 hours; project. Prerequisite: Computer Science Engineering 252 or course 273. Advanced topics in the theoretical foundations of network measurements, modeling, and statistical inferencing. Applications to Internet engineering, routing optimization, load balancing, traffic engineering, fault tolerance, anomaly detection, and network security. Individual project requirement. Offered in alternate years. — III.

276. Fault-Tolerant Computer Systems: Design and Analysis (3)
Lecture—3 hours. Prerequisite: courses 170, 180A. Introduces fault-tolerant digital system theory and practice. Topics include correct and classic fault tolerant techniques based on hardware redundancy, time redundancy, information redundancy, and software redundancy. Examines hardware and software reliability analysis, design, and test. Not open for credit to students who have completed course 276A. Offered in alternate years. — II.

277. Graphs Architecture (3)
Lecture—3 hours. Prerequisite: Computer Science Engineering 154B or course 170, Computer Science Engineering 175. Design and analysis of the architecture of computer graphics systems. Topics include the graphics pipeline with a concentration on hardware versus software systems, exploiting parallelism in graphics, and case studies of noteworthy and modern graphics architectures. Offered in alternate years. — II.

278. Computer Arithmetic for Digital Implementation (3)
Lecture—3 hours. Prerequisite: courses 170, 180A. The design and implementation of computer arithmetic logics units are studied with particular emphasis on high-speed parallel arithmetic requirements. Additional (subtraction), multiplication and division operations are covered, and fixed and floating-point representations are examined. Offered in alternate years. — III.

281. VLSI Digital Signal Processing (4)
Lecture—3 hours; projects. Prerequisite: courses 150B, 170, 180B or consent of instructor. Digital signal processors, building blocks, and algorithms. Design and implementation of processor algorithms, architectures, control, functional units, and circuit topologies for increased performance and reduced circuit size and power dissipation. — II.

282. Hardware Software Codeign (3)
Lecture—2 hours; discussion—1 hour. Prerequisite: course 170, 180B. Specification and design of embedded systems; modeling and performance estimation; hardware/software partitioning; co-simulation; design reuse; platform-based design; reconfigurable computing. — III.

283. Advanced Design Verification of Digital Systems (4)
Lecture—3 hours; project. Prerequisite: courses 170 and 180A. Design verification techniques for digital systems; simulation-based design verification techniques; formal verification techniques, including equivalence checking, model checking, and theorem proving; timing analysis and verification; application of design verification techniques to microprocessors. Offered in alternate years. — II.

Lecture—4 hours. Prerequisite: courses 170 and 180B, or consent of instructor. Computer Science Engineering 122A recommended. Introduction to design and optimization of digital computing systems for embedded applications. Topics include combinational optimization techniques, performance and energy optimization in embedded systems, compilation and architecture-specific mapping, programmable and reconfigurable platforms; design automation and algorithmic improvements to design process. — II. (II.)

286. Introduction to Digital System Testing (3)
Lecture—3 hours. Prerequisite: course 180A; Statistics 120 or 131A. A review of several current techniques used to diagnose faults in both combinational and sequential circuits. Topics include path sensitization procedures, Boolean difference, D-algorithm, random test generation, TC testing and an analysis of the effects of intermittent faults. Not open for credit to students who have completed course 276A. Offered in alternate years. — II.

289A-V. Special Topics in Electrical and Computer Engineering (1-5)

290. Seminar in Electrical and Computer Engineering (1)
Seminar—1 hour. Discussion and presentation of current research and development in Electrical and Computer Engineering. May be repeated for credit. (S/U grading only). — I, II, III. (I, II, III.)

290C. Graduate Research Group Conference in Electrical and Computer Engineering (1)
Discussion—1 hour. Prerequisite: consent of instructor. Research problems, progress, and techniques in electrical and computer engineering. May be repeated for credit. (S/U grading only). — I, II, III. (I, II, III.)

291. Solid-State Circuit Research Laboratory Seminar (1)
Seminar—1 hour. Prerequisite: graduate standing. Lectures on solid-state circuit and system design by various visiting experts in the field. May be repeated for credit. (S/U grading only). — III. (II, III.)
Engineering: Mechanical and Aerospace Engineering

292. Seminar in Solid-State Technology (1) Seminar—1 hour. Prerequisite: graduate standing. Lectures and discussions on solid-state technology by various visiting experts in the field. May be repeated for credit. (S/U grading only.)—II. (III.)

293. Computer Engineering Research Seminar (1) Seminar—1 hour. Prerequisite: graduate standing or consent of instructor. Lectures, tutorials, and seminars on topics in computer engineering. May be repeated for credit up to four times. (S/U grading only.)—II., III., (IV.)

294. Communications, Signal and Image Processing Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Communications, signal and image processing, video engineering and computer vision. May be repeated for credit. (S/U grading only.)—II., III., (IV.)

295. Systems, Control and Robotics Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Seminars on current research in systems and control by faculty and visiting experts. Technical presentations and lectures on current topics in robotics research and robotics technology. May be repeated for credit. (S/U grading only.)—II. (III.)

296. Photonics Research Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Lectures on photonics and related areas by faculty and visiting experts. May be repeated for credit. (S/U grading only.)—II., III., (IV.)

298. Group Study (1-5) Prerequisite: consent of instructor. (S/U grading only.)

299. Research (1-12) (S/U grading only.)

Professional

390. The Teaching of Electrical Engineering (1) Discussion—1 hour. Prerequisite: meet qualifications for teaching assistant and/or associate-in-electrical Engineering. Participation as a teaching assistant or associate-in-electrical in a designated engineering course. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports. May be repeated for credit. (S/U grading only.)—II. (III.)

396. Teaching Assistant Training Practicum (1-4) Prerequisite: graduate standing. May be repeated for credit. (S/U grading only.)—II., III., (IV.)

Engineering: Mechanical and Aerospace Engineering

(College of Engineering)

C. P. (Case) van Dam, D. Engr., Chairperson of the Department
Benjamin D. Shaw, Ph.D., Vice Chairperson of the Department

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Academic Senate Distinguished Teaching Award
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Emeriti Faculty
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Academic Senate Distinguished Teaching Award
Charles W. Beadle, Ph.D., Professor Emeritus
Jean-Jacques Chatott, Ph.D., Professor Emeritus
Harry A. Dwyer, Ph.D., Professor Emeritus
Andrew A. Frank, Ph.D., Professor Emeritus
Jerald M. Henderson, D. Engr., Professor Emeritus
Myron A. Hoffman, Sc.D., Professor Emeritus
Mont Hubbard, Ph.D., Professor Emeritus
Maury L. Hull, Ph.D., Professor Emeritus
Dean C. Karnopp, Ph.D., Professor Emeritus
John D. Kemper, Ph.D., Professor Emeritus
Wolfgang Kollmann, Ph.D., Professor Emeritus
Donald L. Margolis, Ph.D., Professor Emeritus
Allan A. McKillop, Ph.D., Professor Emeritus
Bruce R. White, Ph.D., Professor Emeritus
Affiliated Faculty
James Schaf, Ph.D., Lecturer
The Mechanical and Aerospace Engineering Undergraduate Programs

The Department of Mechanical and Aerospace Engineering administers three undergraduate programs in the College of Engineering: Mechanical Engineering, Materials Science and Engineering, and Aerospace Science and Engineering. For more information about our programs, please see http://mae.ucdavis.edu/ug.php.

The Mechanical Engineering/Materials Science and Engineering program is not accepting new students. The Materials Science and Engineering program is not accepting new students.

Mission. The Department of Mechanical and Aerospace Engineering is committed to educating future engineers so that they may contribute to the economic growth and well-being of the state, the nation, and the world, and to the advancement of knowledge in the field of mechanical and aerospace sciences.

Objectives. The objectives of the programs offered in Mechanical and Aerospace Engineering include the following: to prepare its graduates to practice mechanical and/or aerospace engineering in a broad range of careers, to enable interested graduates to pursue graduate education, to prepare its graduates to participate in research and development, and in other creative and innovative efforts in science, engineering and technology and to allow interested graduates to pursue entrepreneurial endeavors.

Preparatory Requirements. In order to change to any major offered by the Department of Mechanical and Aerospace Engineering, students must:

• Have a student and have completed at least one quarter (minimum of 12 units) at UC Davis;
• Have completed not more than 135 cumulative units (excluding AP units);
• Be in good academic standing and meet minimum progress requirements;
• Have received a letter grade for all courses that satisfy Engineering degree requirements;
• Have: a) completed at least the following five courses: Mathematics 21A, B, C, Physics 9A and Chemistry 2A and b) have a GPA of 2.800 or better in all completed Mathematics, Physics, Biology and Chemistry courses required for your intended major(s) taken at UC Davis;
• Have a 2.800 UC GPA in completed engineering courses.

Mechanical Engineering Undergraduate Program


The mechanical engineer uses basic science in the design and manufacture of complex engineering systems, requiring the application of physical and mechanical principles to the development of machines, energy conversion systems, materials, and equipment for guidance and control.

Work in this broad field of engineering requires a thorough knowledge of mathematics, physics, chemistry, material science, applied mechanics, thermodynamics, heat transfer, mass transfer, electricity, manufacturing processes, and economics. The Mechanical Engineering program is designed to prepare knowledge in mechanical engineering and associated applied sciences so that graduates may practice in a broad range of industries, pursue graduate studies, participate in research and development, and/or pursue entrepreneurial endeavors.

Areas of Interest

Students spend their third year in further study of fundamental courses, and in the fourth year they may tailor their studies to their interests by selecting courses in controls and systems analysis, fluid mechanics, heat transfer, mechanical design or thermodynamics. Students can either prepare for graduate study in mechanical engineering or obtain a broad background for entering engineering practice.

Students may select elective courses from among the areas of interest listed below:

Mechanical Design. The creation and improvement of products, processes, or systems that are mechanical in nature are the primary activities of a professional mechanical engineer. The development of a product from conceptualization to final designed, manufacturing process selection and planning, quality control and assurance, and life cycle considerations are areas of study and specialization in the area of mechanical design.

Solutions to such major social problems as environmental pollution, the lack of mass transportation, the lack of raw materials, and energy shortages, will depend heavily on the engineer’s ability to create new types of machinery and equipment.

The engineer-designer must have a solid and relatively broad background in the basic physical and engineering sciences and have the ability to synthesize the size from such a background in creative problem solving. In addition to having technical competence, the designer must be able to