Department of Electrical Engineering and Computer Science

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949-824-4821
http://www.eng.uci.edu/dept/eecs

Overview

Electrical Engineering and Computer Science is a broad field encompassing such diverse subject areas as computer systems, distributed computing, computer networks, control, electronics, photonics, digital systems, circuits (analog, digital, mixed-mode, and power electronics), communications, signal processing, electromagnetics, and physics of semiconductor devices. Knowledge of the mathematical and natural sciences is applied to the theory, design, and implementation of devices and systems for the benefit of society. The Department offers three undergraduate degrees: Electrical Engineering, Computer Engineering, as well as Computer Science and Engineering. Computer Science and Engineering is offered in conjunction with the Donald Bren School of Information and Computer Sciences; information is available in the Interdisciplinary Studies section of the Catalogue.

Some electrical engineers focus on the study of electronic devices and circuits that are the basic building blocks of complex electronic systems. Others study power electronics and the generation, transmission, and utilization of electrical energy. A large group of electrical engineers studies the application of these complex systems to other areas, including medicine, biology, geology, and ecology. Still another group studies complex electronic systems such as automatic controls, telecommunications, wireless communications, and signal processing.

Computer engineers are trained in various fields of computer science and engineering. They engage in the design and analysis of digital computers and networks, including software and hardware. Computer design includes topics such as computer architecture, VLSI circuits, computer graphics, design automation, system software, data structures and algorithms, distributed computing, and computer networks. Computer Engineering courses include programming in high-level languages such as Python, C++ and Java; use of software packages for analysis and design; design of system software such as operating systems; design of hardware/software interfaces and embedded systems; and application of computers in solving engineering problems. Laboratories in both hardware and software experiences are integrated within the Computer Engineering curriculum.

The undergraduate curriculum in Electrical Engineering and Computer Engineering provides a solid foundation for future career growth, enabling graduates’ careers to grow technically, administratively, or both. Many electrical and computer engineers will begin work in a large organizational environment as members of an engineering team, obtaining career satisfaction from solving meaningful problems that contribute to the success of the organization’s overall goal. As their careers mature, technical growth most naturally results from the acquisition of an advanced degree and further development of the basic thought processes instilled in the undergraduate years. Administrative growth can result from the development of management skills on the job and/or through advanced degree programs in management.

Graduates of Electrical Engineering, Computer Engineering, and Computer Science and Engineering will find a variety of career opportunities in areas including wireless communication, voice and video coding, biomedical electronics, circuit design, optical devices and communication, semiconductor devices and fabrication, power systems, power electronics, computer hardware and software design, computer networks, design of computer-based control systems, application software, data storage and retrieval, computer graphics, pattern recognition, computer modeling, parallel computing, and operating systems.

On This Page:
- Computer Engineering
- Computer Science and Engineering
- Electrical Engineering

Undergraduate Major in Computer Engineering

Program Educational Objectives: Graduates of the Computer Engineering program will (1) be engaged in professional practice at or beyond the entry level or enrolled in high-quality graduate programs building on a solid foundation in engineering, mathematics, the sciences, humanities and social sciences, and experimental practice as well as modern engineering methods; (2) be innovative in the design, research and implementation of systems and products with strong problem solving, communication, teamwork, leadership, and entrepreneurial skills; (3) proactively function with creativity, integrity and relevance in the ever-changing global environment by applying their fundamental knowledge and experience to solve real-world problems with an understanding of societal, economic, environmental, and ethical issues. (Program educational objectives are those aspects of engineering that help shape the curriculum; achievement of these objectives is a shared responsibility between the student and UCI.)

The undergraduate Computer Engineering curriculum includes a core of mathematics, physics, and chemistry. Engineering courses in fundamental areas fill in much of the remaining curriculum.
Admissions

High School Students: See School Admissions information.

Transfer Students: Preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed the following required courses: two years of approved calculus, one year of calculus-based physics with laboratories (mechanics, electricity and magnetism), completion of lower-division writing, one course in computational methods (e.g., C, C++), and one course in circuit analysis (with laboratory). For course equivalency specific to each college, visit assist.org.

Students are encouraged to complete as many of the lower-division degree requirements as possible prior to transfer. Students who enroll at UCI in need of completing lower-division coursework may find that it will take longer than two years to complete their degrees. For further information, contact The Henry Samueli School of Engineering at 949-824-4334.

Requirements for the B.S. in Computer Engineering

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements:

Mathematics and Basic Science Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 55</td>
<td>Engineering Probability</td>
</tr>
<tr>
<td>EECS 70LA</td>
<td>Network Analysis I Laboratory</td>
</tr>
<tr>
<td>EECS 145</td>
<td>Electrical Engineering Analysis</td>
</tr>
<tr>
<td>I&amp;C SCI 6D</td>
<td>Discrete Mathematics for Computer Science</td>
</tr>
<tr>
<td>MATH 2A- 2B</td>
<td>Single-Variable Calculus</td>
</tr>
<tr>
<td></td>
<td>and Single-Variable Calculus</td>
</tr>
<tr>
<td>MATH 2D</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>Introduction to Linear Algebra</td>
</tr>
<tr>
<td>MATH 3D</td>
<td>Elementary Differential Equations</td>
</tr>
<tr>
<td>PHYSICS 7C</td>
<td>Classical Physics</td>
</tr>
<tr>
<td>PHYSICS 7LC</td>
<td>Classical Physics Laboratory</td>
</tr>
<tr>
<td>PHYSICS 7D- 7E</td>
<td>Classical Physics</td>
</tr>
<tr>
<td></td>
<td>and Classical Physics</td>
</tr>
<tr>
<td>PHYSICS 7LD</td>
<td>Classical Physics Laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>One additional math or basic science elective from the following:</td>
</tr>
<tr>
<td></td>
<td>I&amp;C SCI 6B</td>
</tr>
<tr>
<td></td>
<td>Boolean Logic and Discrete Structures</td>
</tr>
<tr>
<td></td>
<td>MATH 2E</td>
</tr>
<tr>
<td></td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 51A</td>
</tr>
<tr>
<td></td>
<td>Modern Physics</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 52A</td>
</tr>
<tr>
<td></td>
<td>Fundamentals of Experimental Physics</td>
</tr>
<tr>
<td></td>
<td>or other courses as approved by faculty advisor.</td>
</tr>
</tbody>
</table>

Engineering Topics Courses:

Students must complete a minimum of 26 units of engineering design.

Core Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 12</td>
<td>Introduction to Programming</td>
</tr>
<tr>
<td>EECS 20</td>
<td>Computer Systems and C Programming</td>
</tr>
<tr>
<td>EECS 22</td>
<td>Advanced C Programming</td>
</tr>
<tr>
<td>EECS 22L</td>
<td>Software Engineering Project in C Language</td>
</tr>
<tr>
<td>EECS 31</td>
<td>Introduction to Digital Systems</td>
</tr>
<tr>
<td>EECS 31L</td>
<td>Introduction to Digital Logic Laboratory</td>
</tr>
<tr>
<td>EECS 40</td>
<td>Object-Oriented Systems and Programming</td>
</tr>
<tr>
<td>EECS 50</td>
<td>Discrete-Time Signals and Systems</td>
</tr>
<tr>
<td>EECS 70A</td>
<td>Network Analysis I</td>
</tr>
<tr>
<td>EECS 70B</td>
<td>Network Analysis II</td>
</tr>
<tr>
<td>EECS 70LB</td>
<td>Network Analysis II Laboratory</td>
</tr>
<tr>
<td>EECS 111</td>
<td>System Software</td>
</tr>
<tr>
<td>EECS 112</td>
<td>Organization of Digital Computers</td>
</tr>
<tr>
<td>EECS 112L</td>
<td>Organization of Digital Computers Laboratory</td>
</tr>
</tbody>
</table>
EECS 113  Processor Hardware/Software Interfaces
EECS 114  Engineering Data Structures and Algorithms
EECS 118  Introduction to Knowledge and Software Engineering
EECS 119  VLSI
EECS 148  Computer Networks
EECS 159A-159B  Senior Design Project I and Senior Design Project II
EECS 170A  Electronics I
EECS 170LA  Electronics I Laboratory
EECS 170B  Electronics II
EECS 170LB  Electronics II Laboratory

With the approval of a faculty advisor, students select any additional engineering topics courses needed to satisfy school and department requirements.

**Engineering Elective Courses:**

Select, with approval of a faculty advisor, a minimum of three courses of engineering topics.

- COMPSCI 142A  Compilers and Interpreters
- EECS 101  Introduction to Machine Vision
- EECS 116  Introduction to Data Management
- EECS 117  Parallel Computer Systems
- EECS 141A  Communication Systems I
- EECS 141B  Communication Systems II
- EECS 150  Continuous-Time Signals and Systems
- EECS 152A  Digital Signal Processing
- EECS 152B  Digital Signal Processing Design and Laboratory
- EECS 199  Individual Study (up to 3 graded units)
- ENGR 7A-7B  Introduction to Engineering I and Introduction to Engineering II (*)

* ENGR 7A and ENGR 7B can be counted as 4 units of Engineering Electives. ENGR 7A and ENGR 7B are available only to lower-division students. Both ENGR 7A and ENGR 7B must be taken to be counted as an Engineering Elective.

**Engineering Professional Topics Courses**

- ENGR 190W  Communications in the Professional World

At most an aggregate total of 6 units of EECS 199 may be used to satisfy degree requirements; EECS 199 is open to students with a 3.0 GPA or higher.

(The nominal Computer Engineering program will require 187 units of courses to satisfy all university and major requirements. Because each student comes to UCI with a different level of preparation, the actual number of units will vary.)

**Planning a Program of Study**

The sample program of study chart shown is typical for the major in Computer Engineering. Students should keep in mind that this program is based upon a sequence of prerequisites, beginning with adequate preparation in high school mathematics, physics, and chemistry. Students who are not adequately prepared, or who wish to make changes in the sequence for other reasons, must have their program approved by their advisor. Computer Engineering majors must consult at least once every year with the academic counselors in the Student Affairs Office and with their faculty advisor.

**Sample Program of Study — Computer Engineering**

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Winter</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2A</td>
<td>MATH 2B</td>
<td></td>
<td>MATH 2D</td>
</tr>
<tr>
<td>EECS 12</td>
<td>I&amp;C SCI 6D</td>
<td></td>
<td>PHYSICS 7D</td>
</tr>
<tr>
<td>General Education</td>
<td>PHYSICS 7C-7LC</td>
<td></td>
<td>PHYSICS 7LD</td>
</tr>
<tr>
<td>General Education</td>
<td>General Education</td>
<td></td>
<td>EECS 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EECS 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EECS 31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Winter</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 3A</td>
<td>MATH 3D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHYSICS 7E</td>
<td>EECS 22L</td>
<td></td>
<td>EECS 40</td>
</tr>
<tr>
<td>EECS 22</td>
<td>EECS 55</td>
<td></td>
<td>EECS 50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EECS 70B</td>
</tr>
</tbody>
</table>
Undergraduate Major in Computer Science and Engineering (CSE)

This program is administered jointly by the Department of Electrical Engineering and Computer Science (EECS) in The Henry Samueli School of Engineering and the Department of Computer Science in the Donald Bren School of Information and Computer Sciences. For information, see the Interdisciplinary Studies section of the Catalogue.

Requirements for the B.S. in Computer Science and Engineering
All students must meet the University Requirements.
Major Requirements: See the Interdisciplinary Studies section of the Catalogue.

Undergraduate Major in Electrical Engineering

Program Educational Objectives: Graduates of the Electrical Engineering program will (1) engage in professional practice in academia, industry, or government; (2) promote innovation in the design, research and implementation of products and services in the field of electrical engineering through strong communication, leadership and entrepreneurial skills; (3) engage in life-long learning in the field of electrical engineering. (Program educational objectives are those aspects of engineering that help shape the curriculum; achievement of these objectives is a shared responsibility between the student and UCI.)

The undergraduate Electrical Engineering curriculum is built around a basic core of humanities, mathematics, and natural and engineering science courses. It is arranged to provide the fundamentals of synthesis and design that will enable graduates to begin careers in industry or to go on to graduate study. UCI Electrical Engineering students take courses in network analysis, electronics, electronic system design, signal processing, control systems, electromagnetics, and computer engineering. They learn to design circuits and systems to meet specific needs and to use modern computers in problem analysis and solution.

Electrical Engineering majors have the opportunity to select a specialization in Electro-optics and Solid-State Devices; and Systems and Signal Processing. In addition to the courses offered by the Department, the major program includes selected courses from the Donald Bren School of Information and Computer Sciences.

Admissions

High School Students: See School Admissions information.

Transfer Students: Preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed the following required courses: two years of approved calculus, one year of calculus-based physics with laboratories (mechanics, electricity and magnetism), completion of lower-division writing, one course in computational methods (e.g., C, C++), and one course in circuit analysis (with laboratory). For course equivalency specific to each college, visit assist.org.

Students are encouraged to complete as many of the lower-division degree requirements as possible prior to transfer. Students who enroll at UCI in need of completing lower-division coursework may find that it will take longer than two years to complete their degrees. For further information, contact The Henry Samueli School of Engineering at 949-824-4334.
Requirements for the B.S. in Electrical Engineering

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements:

Mathematics and Basic Science Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 1A</td>
<td>General Chemistry for Engineers</td>
</tr>
<tr>
<td>or CHEM 1A</td>
<td>General Chemistry</td>
</tr>
<tr>
<td>EEC5 55</td>
<td>Engineering Probability</td>
</tr>
<tr>
<td>EEC5 70LA</td>
<td>Network Analysis I Laboratory</td>
</tr>
<tr>
<td>EEC5 145</td>
<td>Electrical Engineering Analysis</td>
</tr>
<tr>
<td>MATH 2A-2B</td>
<td>Single-Variable Calculus and Single-Variable Calculus</td>
</tr>
<tr>
<td>MATH 2D</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MATH 2E</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>Introduction to Linear Algebra</td>
</tr>
<tr>
<td>MATH 3D</td>
<td>Elementary Differential Equations</td>
</tr>
<tr>
<td>PHYS 7C</td>
<td>Classical Physics</td>
</tr>
<tr>
<td>PHYS 7LC</td>
<td>Classical Physics Laboratory</td>
</tr>
<tr>
<td>PHYS 7D-7E</td>
<td>Classical Physics</td>
</tr>
<tr>
<td>PHYS 7LD</td>
<td>Classical Physics Laboratory</td>
</tr>
<tr>
<td>PHYS 51A</td>
<td>Modern Physics</td>
</tr>
</tbody>
</table>

Engineering Topics Courses:

Students must complete each of the following courses and accumulate a minimum of 28 units of engineering design:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEC5 1</td>
<td>Introduction to Electrical Engineering and Computer Engineering</td>
</tr>
<tr>
<td>EEC5 10</td>
<td>Computational Methods in Electrical and Computer Engineering</td>
</tr>
<tr>
<td>EEC5 31</td>
<td>Introduction to Digital Systems</td>
</tr>
<tr>
<td>EEC5 31L</td>
<td>Introduction to Digital Logic Laboratory</td>
</tr>
<tr>
<td>EEC5 50</td>
<td>Discrete-Time Signals and Systems</td>
</tr>
<tr>
<td>EEC5 70A</td>
<td>Network Analysis I</td>
</tr>
<tr>
<td>EEC5 70B</td>
<td>Network Analysis II</td>
</tr>
<tr>
<td>EEC5 70LB</td>
<td>Network Analysis II Laboratory</td>
</tr>
<tr>
<td>EEC5 150</td>
<td>Continuous-Time Signals and Systems</td>
</tr>
<tr>
<td>EEC5 159A-159B</td>
<td>Senior Design Project I and Senior Design Project II</td>
</tr>
<tr>
<td>EEC5 160A</td>
<td>Introduction to Control Systems</td>
</tr>
<tr>
<td>EEC5 160LA</td>
<td>Control Systems I Laboratory</td>
</tr>
<tr>
<td>EEC5 170A</td>
<td>Electronics I</td>
</tr>
<tr>
<td>EEC5 170LA</td>
<td>Electronics I Laboratory</td>
</tr>
<tr>
<td>EEC5 170B</td>
<td>Electronics II</td>
</tr>
<tr>
<td>EEC5 170LB</td>
<td>Electronics II Laboratory</td>
</tr>
<tr>
<td>EEC5 170C</td>
<td>Electronics III</td>
</tr>
<tr>
<td>EEC5 170LC</td>
<td>Electronics III Laboratory</td>
</tr>
<tr>
<td>EEC5 180A</td>
<td>Engineering Electromagnetics I</td>
</tr>
</tbody>
</table>

Electrical Engineering Specialization:

Students must satisfy the requirements for one of the five specializations listed below.

Technical Elective Courses:

In addition to a specialization, and with approval of a faculty advisor, students must select a minimum of three other technical elective courses, comprising of at least 10 units. At least one of these courses must be from outside the student’s specialization. All EECS courses not required for the major are approved as technical electives. Four (4) units of 199 course work count as one technical elective. ENGR 7A and ENGR 7B can be counted as 4 units of Technical Electives. ENGR 7A and ENGR 7B are available only to lower-division students. Both ENGR 7A and ENGR 7B must be taken to be counted as a Technical Elective.

Engineering Professional Topics Courses
ENGR 190W Communications in the Professional World

At most an aggregate total of 6 units of EECS 199 may be used to satisfy degree requirements; EECS 199 is open to students with a 3.0 GPA or higher.

(The nominal Electrical Engineering program will require 188-191 units of courses to satisfy all university and major requirements. Because each student comes to UCI with a different level of preparation, the actual number of units will vary.)

Specialization in Electronic Circuit Design:
Requires:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 170D</td>
<td>Integrated Electronic Circuit Design</td>
</tr>
<tr>
<td>EECS 170E</td>
<td>Analog and Communications IC Design</td>
</tr>
<tr>
<td>and select four of the following:</td>
<td></td>
</tr>
<tr>
<td>EECS 166A</td>
<td>Industrial and Power Electronics</td>
</tr>
<tr>
<td>EECS 174</td>
<td>Semiconductor Devices</td>
</tr>
<tr>
<td>EECS 176</td>
<td>Fundamentals of Solid-State Electronics and Materials</td>
</tr>
<tr>
<td>EECS 179</td>
<td>Microelectromechanical Systems (MEMS)</td>
</tr>
<tr>
<td>EECS 182</td>
<td>Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design</td>
</tr>
<tr>
<td>EECS 188</td>
<td>Optical Electronics</td>
</tr>
</tbody>
</table>

Specialization in Semiconductors and Optoelectronics:
Requires:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 174</td>
<td>Semiconductor Devices</td>
</tr>
<tr>
<td>EECS 188</td>
<td>Optical Electronics</td>
</tr>
<tr>
<td>PHYSICS 52A</td>
<td>Fundamentals of Experimental Physics</td>
</tr>
<tr>
<td>and select three of the following:</td>
<td></td>
</tr>
<tr>
<td>EECS 170D</td>
<td>Integrated Electronic Circuit Design</td>
</tr>
<tr>
<td>EECS 176</td>
<td>Fundamentals of Solid-State Electronics and Materials</td>
</tr>
<tr>
<td>EECS 179</td>
<td>Microelectromechanical Systems (MEMS)</td>
</tr>
<tr>
<td>EECS 180B</td>
<td>Engineering Electromagnetics II</td>
</tr>
<tr>
<td>EECS 180C</td>
<td>Engineering Electromagnetics III</td>
</tr>
<tr>
<td>ENGR 54</td>
<td>Principles of Materials Science and Engineering</td>
</tr>
</tbody>
</table>

Specialization in RF, Antennas and Microwaves:
Requires:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 144</td>
<td>Antenna Design for Wireless Communication Links</td>
</tr>
<tr>
<td>EECS 180B</td>
<td>Engineering Electromagnetics II</td>
</tr>
<tr>
<td>EECS 182</td>
<td>Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design</td>
</tr>
<tr>
<td>and select three of the following:</td>
<td></td>
</tr>
<tr>
<td>EECS 170D</td>
<td>Integrated Electronic Circuit Design</td>
</tr>
<tr>
<td>EECS 170E</td>
<td>Analog and Communications IC Design</td>
</tr>
<tr>
<td>EECS 180C</td>
<td>Engineering Electromagnetics III</td>
</tr>
<tr>
<td>EECS 188</td>
<td>Optical Electronics</td>
</tr>
<tr>
<td>PHYSICS 52A</td>
<td>Fundamentals of Experimental Physics</td>
</tr>
</tbody>
</table>

Specialization in Digital Signal Processing:
Requires:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 22</td>
<td>Advanced C Programming</td>
</tr>
<tr>
<td>EECS 152A</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>EECS 152B</td>
<td>Digital Signal Processing Design and Laboratory</td>
</tr>
<tr>
<td>and select three of the following:</td>
<td></td>
</tr>
<tr>
<td>EECS 20</td>
<td>Computer Systems and C Programming</td>
</tr>
<tr>
<td>EECS 101</td>
<td>Introduction to Machine Vision</td>
</tr>
<tr>
<td>EECS 112</td>
<td>Organization of Digital Computers</td>
</tr>
<tr>
<td>EECS 141A</td>
<td>Communication Systems I</td>
</tr>
<tr>
<td>EECS 141B</td>
<td>Communication Systems II</td>
</tr>
</tbody>
</table>

Specialization in Communications:
Requires:
Program of Study

Listed below are sample programs for each of the five specializations within Electrical Engineering. These sample programs are typical for the accredited major in Electrical Engineering. Students should keep in mind that this program is based upon a rigid set of prerequisites, beginning with adequate preparation in high school mathematics, physics, and chemistry. Therefore, the course sequence should not be changed except for the most compelling reasons. Students who are not adequately prepared, or who wish to make changes in the sequence for other reasons, must have their programs approved by their advisor. Electrical Engineering majors must consult with the academic counselors in the Student Affairs Office and with their faculty advisors at least once a year.

Sample Program of Study — Electrical Engineering (Electronic Circuit Design Specialization)

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Winter</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 2A</td>
<td>MATH 2B</td>
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Sophomore

<table>
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<th>Spring</th>
<th>Fall</th>
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<tbody>
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Junior

<table>
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Senior

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Students must obtain approval for their program of study and must see their faculty advisor at least once each year.

Sample Program of Study — Electrical Engineering (Semiconductors and Optoelectronics)

<table>
<thead>
<tr>
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<th>Winter</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
<th>Fall</th>
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### Sophomore

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<tbody>
<tr>
<td>MATH 3A</td>
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<td>PHYSICS 52A</td>
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<tr>
<td>EECS 31L</td>
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<table>
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<td>EECS 70LA</td>
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### Junior

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>EECS 145</td>
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<tr>
<td>EECS 180A</td>
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### Senior

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<td>EECS 170B</td>
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<tr>
<td>EECS 180A</td>
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### Sample Program of Study — Electrical Engineering (RF, Antennas and Microwaves)

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<th>Spring</th>
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<table>
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<th>Spring</th>
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<tbody>
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<td>EECS 174</td>
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<tr>
<td>EECS 180A</td>
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### Sample Program of Study — Electrical Engineering (Digital Signal Processing Specialization)

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<tr>
<td>PHYSICS 7C</td>
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Students must obtain approval for their program of study and must see their faculty advisor at least once each year.
Students must obtain approval for their program of study and must see their faculty advisor at least once each year.

### Sample Program of Study — Electrical Engineering (Communication Specialization)

<table>
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<td>MATH 2D</td>
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</tr>
</tbody>
</table>

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On This Page:

- Electrical and Computer Engineering
Graduate Study in Electrical and Computer Engineering

The Department offers M.S. and Ph.D. degrees in Electrical and Computer Engineering with a concentration in Electrical Engineering and in Computer Engineering. Because most graduate courses are not repeated every quarter, students should make every effort to begin their graduate program in the fall.

Detailed descriptions of the two concentrations are as follows.

Electrical Engineering Concentration (EE)

The Electrical Engineering faculty study the following areas: optical and solid-state devices, including quantum electronics and optics, integrated electro-optics and acoustics, design of semiconductor devices and materials, analog and mixed-signal IC design, microwave and microwave devices, and scanning acoustic microscopy; systems engineering and signal processing, including communication theory, machine vision, signal processing, power electronics, neural networks, communications networks, systems engineering, and control systems. Related communication networks topics are also addressed by the Networked Systems M.S. and Ph.D. degrees (listed in the Interdisciplinary Studies section of the Catalogue).

Computer Engineering Concentration (CPE)

The concentration in Computer Engineering provides students with a solid base in the design, development, and evaluation of computer systems. Thrust areas include computer architecture, software, and embedded systems, but the program is highly customizable to the specific interests of the student. The research activities of the faculty in this concentration include parallel and distributed computer systems, distributed software architectures and databases, ultra-reliable real-time computer systems, VLSI architectures, reconfigurable computing, computer design automation, low-power design, embedded systems, computer communication protocols, computer networks, security, programming languages for parallel/distributed processing, knowledge management, service-oriented architectures, and software engineering.

Master of Science Degree General Requirements

Two plans are offered for the M.S.: a thesis option and a comprehensive examination option. For either option, students are required to develop a complete program of study with advice from their faculty advisor. The graduate advisor must approve the study plan. Part-time study toward the M.S. is available. The program of study must be completed within four calendar years from first enrollment.

Plan I: Thesis Option

The thesis option requires completion of 12 courses of study; an original research investigation; the completion of an M.S. thesis; and approval of the thesis by a thesis committee. The thesis committee is composed of three full-time faculty members with the faculty advisor of the student serving as the chair. Required undergraduate core courses and graduate seminar courses, such as EECS 290, EECS 292, EECS 293, EECS 294, and EECS 295, may not be counted toward the 12 courses. No more than one course of EECS 299 and one undergraduate elective course may be counted toward the 12 courses. Up to four of the required 12 courses may be from EECS 296 (M.S. Thesis Research) with the approval of the student’s thesis advisor. Additional concentration-specific requirements are as follows; a list of core and concentration courses is given at the end of this section.

Electrical Engineering Concentration:

At least seven concentration courses in the Electrical Engineering Concentration (EE) must be completed. All courses must be completed with a grade of B (3.0) or better.

Computer Engineering Concentration:

Three core courses in the Computer Engineering Concentration (CPE) must be completed: EECS 211, EECS 213, and EECS 215. At least four additional concentration or approved courses must also be completed. All courses must be completed with a grade of B (3.0) or better.

Plan II: Comprehensive Examination Option

The comprehensive examination option requires the completion of 12 courses and a comprehensive examination. Only one EECS 299 course can be counted if the EECS 299 course is four or more units. Undergraduate core courses and graduate seminar courses, such as EECS 290, EECS 292, EECS 293, EECS 294, and EECS 295, may not be counted toward the 12 courses requirement. No more than two of undergraduate elective courses may be counted. In fulfillment of the comprehensive examination element of the M.S. program, students can choose one of the two alternatives: 1) EECS 290 Curricular Practical Training or 2) EECS 294 Electrical Engineering and Computer Science Colloquium. Either of the two alternatives may be taken for 1 unit and completed with a satisfactory grade to fulfill the comprehensive exam requirements. Additional concentration-specific requirements are as follows; a list of core and concentration courses is given at the end of this section.

Electrical Engineering Concentration:

Students enrolled in the Electrical Engineering (EE) concentration who choose the Comprehensive Examination option must select one of the following plans of study.

Circuits and Devices Plan of Study:
Select four of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
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<tbody>
<tr>
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<td>Advanced Analog Integrated Circuit Design I</td>
</tr>
<tr>
<td>EECS 270B</td>
<td>Advanced Analog Integrated Circuit Design II</td>
</tr>
<tr>
<td>EECS 277A</td>
<td>Advanced Semiconductor Devices I</td>
</tr>
<tr>
<td>EECS 277B</td>
<td>Advanced Semiconductor Devices II</td>
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<tr>
<td>EECS 280A</td>
<td>Advanced Engineering Electromagnetics I</td>
</tr>
<tr>
<td>EECS 285A</td>
<td>Optical Communications</td>
</tr>
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</table>

At least five additional courses from the list of EE concentration courses must be completed. All must be completed with a grade of B (3.0) or better.

**Systems Plan of Study:**

Select four of the following: 1

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
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<td>Digital Communications I</td>
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<td>EECS 250</td>
<td>Digital Signal Processing I</td>
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<tr>
<td>EECS 251A</td>
<td>Detection, Estimation, and Demodulation Theory</td>
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<td>EECS 260A</td>
<td>Linear Systems I</td>
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<td>EECS 267A</td>
<td>Industrial and Power Electronics</td>
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</table>

At least five additional courses from the list of EE concentration courses must be completed. All must be completed with a grade of B (3.0) or better.

1 If all six courses are not offered in an academic year, students who graduate in that year can petition to replace the courses that are not offered by EECS 242 and/or EECS 244.

**Electrical Engineering Concentration Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
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<td>Principles of Imaging and Techniques in Medical Imaging I: X-ray, Nuclear, and NMR Imaging</td>
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<td>EECS 202C</td>
<td>Techniques in Medical Imaging II: Ultrasound, Electrophysiological, Optical</td>
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<td>EECS 213</td>
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<tr>
<td>EECS 215</td>
<td>Design and Analysis of Algorithms</td>
</tr>
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<td>EECS 267A-267B</td>
<td>Industrial and Power Electronics and Topics in Industrial and Power Electronics</td>
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<td>EECS 270A-270B</td>
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EECS 275A-275B
Very Large Scale Integration (VLSI) Project
and Very Large Scale Integration (VLSI) Project Testing

EECS 277A
Advanced Semiconductor Devices I

EECS 277B
Advanced Semiconductor Devices II

EECS 277C
Nanotechnology

EECS 278
Micro-System Design

EECS 279
Micro-Sensors and Actuators

EECS 280A
Advanced Engineering Electromagnetics I

EECS 280B
Advanced Engineering Electromagnetics II

EECS 282
Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design II

EECS 285A
Optical Communications

EECS 285B
Lasers and Photonics

EECS 285C
Nano Imaging

EECS 298
Topics in Electrical Engineering and Computer Science

Computer Engineering Concentration Courses

Computer Engineering Concentration:
Three core courses in the Computer Engineering Concentration (CPE) must be completed: EECS 211, EECS 213, and EECS 215. At least five additional concentration or approved courses must also be completed. All courses must be completed with a grade of B (3.0) or better.

Computer Engineering Concentration:

EECS 211
Advanced System Software ¹

EECS 213
Computer Architecture ¹

EECS 215
Design and Analysis of Algorithms ¹

EECS 217
VLSI System Design

EECS 219
Distributed Software Architecture and Design

EECS 220
Advanced Digital Signal Processing Architecture

EECS 221
Topics in Computer Engineering

EECS 222
Embedded System Modeling

EECS 223
Real-Time Computer Systems

EECS 224
High-Performance Computing

EECS 225
Embedded Systems Design

EECS 226
Embedded System Software

EECS 227
Cyber-Physical System Design

EECS 228
Program Analysis

EECS 229
Low Power SoC Design

EECS 230
Energy Efficiency

EECS 248A
Computer and Communication Networks

EECS 298
Topics in Electrical Engineering and Computer Science

COMPSCI 233
Networking Laboratory

COMPSCI 234
Advanced Networks

COMPSCI 236
Wireless and Mobile Networking

¹ This course is also a core course.

In addition to fulfilling the course requirements outlined above, it is a University requirement for the Master of Science degree that students fulfill a minimum of 36 units of study.

Doctor of Philosophy Degree General Requirements

The doctoral program in Electrical and Computer Engineering is tailored to the individual background and interest of the student. There are several milestones to pass: admission to the Ph.D. program by the Graduate Committee; Ph.D. preliminary examination on the background and potential for success in the doctoral program; departmental teaching requirement which can be satisfied through service as a teaching assistant or equivalent; original research work; development of a research report and dissertation proposal; advancement to Ph.D. candidacy in the third year (second year for students who entered with a master’s degree) through the Ph.D. qualifying examination conducted on behalf of the Irvine Division of the Academic
Senate; completion of a significant research investigation; and completion and approval of a dissertation. A public Ph.D. dissertation defense is also required. During the Ph.D. study, four units of EECS 290 or EECS 294 must be completed.

The Ph.D. preliminary examination is conducted twice a year, in the spring and fall quarters. Detailed requirements for each concentration are specified in the departmental Ph.D. preliminary examination policies, available from the EECS Graduate Admissions Office. A student who already has an M.S. on enrollment must pass the Ph.D. preliminary examination within one complete academic year cycle after entering the Ph.D. program. A student who does not already have an M.S. on enrollment must pass the Ph.D. preliminary examination within two complete academic year cycles after entering the Ph.D. program. A student has only two chances to take and pass the Ph.D. preliminary examination. A student who fails the Ph.D. preliminary examination twice will be asked to withdraw from the program, or will be dismissed from the program, and may not be readmitted into the program.

The Ph.D. is granted upon the recommendation of the Doctoral Committee and the Dean of Graduate Studies. Part-time study toward the Ph.D. is not permitted. The normative time for completion of the Ph.D. is five years (four years for students who entered with a master's degree). The maximum time permitted is seven years.

**Program in Law and Graduate Studies (J.D./M.S.-ECE; J.D./Ph.D.-ECE)**

Highly qualified students interested in combining the study of law with graduate qualifications in the ECE program are invited to undertake concurrent degree study under the auspices of UC Irvine’s Program in Law and Graduate Studies (PLGS). Students in this program pursue a coordinated curriculum leading to a J.D. degree from the School of Law in conjunction with a Master's or Ph.D. degree in the ECE program. Additional information is available from the PLGS Program Director's Office, 949-824-4158, or by email to plgs@uci.edu. A full description of the program, with links to all relevant application information can be found at the School of Law Concurrent Degree Programs website (http://www.law.uci.edu/academics/interdisciplinary-studies/concurrent-degrees.html) and in the Law School section of the Catalogue.

**Faculty**

Mohammad A. Al Faruque, Ph.D. University of Kaiserslautern, Assistant Professor of Electrical Engineering and Computer Science (system-level design, embedded systems, cyber-physical-systems, multi-core systems)

Nicolaos G. Alexopoulos, Ph.D. University of Michigan, Professor Emeritus of Electrical Engineering and Computer Science

Ender Ayanoglu, Ph.D. Stanford University, Professor of Electrical Engineering and Computer Science (communication systems, communication theory, communication networks)

Nader Bagherzadeh, Ph.D. University of Texas at Austin, Professor of Electrical Engineering and Computer Science; Computer Science (parallel processing, computer architecture, computer graphics, VLSI design)

Neil J. Bershad, Ph.D. Rensselaer Polytechnic Institute, Professor Emeritus of Electrical Engineering and Computer Science

Ozdal Boyraz, Ph.D. University of Michigan, Associate Professor of Electrical Engineering and Computer Science (silicon photonics and optical communications systems)

Peter J. Burke, Ph.D. Yale University, Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Chemical Engineering and Materials Science (nano-electronics, bio-nanotechnology)

Filippo Capolino, Ph.D. University of Florence, Associate Professor of Electrical Engineering and Computer Science (optics/electromagnetics in nanostructures and sensors, antennas/microwaves, RF and wireless systems)

Aparna Chandramowlishwaran, Ph.D. Georgia Institute of Technology, Assistant Professor of Electrical Engineering and Computer Science (parallel programming models, domain specific compilers, algorithm-architecture co-design, n-body particle methods, scientific and high-performance computing)

Pai H. Chou, Ph.D. University of Washington, Professor Emeritus of Electrical Engineering and Computer Science; Computer Science (embedded systems, wireless sensor systems, medical devices, real-time systems, hardware/software co-synthesis)

Jose B. Cruz, Ph.D. University of Illinois at Urbana-Champaign, Professor Emeritus of Electrical Engineering and Computer Science

Franco De Flaviis, Ph.D. University of California, Los Angeles, Professor of Electrical Engineering and Computer Science (microwave systems, wireless communications, electromagnetic circuit simulations)

Brian C. Demsky, Ph.D. Massachusetts Institute of Technology, Associate Professor of Electrical Engineering and Computer Science; Computer Science (compiler programming, language software engineering, fault tolerance)

Rainer B. Doemer, Ph.D. Dortmund University, Professor of Electrical Engineering and Computer Science; Computer Science (system-level design, embedded computer systems, design methodologies, specification and modeling languages)

Ahmed Eltawil, Ph.D. University of California, Los Angeles, Professor of Electrical Engineering and Computer Science (design of system and VLSI architectures for broadband wireless communication, implementations and architectures for digital processing)
Leonard A. Ferrari, Ph.D. University of California, Irvine, Professor Emeritus of Electrical Engineering and Computer Science

Daniel D. Gajski, Ph.D. University of Pennsylvania, Professor Emeritus of Electrical Engineering and Computer Science (embedded systems, software/hardware design, design methodologies and tools, science of design)

Jean-Luc Gaudiot, Ph.D. University of California, Los Angeles, Professor of Electrical Engineering and Computer Science; Computer Science (parallel processing, computer architecture, processor architecture)

Michael M. Green, Ph.D. University of California, Los Angeles, Associate Dean for Undergraduate Student Affairs of The Henry Samueli School of Engineering and Professor of Electrical Engineering and Computer Science (analog/mixed-signal IC design, broadband circuit design, theory of nonlinear circuits)

Glenn E. Healey, Ph.D. Stanford University, Professor of Electrical Engineering and Computer Science (machine vision, computer engineering, image processing, computer graphics, intelligent machines)

Payam Heydari, Ph.D. University of Southern California, Professor of Electrical Engineering and Computer Science (design and analysis of analog, RF and mixed-signal integrated circuits, analysis of signal integrity and high-frequency effects of on-chip interconnects in high-speed VLSI circuits)

Syed A. Jafar, Ph.D. Stanford University, Professor of Electrical Engineering and Computer Science (wireless communication and information theory)

Hamid Jafarkhani, Ph.D. University of Maryland, College Park, Conexant-Broadcom Chair in the Center for Pervasive Communications and UCI Chancellor's Professor of Electrical Engineering and Computer Science (communication theory, coding, wireless networks, multimedia networking)

Pramod Khargonekar, Ph.D. University of Florida, UCI Distinguished Professor of Electrical Engineering and Computer Science (systems and control theory; learning and intelligent systems; applications to renewable energy and smart grid, neural engineering, and economics; leadership and creativity; technology and society)

Stuart A. Kleinfielder, Ph.D. Stanford University, Professor of Electrical Engineering and Computer Science (first integrated sensor/readout arrays for visual, IR, X-ray, charged particles)

Fadi J. Kurdahi, Ph.D. University of Southern California, Director, Center for Embedded Computer Systems and Associate Dean for Graduate and Professional Studies and Professor of Electrical Engineering and Computer Science; Computer Science (VLSI system design, design automation of digital systems)

Tomas Lang, Ph.D. Stanford University, Professor Emeritus of Electrical Engineering and Computer Science

Chin C. Lee, Ph.D. Carnegie Mellon University, Professor of Electrical Engineering and Computer Science (bonding technology, electronic packaging, acoustics, microwaves, semiconductor devices, thermal management)

Henry P. Lee, Ph.D. University of California, Berkeley, Professor of Electrical Engineering and Computer Science (photronics, fiber-optics and compound semiconductors)

Guann-Pyng Li, Ph.D. University of California, Los Angeles, Director of the UCI Division of the California Institute for Telecommunications and Information Technology (Calit2), Director of the Integrated Nanosystems Research Facility and Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Chemical Engineering and Materials Science (high-speed semiconductor technology, optoelectronic devices, integrated circuit fabrication and testing)

Kwei-Jay Lin, Ph.D. University of Maryland, College Park, Professor of Electrical Engineering and Computer Science; Computer Science (real-time systems, distributed systems, service-oriented computing)

Athina Markopoulou, Ph.D. Stanford University, Associate Professor of Electrical Engineering and Computer Science; Computer Science (networking—reliability and security, multimedia networking, measurement and control, design and analysis of network protocols and algorithms, internet reliability and security, multimedia streaming, network measurements and control)

Phillip C-Y Sheu, Ph.D. University of California, Berkeley, Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Computer Science (database systems, interactive multimedia systems)

Jack Sklansky, Sc.D. Columbia University, Professor Emeritus of Electrical Engineering and Computer Science

Keyue M. Smedley, Ph.D. California Institute of Technology, Professor of Electrical Engineering and Computer Science (power electronics, alternative energy power generation, and motion control)

Allen R. Stubberud, Ph.D. University of California, Los Angeles, Professor Emeritus of Electrical Engineering and Computer Science

A. Lee Swindlehurst, Ph.D. Stanford University, Professor of Electrical Engineering and Computer Science (signal processing, estimation and detection theory, applications in wireless communications, geo-positioning, radar, sonar, biomedicine)
Harry H. Tan, Ph.D. University of California, Los Angeles, Professor Emeritus of Electrical Engineering and Computer Science

Chen S. Tsai, Ph.D. Stanford University, UCI Chancellor's Professor of Electrical Engineering and Computer Science (integrated and fiber optics, devices and materials, integrated acoustooptics and magnetooptics, integrated microwave magnetics, Ultrasonic Atomization for Nanoparticles Synthesis, silicon photonics)

Wei Kang (Kevin) Tsai, Ph.D. Massachusetts Institute of Technology, Professor Emeritus of Electrical Engineering and Computer Science

Zhiying Wang, Ph.D. California Institute of Technology, Assistant Professor of Electrical Engineering and Computer Science (information theory, coding for storage, compression and computation for genomic data)

H. Kumar Wickramasinghe, Ph.D. University of London, Henry Samuell Endowed Chair in Engineering and Department Chair and Professor of Electrical Engineering and Computer Science; Biomedical Engineering; Chemical Engineering and Materials Science (nanoscale measurements and characterization, scanning probe microscopy, storage technology, nano-bio measurement technology)

Affiliate Faculty

Lubomir Bic, Ph.D. University of California, Irvine, Professor of Computer Science; Electrical Engineering and Computer Science (parallel and distributed computing, mobile agents)

Elaheh Bozorgzadeh, Ph.D. University of California, Los Angeles, Associate Professor of Computer Science; Electrical Engineering and Computer Science (design automation and synthesis for embedded systems, VLSI CAD, reconfigurable computing)

Carter Butts, Ph.D. Carnegie Mellon University, Professor of Sociology; Electrical Engineering and Computer Science; Statistics (mathematical sociology, social networks, quantitative methodology, human judgment and decision making, economic sociology)

Zhongping Chen, Ph.D. Cornell University, Professor of Biomedical Engineering; Electrical Engineering and Computer Science; Otolaryngology; Surgery (biomedical optics, optical coherence tomography, bioMEMS, biomedical devices)

Nikil D. Dutt, Ph.D. University of Illinois at Urbana–Champaign, UCI Chancellor's Professor of Computer Science; Cognitive Sciences; Electrical Engineering and Computer Science (embedded systems, computer architecture, electronic design automation, software systems, brain-inspired architectures and computing)

Magda S. El Zarki, Ph.D. Columbia University, Professor of Computer Science; Electrical Engineering and Computer Science; Informatics (telecommunications, networks, wireless communication, video transmission)

Charless C. Fowlkes, Ph.D. University of California, Berkeley, Associate Professor of Computer Science; Cognitive Sciences; Electrical Engineering and Computer Science (computer vision, machine learning, computational biology)

Michael S. Franz, Ph.D. Swiss Federal Institute of Technology in Zurich, Professor of Computer Science; Electrical Engineering and Computer Science (systems software, particularly compilers and virtual machines, trustworthy computing, software engineering)

Michael T. Goodrich, Ph.D. Purdue University, UCI Chancellor's Professor of Computer Science; Electrical Engineering and Computer Science (computer security, algorithm design, data structures, Internet algorithmics, geometric computing, graphic drawing)

Gultekin Gulsen, Ph.D. Bogazici University, Associate Professor of Radiological Sciences; Biomedical Engineering; Electrical Engineering and Computer Science; Physics and Astronomy (in vivo molecular imaging, diffuse optical tomography, fluorescence tomography, photo-magnetic imaging, multi-modality imaging)

Ian G. Harris, Ph.D. University of California, San Diego, Associate Professor of Computer Science; Electrical Engineering and Computer Science (hardware/software covalidation, manufacturing test)

Dan S. Hirschberg, Ph.D. Princeton University, Professor of Computer Science; Electrical Engineering and Computer Science (analyses of algorithms, concrete complexity, data structures, models of computation)

Scott A. Jordan, Ph.D. University of California, Berkeley, Professor of Computer Science; Electrical Engineering and Computer Science (pricing and differentiated services in the Internet, resource allocation in wireless networks, telecommunications policy)

Frithjof Kruggel, M.D. Ludwig Maximilian University of Munich, Professor of Biomedical Engineering; Electrical Engineering and Computer Science (biomedical signal and image processing, anatomical and functional neuroimaging in humans, structure-function relationship in the human brain)

Marco Levorato, Ph.D. University of Padua, Assistant Professor of Computer Science; Electrical Engineering and Computer Science

Aditi Majumder, Ph.D. University of North Carolina at Chapel Hill, Professor of Computer Science; Electrical Engineering and Computer Science (novel displays and cameras for computer graphics and visualization, human-computer interaction, applied computer vision)
Courses

EECS 1. Introduction to Electrical Engineering and Computer Engineering. 1 Unit.
Introduction to the fields of Electrical Engineering and Computer Engineering, including possible careers in both traditional and new emerging areas. Background on both the Electrical Engineering and the Computer Engineering majors, curriculum requirements, specializations, and faculty research interests. Course may be offered online.

(Design units: 0)
Restriciton: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 10. Computational Methods in Electrical and Computer Engineering. 4 Units.

(Design units: 0)
Corequisite: MATH 2A
Prerequisite: MATH 2A
Overlaps with EECS 12, I&C SCI 31.
Restriction: Electrical Engineering Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment.
EECS 12. Introduction to Programming. 4 Units.

(Design units: 0)
Corequisite: MATH 2A
Overlaps with EECS 10, I&C SCI 31.
Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 20. Computer Systems and C Programming. 4 Units.
Introduction to computing systems. Data representation and operations. Simple logic design. Basic computer organization. Instruction set architecture and assembly language programming. Introduction to C. Functions and recursion, data structures, pointers. Programming laboratory.

(Design units: 1)
Prerequisite: EECS 12
Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 22. Advanced C Programming. 3 Units.

(Design units: 1)
Prerequisite: EECS 10 or EECS 20
Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 22L. Software Engineering Project in C Language. 3 Units.
Hands-on experience with the ANSI-C programming language. Medium-sized programming projects, team work. Software specification, documentation, implementation, testing. Definition of data structures and application programming interface. Creation of program modules, linking with external libraries. Rule-based compilation, version control.

(Design units: 3)
Prerequisite: EECS 22
Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 31. Introduction to Digital Systems. 4 Units.
Digital representation of information. Specification, analysis, design and optimization or combinational and sequential logic, register-transfer components and register-transfer systems with datapaths and controllers. Introduction to high-level and algorithmic state-machines and custom processors.

(Design units: 2)
Prerequisite: I&C SCI 31 or EECS 10 or EECS 12 or ENGRMAE 10
Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 31L. Introduction to Digital Logic Laboratory. 3 Units.
Introduction to common digital integrated circuits: gates, memory circuits, MSI components. Operating characteristics, specifications, applications. Design of simple combinational and sequential digital systems (arithmetic processors game-playing machines). Construction and debugging techniques using hardware description languages and CAD tools.

(Design units: 3)
Prerequisite: EECS 31 and (EECS 10 or EECS 12 or I&C SCI 32)
Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.
EECS 40. Object-Oriented Systems and Programming. 4 Units.
Constructors. Inheritance basics. Programming with inheritance. Dynamic binding and polymorphism. Exception handling. An overview of streams and
file input/output. Programming laboratory.

(Design units: 2)
Prerequisite: EECS 22L
Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 50. Discrete-Time Signals and Systems. 4 Units.
Analysis of discrete-time linear-time-invariant (DTLTI) systems in the time domain and using z-transforms. Introduction to techniques based on Discrete-
Time, Discrete, and Fast Fourier Transforms. Examples of their application to digital signal processing and digital communications.

(Design units: 0)
Prerequisite: EECS 70A
Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for
enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 55. Engineering Probability. 4 Units.
Sets and set operations; nature of probability, sample spaces, fields of events, probability measures; conditional probability, independence, random
variables, distribution functions, density functions, conditional distributions and densities; moments, characteristic functions, random sequences,
independent and Markov sequences.

(Design units: 0)
Prerequisite: MATH 2D
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 70A. Network Analysis I. 4 Units.
Modeling and analysis of electrical networks. Basic network theorems. Sinusoidal steady state and transient analysis of RLC networks and the
impedance concept.

(Design units: 1)
Corequisite: MATH 3D
Prerequisite: PHYSICS 7D and (EECS 10 or EECS 12 or ENGRMAE 10 or I&C SCI 31)
Overlaps with ENGRMAE 60.
Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for
enrollment. Mechanical Engineering Majors have first consideration for enrollment. Aerospace Engineering Majors have first consideration for
enrollment. Civil Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.
Materials Science Engineering Majors have first consideration for enrollment. Environmental Engineering Majors have first consideration for enrollment.

EECS 70B. Network Analysis II. 4 Units.
Laplace transforms, complex frequency, and the s-plane. Network functions and frequency response, including resonance. Bode plots. Two-port network
characterization.

(Design units: 1)
Corequisite: EECS 70LB
Prerequisite: (BME 60B or EECS 10 or EECS 12 or I&C SCI 31 or ENGRCEE 20 or ENGRMAE 10) and EECS 70A
Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.
Materials Science Engineering Majors have first consideration for enrollment.
EECS 70LA. Network Analysis I Laboratory. 1 Unit.
Laboratory to accompany EECS 70A.

(Design units: 0)
Corequisite: EECS 70A
Prerequisite: PHYSICS 7D and EECS 10

EECS 70LB. Network Analysis II Laboratory. 1 Unit.
Laboratory to accompany EECS 70B. Materials fee.

(Design units: 1)
Corequisite: EECS 70B
Prerequisite: (BME 60B or EECS 10 or EECS 12 or I&C SCI 31 or ENGRCEE 20 or ENGRMAE 10) and EECS 70A

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 101. Introduction to Machine Vision. 3 Units.
The use of digital computers for the analysis of visual scenes: image formation and sensing, color, segmentation, shape estimation, motion, stereo, pattern classification, computer architectures, applications. Computer experiments are used to illustrate fundamental principles.

(Design units: 2)
Prerequisite: EECS 150 or EECS 50

Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 111. System Software. 4 Units.
Multiprogramming, interrupt, processes, kernel, parallelism, critical sections, deadlocks, communication, multiprocessing, multilevel memory management, binding, name management, file systems, protection, resource allocation, scheduling. Experience with concurrent programming, synchronization mechanisms, interprocess communication.

(Design units: 2)
Prerequisite: EECS 112 and (I&C SCI 46 or EECS 114)

Overlaps with COMPSCI 143A.

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 112. Organization of Digital Computers. 4 Units.
Building blocks and organization of digital computers, the arithmetic, control, and memory units, and input/output devices and interfaces. Microprogramming and microprocessors.

(Design units: 4)
Prerequisite: EECS 31L

Overlaps with COMPSCI 152.

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 112L. Organization of Digital Computers Laboratory. 3 Units.
Specification and implementation of a processor-based system using a hardware description language such as VHDL. Hands-on experience with design tools including simulation, synthesis, and evaluation using testbenches.

(Design units: 3)
Prerequisite: EECS 112

Restriction: Computer Science Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.
EECS 113. Processor Hardware/Software Interfaces. 4 Units.
Hardware/software interfacing, including memory and bus interfaces, devices, I/O, and compiler code generation/instruction scheduling. Experience microcontroller programming and interfacing. Specific compiler code generation techniques including local variable and register allocations, instruction dependence and scheduling, and code optimization.

(Design units: 3)
Prerequisite: EECS 112

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 114. Engineering Data Structures and Algorithms. 4 Units.
Introduces abstract behavior of classes data structures, alternative implementations, informal analysis of time and space efficiency. Also introduces classic algorithms and efficient algorithm design techniques (recursion, divide-and-conquer, branch-and-bound, dynamic programming).

(Design units: 2)
Prerequisite: EECS 40

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 116. Introduction to Data Management. 4 Units.
Introduction to the design of databases and the use of database management systems (DBMS) for applications. Topics include entity-relationship modeling for design, relational data model, relational algebra, relational design theory, and Structured Query Language (SQL) programming.

(Design units: 1)
Prerequisite: I&C SCI 33 or CSE 43 or EECS 114. I&C SCI 33 with a grade of C or better. CSE 43 with a grade of C or better

Same as COMPSCI 122A.

Restriction: Computer Science Engineering Majors have first consideration for enrollment. School of Info & Computer Sci students have first consideration for enrollment.

EECS 117. Parallel Computer Systems. 4 Units.
Fundamentals of parallel computing with designing, analyzing, implementing parallel algorithms on HPC architectures. Parallel models: work-depth, I/O memory models. Parallel architectures: shared-memory machines, distributed-memory machines, vector processors. Parallel algorithms and programming models for each machine type are discussed.

(Design units: 1)
Prerequisite: EECS 20 and EECS 114 and EECS 112

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 118. Introduction to Knowledge and Software Engineering. 4 Units.
Introduction of basic concepts in knowledge engineering and software engineering. Knowledge representation and reasoning, search planning, software life cycle, requirements engineering, software design languages, declarative programming, testing, database and web programming.

(Design units: 2)
Prerequisite: EECS 40

Restriction: Computer Engineering Majors have first consideration for enrollment.

EECS 119. VLSI. 4 Units.
Design techniques for Very Large Scale Integrated (VLSI) systems and chips. Review CMOS and related process technologies; primitives such as logic gates and larger design blocks; layout; floor planning; design hierarchy, component interfaces; use of associated CAD tools for design.

(Design units: 4)
Prerequisite: EECS 112 and EECS 170B

Overlaps with EECS 170D, CSE 112.

Restriction: Computer Engineering Majors have first consideration for enrollment.
EECS 141A. Communication Systems I. 3 Units.
Introduction to analog communication systems including effects of noise. Modulation-demodulation for AM, DSB-SC, SSB, VSB, QAM, FM, PM, and PCM with application to radio, television, and telephony. Signal processing as applied to communication systems.

(Design units: 1)
Prerequisite: EECS 55 and EECS 150
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment.

EECS 141B. Communication Systems II. 3 Units.

(Design units: 1)
Prerequisite: EECS 141A
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment.

EECS 144. Antenna Design for Wireless Communication Links. 4 Units.

(Design units: 0)
Prerequisite: EECS 180A

EECS 145. Electrical Engineering Analysis. 4 Units.
Vector calculus, complex functions and linear algebra with applications to electrical engineering problems.

(Design units: 0)
Prerequisite: MATH 3D
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 148. Computer Networks. 4 Units.
Computer network architectures, protocols, and applications. Internet congestion control, addressing, and routing. Local area networks. Multimedia networking.

(Design units: 2)
Prerequisite: EECS 55 or STATS 67
Same as COMPSCI 132.
Restriction: Computer Engineering Majors have first consideration for enrollment. Computer Science Engineering Majors have first consideration for enrollment.

EECS 150. Continuous-Time Signals and Systems. 4 Units.
Characteristics and properties of continuous-time (analog) signals and systems. Analysis of linear time-invariant continuous-time systems using differential equation convolutional models. Analysis of these systems using Laplace transforms, Fourier series, and Fourier transforms. Examples from applications to telecommunications.

(Design units: 0)
Prerequisite: EECS 70A and EECS 145
Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.
EECS 152A. Digital Signal Processing. 3 Units.
Nature of sampled data, sampling theorem, difference equations, data holds, z-transform, w-transform, digital filters, Butterworth and Chebychev filters, quantization effects.

(Design units: 2)
Prerequisite: EECS 50
Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 152B. Digital Signal Processing Design and Laboratory. 3 Units.
Design and implementation of algorithms on a DSP processor and using computer simulation. Applications in signal and image processing, communications, radar, etc.

(Design units: 3)
Prerequisite: (EECS 22 or I&C SCI 45C) and EECS 152A
Restriction: Computer Science Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 159A. Senior Design Project I. 3 Units.
Teaches problem definition, detailed design, integration, and testability with teams of students specifying, designing, building, and testing complex systems. Lectures include engineering values, discussions, and ethical ramifications of engineering decisions.

(Design units: 3)
Prerequisite: EECS 113 or EECS 170C or COMPSCI 145
Restriction: Seniors only. Computer Science Engineering Majors only. Electrical Engineering Majors only. Computer Engineering Majors only.

EECS 159B. Senior Design Project II. 3 Units.
Teaches problem definition, detailed design, integration, and testability with teams of students specifying, designing, building, and testing complex systems. Lectures include engineering values, discussions, and ethical ramifications of engineering decisions.

(Design units: 3)
Prerequisite: EECS 159A
Restriction: Computer Science Engineering Majors only. Electrical Engineering Majors only. Computer Engineering Majors only.

EECS 160A. Introduction to Control Systems. 4 Units.
Modeling, stability, and specifications of feedback control systems. Root locus, Bode plots, Nyquist criteria, and state-space methods for dynamic analysis and design.

(Design units: 2)
Corequisite: EECS 160LA
Prerequisite: (EECS 10 or ENGRMAE 10) and EECS 150 and EECS 170B and EECS 170LB
Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 160LA. Control Systems I Laboratory. 1 Unit.
Laboratory accompanying EECS 160A. Materials fee.

(Design units: 1)
Corequisite: EECS 160A
Restriction: Electrical Engineering Majors have first consideration for enrollment.
EECS 163. Power Systems. 4 Units.
Generation, transmission, and use of electrical energy. Fault calculation, protection, stability, and power flow.
(Design units: 1)
Corequisite: EECS 163L
Prerequisite: EECS 70B
Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 163L. Power Systems Laboratory. 1 Unit.
Experiments and field trips relevant to studies in power systems. Materials fee.
(Design units: 0)
Corequisite: EECS 163
Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 166A. Industrial and Power Electronics. 4 Units.
Power switching devices, pulse width modulation (PWM) methods, switching converter topologies, control, and magnetics. Materials fee.
(Design units: 2)
Prerequisite: EECS 170C and EECS 160A
Restriction: Electrical Engineering Majors have first consideration for enrollment.
Concurrent with EECS 267A.

EECS 170A. Electronics I. 4 Units.
The properties of semiconductors, electronic conduction in solids, the physics and operation principles of semiconductor devices such as diodes and transistors, transistor equivalent circuits, and transistor amplifiers.
(Design units: 1)
Corequisite: PHYSICS 7E
Prerequisite: PHYSICS 7D and EECS 70A
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 170B. Electronics II. 4 Units.
Design and analysis of single-stage amplifiers, biasing circuits, inverters, logic gates, and memory elements based on CMOS transistors.
(Design units: 2)
Corequisite: EECS 170LB
Prerequisite: EECS 70B and EECS 170A and EECS 170LA
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

EECS 170C. Electronics III. 4 Units.
Principles of operation, design, and utilization of integrated circuit modules, including multi-stage amplifiers, operational amplifiers and logic circuits.
(Design units: 2)
Corequisite: EECS 170LC
Prerequisite: EECS 170B and EECS 170LB
Restriction: Electrical Engineering Majors have first consideration for enrollment.
EECS 170D. Integrated Electronic Circuit Design. 4 Units.
Design and fabrication of modern digital integrated circuits. Fabrication of CMOS process, transistor-level design simulation, functional characteristics of basic digital integrated circuits, and different logic families including the static and dynamic logic, layout, and extraction of digital circuits.

(Design units: 4)
Prerequisite: EECS 170C and EECS 170LC
Overlaps with EECS 119, CSE 112.
Restriction: Electrical Engineering Majors have first consideration for enrollment. Computer Engineering Majors have first consideration for enrollment.

EECS 170E. Analog and Communications IC Design. 4 Units.
Advanced topics in design of analog and communications integrated circuits. Topics include: implementation of passive components in integrated circuits; overview of frequency response of amplifiers, bandwidth estimation techniques, high-frequency amplifier design; design of radio-frequency oscillators.

(Design units: 3)
Prerequisite: EECS 170C

EECS 170LA. Electronics I Laboratory. 1 Unit.
Laboratory accompanying EECS 170A to perform experiments on semiconductor material properties, semiconductor device physics and operation principles, and transistor amplifiers to improve experimental skills and to enhance the understanding of lecture materials.

(Design units: 1)
Corequisite: EECS 170A and PHYSICS 7E
Prerequisite: PHYSICS 7D and EECS 70B
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

EECS 170LB. Electronics II Laboratory. 1 Unit.
Laboratory accompanying EECS 170B.

(Design units: 1)
Corequisite: EECS 170B
Prerequisite: EECS 170A and EECS 170LA
Restriction: Computer Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment.

EECS 170LC. Electronics III Laboratory. 1 Unit.
Laboratory accompanying EECS 170C to provide hands-on training in design of digital/analog circuits/subsystems. Materials fee.

(Design units: 1)
Corequisite: EECS 170C
Prerequisite: EECS 170B and EECS 170LB
Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 174. Semiconductor Devices. 4 Units.
Metal-semiconductor junctions, diodes, bipolar junction transistors, MOS structures, MOSFETs, CMOS technology, LEDs, and laser diodes.

(Design units: 1)
Prerequisite: EECS 170A
Restriction: Electrical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.
EECS 176. Fundamentals of Solid-State Electronics and Materials. 4 Units.
Physical properties of semiconductors and the roles materials play in device operation. Topics include: crystal structure, phonon vibrations, energy band, transport phenomenon, optical properties and quantum confinement effect essential to the understanding of electronic, optoelectronic and nanodevices.

(Design units: 1)
Prerequisite: EECS 170A
Restriction: Electrical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

EECS 179. Microelectromechanical Systems (MEMS). 4 Units.
Small-scale machines, small-scale phenomena, MEMS fabrication, MEMS CAD tools, MEMS devices and packaging, MEMS testing.

(Design units: 2)
Restriction: Upper-division students only. Electrical Engineering Majors have first consideration for enrollment. Biomedical Engineering Majors have first consideration for enrollment.

EECS 180A. Engineering Electromagnetics I. 4 Units.
Electrostatics, magnetostatics, and electromagnetic fields: solutions to problems in engineering applications; transmission lines, Maxwell’s equations and phasors, plane wave propagation, reflection, and transmission. Formerly EECS 180.

(Design units: 1)
Corequisite: MATH 2D and MATH 3D
Prerequisite: PHYSICS 7E and EECS 145
Restriction: Biomedical Engineering Majors have first consideration for enrollment. Electrical Engineering Majors have first consideration for enrollment. Materials Science Engineering Majors have first consideration for enrollment.

EECS 180B. Engineering Electromagnetics II. 4 Units.
Time-varying electromagnetic fields, plane waves, polarization, guidance of waves like rectangular waveguides and microstrips, optical fibers resonant cavities, skin effects and losses, spherical waves, radiation and reception of waves, antenna basics. Formerly EECS 187.

(Design units: 1)
Prerequisite: EECS 180A
Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 180C. Engineering Electromagnetics III. 4 Units.

(Design units: 0)
Prerequisite: EECS 180B
Restriction: Electrical Engineering Majors have first consideration for enrollment.

EECS 182. Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design. 4 Units.
Design of microwave amplifiers including low-noise amplifiers, multiple stage amplifiers, power amplifiers, and introduction to broadband amplifiers. The goal is to provide the basic knowledge for the design of microwave amplifiers ranging from wireless system to radar system.

(Design units: 3)
Prerequisite: EECS 180A

EECS 188. Optical Electronics. 4 Units.
Photodiodes and optical detection, photometry and radiometry, geometric optics, lens theory, imaging system, EM wave propagation, optical waveguides and fibers, heterojunction structures, laser theory, semiconductor lasers, and optical transmission system.

(Design units: 1)
Prerequisite: EECS 180A
Restriction: Electrical Engineering Majors have first consideration for enrollment.
EECS 195. Special Topics in Electrical and Computer Engineering. 1-4 Units.
Studies special topics in selected areas of Electrical and Computer Engineering. Topics addressed vary each quarter.

(Design units: 1-4)
Prerequisite: Prerequisites vary.
Repeatability: Unlimited as topics vary.

EECS 198. Group Study. 1-4 Units.
Group study of selected topics in Electrical and Computer Engineering.

(Design units: 1-4)
Repeatability: May be repeated for credit unlimited times.
Restriction: Upper-division students only.

EECS 199. Individual Study. 1-4 Units.
For undergraduate Engineering majors in supervised but independent reading, research, or design. Students taking Individual study for design credit are to submit a written paper to the instructor and to the Undergraduate Student Affairs Office in the School of Engineering.

(Design units: 1-4)
Repeatability: May be taken for credit for 8 units.

EECS 199P. Individual Study. 1-4 Units.
For undergraduate Engineering majors in supervised but independent reading, research, or design. Students taking individual study for design credit are to submit a written paper to the instructor and to the Student Affairs Office in the School of Engineering.

(Design units: 1-4)
Grading Option: Pass/no pass only.
Repeatability: May be repeated for credit unlimited times.

EECS 202A. Principles of Imaging. 4 Units.
Linear systems, probability and random processes, image processing, projecting imaging, tomographic imaging.

Same as PHYSICS 233A.
Restriction: Graduate students only.
Concurrent with PHYSICS 147A.

EECS 202B. Techniques in Medical Imaging I: X-ray, Nuclear, and NMR Imaging. 4 Units.
Ionizing radiation, planar and tomographic radiographic and nuclear imaging, magnetism, NMR, MRI imaging.

Prerequisite: EECS 202A

Same as PHYSICS 233B.
Restriction: Graduate students only.
Concurrent with PHYSICS 147B.

EECS 202C. Techniques in Medical Imaging II: Ultrasound, Electrophysiological, Optical. 4 Units.
Sound and ultrasound, ultrasonic imaging, physiological electromagnetism, EEG, MEG, ECG, MCG, optical properties of tissues, fluorescence and bioluminescence, MR impedance imaging, MR spectroscopy, electron spin resonance and ESR imaging.

Prerequisite: EECS 202B

Same as PHYSICS 233C.
Restriction: Graduate students only.
Concurrent with PHYSICS 147C.
EECS 203A. Digital Image Processing. 4 Units.
Pixel-level digital image representation and elementary operations; Fourier and other unitary transforms; compression, enhancement, filtering, and restoration; laboratory experience is provided.

Restriction: Graduate students only.

EECS 211. Advanced System Software. 4 Units.
Study of operating systems including interprocess communication, scheduling, resource management, concurrency, reliability, validation, protection and security, and distributed computing support. System software design languages and modeling analysis.

Restriction: Graduate students only.

EECS 213. Computer Architecture. 4 Units.
Problems in hardware, firmware (microprogram), and software. Computer architecture for resource sharing, real-time applications, parallelism, microprogramming, and fault tolerance. Various architectures based on cost/performance and current technology.

Restriction: Graduate students only.

EECS 215. Design and Analysis of Algorithms. 4 Units.
Computer algorithms from a practical standpoint. Algorithms for symbolic and numeric problems such as sorting, searching, graphs, and network flow. Analysis includes algorithm time and space complexity.

EECS 217. VLSI System Design. 4 Units.
Overview of integrated fabrication, circuit simulation, basic device physics, device layout, timing; MOS logic design; layout generation, module generation, techniques for very large scale integrated circuit design.

Restriction: Graduate students only.

EECS 219. Distributed Software Architecture and Design. 4 Units.
Practical issues for reducing the software complexity, lowering cost, and designing and implementing distributed software applications. Topics include the distributed object model distributed environment, platform-independent software agents and components, the middleware architecture for distributed real-time and secure services.

Prerequisite: EECS 211

Restriction: Graduate students only.

EECS 220. Advanced Digital Signal Processing Architecture. 4 Units.
Study the latest DSP architectures for applications in communication (wired and wireless) and multimedia processing. Emphasis given to understanding the current design techniques and to evaluate the performance, power, and application domain of the latest DSP processors.

Prerequisite: EECS 213

Restriction: Graduate students only.

EECS 221. Topics in Computer Engineering. 4 Units.
New research results in computer engineering.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EECS 222. Embedded System Modeling. 4 Units.
Computational models for embedded systems. System-level specification and description languages. Concepts, requirements, examples. Embedded system models at different levels of abstraction. Modeling of test benches, design under test, IP components. Discrete event simulation, semantics, and algorithms. Formerly EECS 222A.

Restriction: Graduate students only.

EECS 223. Real-Time Computer Systems. 4 Units.
Time bases, clock synchronization, real-time communication protocols, specification of requirements, task scheduling. Validation of timelines, real-time configuration management.

Prerequisite: EECS 211 and EECS 213

Restriction: Graduate students only.
EECS 224. High-Performance Computing. 4 Units.
Fundamentals of high-performance computing, covering both theory and practice. Topics include performance analysis and tuning, design of parallel and I/O efficient algorithms, basics of parallel machine architectures, and current/emerging programming models (shared memory, distributed memory, and accelerators).
Prerequisite: EECS 215 or COMPSCI 260
Restriction: Graduate students only.

EECS 225. Embedded Systems Design. 4 Units.
Embedded systems design flow and methodology. Design space exploration. Co-design of hardware and software, embedded architecture and network exploration and synthesis. System software/hardware interface generation. Real-time constraints, specification-to-architecture mapping, design tools and methodologies. Formerly EECS 222B.
Restriction: Graduate students only.

EECS 226. Embedded System Software. 4 Units.
Embedded system software concepts, requirements, examples, for engineering applications such as multimedia and automotive. Software generation methodology. Algorithmic specification, design constraints. Embedded operating systems. Static, dynamic, real-time scheduling. Input/output, interrupt handling. Code generation, compilation, instruction set simulation. Formerly EECS 222C.
Restriction: Graduate students only.

EECS 227. Cyber-Physical System Design. 4 Units.
Model-based design of cyber-physical systems including, e.g., plant, sensing, control, actuation, embedded hardware/software, communication, real-time analysis, various levels of simulation (MILS, SILS, HILS), tools and methodologies for automatic synthesis, and application from various interdisciplinary domains.
Restriction: Graduate students only.

EECS 228. Program Analysis. 4 Units.
Advance study of programming languages, compilers, and interpreters. Static and dynamic program analysis and its use in compilation, optimization, garbage collection, bug finding, and parallelization.
Prerequisite: EECS 215 or COMPSCI 260
Restriction: Graduate students only.

EECS 229. Low Power SoC Design. 4 Units.
From an inverter to server centers, low-power design theory and practice in modern systems-on-chip (SoC), energy efficient design time and runtime methods are surveyed at circuit, RTL, and architecture levels. Lab assignments will help students quantify tradeoffs and design practices.
Prerequisite: EECS 217
Restriction: Graduate students only.

EECS 230. Energy Efficiency. 4 Units.
Green energy sources for production, transmission, storage, and utilization of electricity, with a special focus on solar, wind, and nuclear energy production. Study of newly developed renewable sources of energy including capital cost, product cost, environmental issues, and technical feasibility.

EECS 240. Random Processes. 4 Units.
Restriction: Graduate students only.

EECS 241A. Digital Communications I. 4 Units.
Concepts and applications of digital communication systems. Baseband digital transmission of binary, multiamplitude, and multidimensional signals. Introduction to and performance analysis of different modulation schemes.
EECS 241B. Digital Communications II. 4 Units.
Concepts and applications of equalization, multi-carrier modulation, spread spectrum and CDMA. Digital communications through fading memory channels.

Prerequisite: EECS 241A
Restriction: Graduate students only.

EECS 242. Information Theory. 4 Units.
Fundamental capabilities and limitations of information sources and information transmission systems. Analytical framework for modeling and evaluating communication systems: entropy, mutual information asymptotic equipartition property, entropy rates of a stochastic process, data compression, channel capacity, differential entropy, the Gaussian channel.

Prerequisite: EECS 240

EECS 243. Error Correcting Codes. 4 Units.
Different techniques for error correcting codes and analyzing their performance. Linear block codes; cyclic codes; convolutional codes. Minimum distance; optimal decoding; Viterbi decoding; bit error probability. Coding gain; trellis coded modulation.

Prerequisite: EECS 240
Restriction: Graduate students only.

EECS 244. Wireless Communications. 4 Units.

Prerequisite: EECS 241B
Restriction: Graduate students only.

EECS 245. Space-Time Coding. 4 Units.
A fundamental study of: Capacity of MIMO Channels, space-time code design criteria, space-time block codes, space-time trellis codes, differential detection for multiple antennas, spatial multiplexing, BLAST.

Prerequisite: EECS 242
Restriction: Graduate students only.

EECS 247. Information Storage. 4 Units.
Storage architecture, storage network and networking algorithms in data centers, principle of storage devices and non-volatile memory, data consistency, data availability and integrity, power management.

Restriction: Graduate students only.

EECS 248A. Computer and Communication Networks. 4 Units.

Prerequisite: EECS 148 or COMPSCI 132
Same as COMPSCI 232, NET SYS 201.
Restriction: Graduate students only.

EECS 250. Digital Signal Processing I. 4 Units.
Fundamental principles of digital signal processing, sampling, decimation and interpolation, discrete Fourier transforms and FFT algorithms, transversal and recursive filters, discrete random processes, and finite-word effects in digital filters.

Restriction: Graduate students only.
EECS 251A. Detection, Estimation, and Demodulation Theory. 4 Units.
Prerequisite: EECS 240

EECS 251B. Detection, Estimation, and Demodulation Theory. 4 Units.
Prerequisite: EECS 240

EECS 260A. Linear Systems I. 4 Units.
State-space representation of continuous-time and discrete-time linear systems. Controllability, observability, stability. Realization of rational transfer functions.
Restriction: Graduate students only.

EECS 261A. Linear Optimization Methods. 4 Units.
Restriction: Graduate students only.

EECS 267A. Industrial and Power Electronics. 4 Units.
Power switching devices, pulse width modulation (PWM) methods, switching converter topologies, control, and magnetics. Materials fee.
Restriction: Graduate students only.
Concurrent with EECS 166A.

EECS 267B. Topics in Industrial and Power Electronics. 4 Units.
Practical design of switching converters, electromagnetic compatibility, thermal management, and/or control methods.
Prerequisite: EECS 267A
Restriction: Graduate students only.

EECS 270A. Advanced Analog Integrated Circuit Design I. 4 Units.
Basic transistor configurations; differential pairs; active load/current sources; supply/temperature-independent biasing; op-amp gain and output stages; amplifier frequency response and stability compensation; nonidealities in op-amps; noise and dynamic range in analog circuits.
Restriction: Graduate students only.

EECS 270B. Advanced Analog Integrated Circuit Design II. 4 Units.
Advanced transistor modeling issues; discrete-time and continuous-time analog Integrated Circuit (IC) filters; phase-locked loops; design of ICs operating at radio frequencies; low-voltage/low-power design techniques; A/D and D/A converters; AGC circuits.
Prerequisite: EECS 270A
Restriction: Graduate students only.

EECS 270C. Design of Integrated Circuits for Broadband Applications. 4 Units.
Topics include: broadband standards and protocols; high-frequency circuit design techniques; PLL theory and design; design of transceivers; electrical/optical interfaces.
Prerequisite: EECS 270A
Restriction: Graduate students only.

EECS 270D. Radio-Frequency Integrated Circuit Design. 4 Units.
Topics include: RF component modeling; matching network design; transmission line theory/modeling; Smith chart and S-parameters; noise modeling of active and passive components; high-frequency amplifier design; low-noise amplifier (LNA) design; mixer design; RF power amplifier.
Prerequisite: EECS 270A
Restriction: Graduate students only.
EECS 272. Topics in Electrical Engineering. 4 Units.
New research results in electronic system design.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

EECS 275A. Very Large Scale Integration (VLSI) Project. 4 Units.
Students create VLSI design projects from conception through architecture, floor planning, detailed design, simulation, verification, and submission for project fabrication. Emphasis on practical experience in robust VLSI design techniques. (Successful students are expected to take EECS 275B.).

Restriction: Graduate students only.

EECS 275B. Very Large Scale Integration (VLSI) Project Testing. 4 Units.
Test and document student-created Complementary Metal Oxide Semiconductor (CMOS) Very Large Scale Integration (VLSI) projects designed in EECS 275A. Emphasis on practical laboratory experience in VLSI testing techniques. Materials fee.

Prerequisite: EECS 275A

Restriction: Graduate students only.

EECS 277A. Advanced Semiconductor Devices I. 4 Units.
Advanced complementary metal-oxide-semiconductor field-effect transistors (CMOSFET), device scaling, device modeling and fabrication, equivalent circuits, and their applications for digital, analog, RF.

Restriction: Graduate students only.

EECS 277B. Advanced Semiconductor Devices II. 4 Units.
Metal-semiconductor field-effect transistors (MESFET), heterojunction bipolar transistors (HBT), microwave semiconductor devices, equivalent circuits, device modeling and fabrication, microwave amplifiers, transmitters, and receivers.

Restriction: Graduate students only.

EECS 277C. Nanotechnology. 4 Units.

Restriction: Graduate students only.

EECS 278. Micro-System Design. 4 Units.
Covers the fundamentals of the many disciplines needed for design of Micro-Electro-Mechanical Systems (MEMS): microfabrication technology, structural mechanics on micro-scale, electrostatics, circuit interface, control, computer-aided design, and system integration.

Same as ENGRMAE 247.

Restriction: Graduate students only.

EECS 279. Micro-Sensors and Actuators. 4 Units.
Introduction to the technology of Micro-Electro-Mechanical Systems (MEMS). Fundamental principles and applications of important microsensors, actuation principles on microscale. Introduction to the elements of signal processing; processing of materials for micro sensor/actuator fabrication; smart sensors and microsensor/microactuator array devices.

Same as ENGRMAE 249.

Restriction: Graduate students only.

EECS 280A. Advanced Engineering Electromagnetics I. 4 Units.
Stationary electromagnetic fields, Maxwell's equations, circuits and transmission lines, plane waves, guided waves, and radiation.

Restriction: Graduate students only.

EECS 280B. Advanced Engineering Electromagnetics II. 4 Units.
Two- and three-dimensional boundary value problems, dielectric waveguides and other special waveguides, microwave networks and antenna arrays, electromagnetic properties of materials, and electromagnetic optics.

Prerequisite: EECS 280A

Restriction: Graduate students only.
EECS 282. Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design II. 4 Units.
Design of microwave amplifiers using computer-aided design tools. Covers low-noise amplifiers, multiple stage amplifiers, broadband amplifiers, and power amplifiers. Hybrid circuit design techniques including filters and baluns. Theory and design rules for microwave oscillator design.
Restriction: Graduate students only.

EECS 285A. Optical Communications. 4 Units.
Introduction to fiber optic communication systems, optical and electro-optic materials, and high-speed optical modulation and switching devices.
Restriction: Graduate students only.

EECS 285B. Lasers and Photonics. 4 Units.
Covers the fundamentals of lasers and applications, including Gaussian beam propagation, interaction of optical radiation with matters, and concepts of optical gain and feedback. Applications are drawn from diverse fields of optical communication, signal processing, and material diagnosis.
Prerequisite: Undergraduate course work in electromagnetic theory and atomic physics.

EECS 285C. Nano Imaging. 4 Units.
Theory and practice of modern nanoscale imaging techniques and applications. Traces the development of microscopy from ancient times to modern day techniques used for visualizing the nano-world from atoms to molecules including hands-on experience in the laboratory.
Restriction: Graduate students only.

EECS 285D. Biomedical and Wearable Microdevices. 4 Units.
Preliminary details on prototyping and fabrication techniques for biomedical and wearable microdevices. Behavior and properties of modern microdevice materials such as hydrogel, PDMS, biopolymer, smart materials, and their uses. Basic biosensing modalities and practical implementations in modern devices.
Prerequisite: Knowledge of undergraduate-level basic physics is required.
Restriction: Graduate students only.

EECS 280. Curricular Practical Training. 1 Unit.
Curricular practical training. Students will go through practical training under an industry mentor in a technical field corresponding to their concentration area.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

EECS 282. Preparation for M.S. Comprehensive Examination. 1-8 Units.
Individual reading and preparation for the M.S. comprehensive examination.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

EECS 283. Preparation for Ph.D. Preliminary Examination. 1-8 Units.
Individual reading and preparation for the Ph.D. preliminary examination.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

EECS 284. Electrical Engineering and Computer Science Colloquium. 1 Unit.
Invited speakers discuss their latest research results in electrical engineering and computer science.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.
EECS 295. Seminars in Engineering. 1-4 Units.
Scheduled each year by individual faculty in major field of interest.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

EECS 296. Master of Science Thesis Research. 1-16 Units.
Individual research or investigation conducted in the pursuit of preparing and completing the thesis required for the M.S. degree in Engineering.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

EECS 297. Doctor of Philosophy Dissertation Research. 1-16 Units.
Individual research or investigation conducted in preparing and completing the dissertation required for the Ph.D. degree in Engineering.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

EECS 298. Topics in Electrical Engineering and Computer Science. 4 Units.
Study of Electrical and Computer Engineering concepts.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

EECS 299. Individual Research. 1-16 Units.
Individual research or investigation under the direction of an individual faculty member.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.