Department of Electrical Engineering and Computer Science

2213 Engineering Hall; 949-824-4821
http://www.eng.uci.edu/dept/eecs
H. Kumar Wickramsinghe, Department Chair

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.

• Computer Engineering (p. 1)
• Computer Science and Engineering (p. 4)
• Electrical Engineering (p. 4)

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

Transfer Students: Preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed the following required courses: one year 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 two additional approved courses for the major.

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. Degree in Computer Engineering

All students must meet the University Requirements [here](http://catalogue.uci.edu/previouseditions/2014-15/informationforadmittedstudents/requirementsforabachelorsdegree).

All students must meet the School Requirements [here](http://catalogue.uci.edu/previouseditions/2014-15/thehenrysamuelischoolofengineering/#undergraduatestudytext).

Major Requirements:

Mathematics and Basic Science Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</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 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 and Classical Physics</td>
</tr>
<tr>
<td>PHYSICS 7LD</td>
<td>Classical Physics Laboratory</td>
</tr>
</tbody>
</table>

One additional math or basic science elective from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&amp;C SCI 6B</td>
<td>Boolean Algebra and Logic</td>
</tr>
<tr>
<td>MATH 2E</td>
<td>Multivariable Calculus</td>
</tr>
<tr>
<td>PHYSICS 51A</td>
<td>Modern Physics</td>
</tr>
<tr>
<td>PHYSICS 52A</td>
<td>Fundamentals of Experimental Physics</td>
</tr>
</tbody>
</table>

or other courses as approved by faculty advisor.

Engineering Topics Courses:

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

Core Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 1</td>
<td>Introduction to Electrical Engineering and Computer Engineering</td>
</tr>
<tr>
<td>EECS 12</td>
<td>Introduction to Programming</td>
</tr>
<tr>
<td>EECS 20</td>
<td>Computer Systems and Programming in C</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>
<tr>
<td>EECS 113</td>
<td>Processor Hardware/Software Interfaces</td>
</tr>
</tbody>
</table>
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 152A** Digital Signal Processing
- **EECS 152B** Digital Signal Processing Design and Laboratory
- **EECS 199** Individual Study (up to 3 graded units)

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 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.)

**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**

### Freshman

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

### Sophomore

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MATH 3A</strong></td>
<td><strong>MATH 3D</strong></td>
<td><strong>EECS 40</strong></td>
</tr>
<tr>
<td><strong>PHYSICS 7E</strong></td>
<td><strong>EECS 22L</strong></td>
<td><strong>EECS 50</strong></td>
</tr>
<tr>
<td><strong>EECS 22</strong></td>
<td><strong>EECS 55</strong></td>
<td><strong>EECS 70B</strong></td>
</tr>
<tr>
<td><strong>EECS 31L</strong></td>
<td><strong>EECS 70A</strong></td>
<td><strong>EECS 70LB</strong></td>
</tr>
<tr>
<td>Math/Science Elective</td>
<td><strong>EECS 70LA</strong></td>
<td><strong>General Education</strong></td>
</tr>
</tbody>
</table>

### Junior

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EECS 112</strong></td>
<td><strong>EECS 112L</strong></td>
<td><strong>EECS 111</strong></td>
</tr>
<tr>
<td><strong>EECS 114</strong></td>
<td><strong>EECS 150</strong></td>
<td><strong>EECS 113</strong></td>
</tr>
<tr>
<td><strong>EECS 145</strong></td>
<td><strong>EECS 170B</strong></td>
<td><strong>EECS 118</strong></td>
</tr>
</tbody>
</table>
Students must obtain approval for their program of study and must see their faculty advisor at least once each year.

**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 (http://catalogue.uci.edu/previouseditions/2014-15/interdisciplinarystudies/computerscienceandengineering) section of the Catalogue.

**Requirements for the B.S. Degree in Computer Science and Engineering**

All students must meet the University Requirements (http://catalogue.uci.edu/previouseditions/2014-15/informationforadmittedstudents/requirementsforabachelorsdegree).


**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**


Transfer Students: Preference will be given to junior-level applicants with the highest grades overall, and who have satisfactorily completed the following required courses: one year 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 two additional approved courses for the major.

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. Degree in Electrical Engineering**

All students must meet the University Requirements (http://catalogue.uci.edu/previouseditions/2014-15/informationforadmittedstudents/requirementsforabachelorsdegree).

All students must meet the School Requirements (http://catalogue.uci.edu/previouseditions/2014-15/thehenrysamuelischoolofengineering/#undergraduatetestudytext).

Major Requirements:

Mathematics and Basic Science Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A</td>
<td>General Chemistry</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 Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 1</td>
<td>Introduction to Electrical Engineering and Computer Engineering</td>
</tr>
<tr>
<td>EECS 10</td>
<td>Computational Methods in Electrical and Computer</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 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 150</td>
<td>Continuous-Time Signals and Systems</td>
</tr>
<tr>
<td>EECS 159A</td>
<td>Senior Design Project I</td>
</tr>
<tr>
<td>EECS 159B</td>
<td>Senior Design Project II</td>
</tr>
<tr>
<td>EECS 159CW</td>
<td>Senior Design Project III</td>
</tr>
<tr>
<td>EECS 160A</td>
<td>Introduction to Control Systems</td>
</tr>
<tr>
<td>EECS 160LA</td>
<td>Control Systems I Laboratory</td>
</tr>
<tr>
<td>EECS 170A</td>
<td>Electronics I</td>
</tr>
<tr>
<td>EECS 170LA</td>
<td>Electronics I Laboratory</td>
</tr>
<tr>
<td>EECS 170B</td>
<td>Electronics II</td>
</tr>
<tr>
<td>EECS 170LB</td>
<td>Electronics II Laboratory</td>
</tr>
<tr>
<td>EECS 170C</td>
<td>Electronics III</td>
</tr>
<tr>
<td>EECS 170LC</td>
<td>Electronics III Laboratory</td>
</tr>
<tr>
<td>EECS 180A</td>
<td>Engineering Electromagnetics</td>
</tr>
<tr>
<td>EECS 199</td>
<td>Control Systems Laboratory</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.

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 Code</th>
<th>Course 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>
</tbody>
</table>

and select four of the following:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 166A</td>
<td>Industrial and Power Electronics</td>
</tr>
<tr>
<td>EECS 166B</td>
<td>Advanced Topics in 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 178</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 Code</th>
<th>Course 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>
</tbody>
</table>

and select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<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 Code</th>
<th>Course 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>
</tbody>
</table>

and select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 170D</td>
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<td>EECS 170E</td>
<td>Analog and Communications IC Design</td>
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<td>EECS 180C</td>
<td>Engineering Electromagnetics III</td>
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<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 Code</th>
<th>Course 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>
</tbody>
</table>

and select four of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 20</td>
<td>Computer Systems and Programming in C</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>
<tr>
<td>EECS 160B</td>
<td>Sampled-Data and Digital Control Systems</td>
</tr>
</tbody>
</table>

**Specialization in Communications:**

** Requires:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 141A</td>
<td>Communication Systems I</td>
</tr>
<tr>
<td>EECS 141B</td>
<td>Communication Systems II</td>
</tr>
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</table>

and select four of the following:

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<td>EECS 22</td>
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</tr>
<tr>
<td>EECS 144</td>
<td>Antenna Design for Wireless Communication Links</td>
</tr>
<tr>
<td>EECS 148</td>
<td>Computer Networks</td>
</tr>
<tr>
<td>EECS 152A</td>
<td>Digital Signal Processing</td>
</tr>
</tbody>
</table>
### 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>
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<th>Year</th>
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<th>Winter</th>
<th>Spring</th>
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**Sophomore**

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**Junior**

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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)**

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**Sophomore**

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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 (RF, Antennas and Microwaves)

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<th>Spring</th>
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<tbody>
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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 (Digital Signal Processing Specialization)

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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 (Communication Specialization)

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</tbody>
</table>

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

### 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. degree: 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. degree 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 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.

Computer Engineering Concentration:

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

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 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. degree program, students will complete one term paper-length report on the current state-of-the-art of a technical field corresponding to the concentration area. The term paper is completed as part of the end-of-course requirements for one of the following three alternatives 1) EECS 290 Curricular Practical Training, 2) EECS 294 Electrical Engineering and Computer Science Colloquium, or 3) EECS 299 Individual Research taken under the graduate advisor which will involve reviewing an IEEE journal publication in the concentration area and submitting a review summary as the term-paper. Any of the three 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>
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<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
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<td>EECS 270B</td>
<td>Advanced Analog Integrated Circuit Design II</td>
</tr>
<tr>
<td>EECS 277A</td>
<td>Advanced Semiconductor Devices I</td>
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<tr>
<td>EECS 277B</td>
<td>Advanced Semiconductor Devices II</td>
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<td>EECS 280A</td>
<td>Advanced Engineering Electromagnetics I</td>
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<tr>
<td>EECS 285A</td>
<td>Optical Communications</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.

Systems Plan of Study:

Select four of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 240</td>
<td>Random Processes</td>
</tr>
</tbody>
</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.

## List of Concentration Courses for

### Electrical Engineering Concentration:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EECS 202A-202B</td>
<td>Principles of Imaging and Techniques in Medical Imaging I: X-ray, Nuclear, and NMR Imaging</td>
</tr>
<tr>
<td>EECS 203A</td>
<td>Digital Image Processing</td>
</tr>
<tr>
<td>EECS 210</td>
<td>Modeling and Rendering for Image Synthesis</td>
</tr>
<tr>
<td>EECS 213</td>
<td>Computer Architecture</td>
</tr>
<tr>
<td>EECS 215</td>
<td>Design and Analysis of Algorithms</td>
</tr>
<tr>
<td>EECS 217</td>
<td>VLSI System Design</td>
</tr>
<tr>
<td>EECS 240</td>
<td>Random Processes</td>
</tr>
<tr>
<td>EECS 241A-241B</td>
<td>Digital Communications I and Digital Communications II</td>
</tr>
<tr>
<td>EECS 242</td>
<td>Information Theory</td>
</tr>
<tr>
<td>EECS 243</td>
<td>Error Correcting Codes</td>
</tr>
<tr>
<td>EECS 244</td>
<td>Wireless Communications</td>
</tr>
<tr>
<td>EECS 245</td>
<td>Space-Time Coding</td>
</tr>
<tr>
<td>EECS 248A</td>
<td>Computer and Communication Networks</td>
</tr>
<tr>
<td>EECS 250</td>
<td>Digital Signal Processing I</td>
</tr>
<tr>
<td>EECS 251A-251B</td>
<td>Detection, Estimation, and Demodulation Theory and Detection, Estimation, and Demodulation Theory</td>
</tr>
<tr>
<td>EECS 260A</td>
<td>Linear Systems I</td>
</tr>
<tr>
<td>EECS 261A</td>
<td>Linear Optimization Methods</td>
</tr>
<tr>
<td>EECS 267A-267B</td>
<td>Industrial and Power Electronics and Topics in Industrial and Power Electronics</td>
</tr>
<tr>
<td>EECS 270A</td>
<td>Advanced Analog Integrated Circuit Design I</td>
</tr>
<tr>
<td>EECS 270B-270C-270D</td>
<td>Advanced Analog Integrated Circuit Design II and Design of Integrated Circuits for Broadband Applications and Radio-Frequency Integrated Circuit Design</td>
</tr>
<tr>
<td>EECS 272</td>
<td>Topics in Electronic System Design</td>
</tr>
<tr>
<td>EECS 274</td>
<td>Biomedical Microdevices (MEMOS)</td>
</tr>
<tr>
<td>EECS 275A-275B</td>
<td>Very Large Scale Integration (VLSI) Project and Very Large Scale Integration (VLSI) Project Testing</td>
</tr>
<tr>
<td>EECS 277A-277B-277C</td>
<td>Advanced Semiconductor Devices I and Advanced Semiconductor Devices II and Nanotechnology</td>
</tr>
<tr>
<td>EECS 278</td>
<td>Micro-System Design</td>
</tr>
<tr>
<td>EECS 279</td>
<td>Micro-Sensors and Actuators</td>
</tr>
<tr>
<td>EECS 280A</td>
<td>Advanced Engineering Electromagnetics I</td>
</tr>
<tr>
<td>EECS 280B</td>
<td>Advanced Engineering Electromagnetics II</td>
</tr>
<tr>
<td>EECS 282</td>
<td>Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design II</td>
</tr>
<tr>
<td>EECS 285A</td>
<td>Optical Communications</td>
</tr>
<tr>
<td>EECS 285B</td>
<td>Lasers and Photonics</td>
</tr>
</tbody>
</table>
List of Concentration Courses for

Computer Engineering Concentration:

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

- EECS 210  
  Modeling and Rendering for Image Synthesis
- EECS 211  
  Advanced System Software
- EECS 213  
  Computer Architecture
- EECS 215  
  Design and Analysis of Algorithms
- EECS 217  
  VLSI System Design
- EECS 219  
  Distributed Software Architecture and Design
- EECS 221  
  Topics in Computer Engineering
- EECS 222  
  Embedded System Modeling
- EECS 223  
  Real-Time Computer Systems
- EECS 225  
  Embedded Systems Design
- EECS 226  
  Embedded System Software
- EECS 227  
  Cyber-Physical System Design
- EECS 230  
  Energy Efficiency
- EECS 248A  
  Computer and Communication Networks
- COMPSCI 233  
  Networking Laboratory
- COMPSCI 234  
  Advanced Networks
- COMPSCI 236  
  Wireless and Mobile Networking

1 This course is also a core course.

NOTE: Students who entered prior to fall of 2012 should follow the course requirements outlined within the Catalogue of the year they entered. The change in number of units per course is not intended to change the course requirements for the degree nor to have any impact in the number of courses students are taking. As such, students will need to continue to meet the same high standards and plan of study requirements as previously required. Students will work with their advisor to create a plan of study encompassing the equivalent topical requirements, as well as the equivalent number of courses to the previous 36-unit requirement.

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 quarters of EECS 290, EECS 294, or EECS 299 (taken with the graduate advisor) 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. The depth examination is conducted during each spring quarter. 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. degree is granted upon the recommendation of the Doctoral Committee and the Dean of Graduate Studies. Part-time study toward the Ph.D. degree 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.
Graduate Specialization in Teaching
The graduate specialization in Teaching will allow Engineering Ph.D. students to receive practical training in pedagogy designed to enhance their knowledge and skill set for future teaching careers. Students will gain knowledge and background in college-level teaching and learning from a variety of sources, and experience in instructional practices. Students completing the specialization in Teaching must fulfill all of their Ph.D. requirements in addition to the specialization requirements. Upon fulfillment of the requirements, students will be provided with a certificate of completion. Upon receipt of the certificate of completion, the students can then append “Specialization in Teaching” to their curricula vitae. For details visit the Graduate Specialization in Teaching website.

The graduate specialization in Teaching is available only for certain degree programs and concentrations:
• Ph.D. degree in Biomedical Engineering
• Ph.D. degree in Electrical and Computer Engineering
• Ph.D. degree in Engineering with a concentration in Materials and Manufacturing Technology

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 Gradate 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 e-mail 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 (http://www.law.uci.edu/plgs) website and in the Law School (http://catalogue.uci.edu/previouseditions/2014-15/schooloflaw/#lawandgraduatetestudiestext) 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 (high-frequency integrated circuit antennas, wireless communication, materials)
Animashree Anandkumar, Ph.D. Cornell University, Assistant Professor of Electrical Engineering and Computer Science; Computer Science (statistical inference and learning of graphical models, scalable network algorithms)
Ender Ayanoglu, Ph.D. Stanford University, Professor of Electrical Engineering and Computer Science (communication systems, communication theory, communication networks)
Mark G. Bachman, Ph.D. University of Texas at Austin, Assistant Professor of Electrical Engineering and Computer Science; Biomedical Engineering (integrated microsystems, microfabrication technology, biomedical microdevices, sensor systems, human sensing, human-machine interface)
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)
Casper W. Barnes, Ph.D. Stanford University, Professor Emeritus of Electrical Engineering and Computer Science
Neil J. Bershad, Ph.D. Rensselaer Polytechnic Institute, Professor Emeritus of Electrical Engineering and Computer Science (communication and information theory, signal processing)
Lubomir Bic, Ph.D. University of California, Irvine, Professor of Computer Science; Biomedical Engineering; Electrical Engineering and Computer Science (parallel and distributed computing, mobile agents)
Ozdal Boyraz, Ph.D. University of Michigan, Associate Professor of Electrical Engineering and Computer Science (silicon photonics and optical communications systems)
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)
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)
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)
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)
Zhongping Chen, Ph.D. Cornell University, Professor of Biomedical Engineering; Chemical Engineering and Materials Science; Electrical Engineering and Computer Science; Otolaryngology; Surgery (biomedical optics, optical coherence tomography, bioMEMS, biomedical devices)

Pai H. Chou, Ph.D. University of Washington, Professor 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

Hooman Darabi, Ph.D. University of California, Los Angeles, Assistant Adjunct Professor of Electrical Engineering and Computer Science (analog and RF integrated circuit design for wireless communication)

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 (compiler programming, language software engineering, fault tolerance)

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

Nikil D. Dutt, Ph.D. University of Illinois at Urbana-Champaign, UCI Chancellor's Professor of Computer Science; 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)

Ahmed Eltawil, Ph.D. University of California, Los Angeles, Associate 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 (machine vision, signal processing, computer graphics)

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)

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 (parallel processing, computer architecture, processor architecture)

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, graphical drawing)

Michael M. Green, Ph.D. University of California, Los Angeles, Professor of Electrical Engineering and Computer Science (analog/mixed-signal IC design, broadband circuit design, theory of nonlinear circuits)

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)

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)

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)

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)

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)

David P. Kirkby, Ph.D. California Institute of Technology, Professor of Physics and Astronomy; Electrical Engineering and Computer Science (observational cosmology, data science, embedded systems)

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 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 (numerical processors and multiprocessors, parallel computer systems)

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 (photonics, 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)

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

Athina Markopoulou, Ph.D. Stanford University, Associate Professor of Electrical Engineering and Computer Science; Information and Computer Sciences (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)

Gopi Meenakshisundaram, Ph.D. University of North Carolina at Chapel Hill, Professor of Computer Science; Electrical Engineering and Computer Science (geometry and topology for computer graphics, image-based rendering, object representation, surface reconstruction, collision detection, virtual reality, telepresence)

Sabee Y. Molloi, Ph.D. University of Wisconsin-Madison, Professor of Radiological Sciences; Biomedical Engineering; Electrical Engineering and Computer Science (quantitative aspects of medical x-ray imaging and its applications to cardiac and breast imaging)

Zoran Nenadic, Ph.D. Washington University, Associate Professor of Biomedical Engineering; Electrical Engineering and Computer Science (adaptive biomedical signal processing, control algorithms for biomedical devices, brain-machine interfaces, modeling and analysis of biological neural networks)

Alexandru Nicolau, Ph.D. Yale University, Professor of Computer Science; Electrical Engineering and Computer Science (architecture, parallel computation, programming languages and compilers)

Henry Samuell, Ph.D. University of California, Los Angeles, Adjunct Professor of Electrical Engineering and Computer Science (digital signal processing, communications systems engineering, CMOS integrated circuit design for applications in high-speed data transmission systems)

Isaac D. Scherson, Ph.D. Weizmann Institute of Science, Professor of Computer Science; Electrical Engineering and Computer Science (parallel computing architectures, massively parallel systems, parallel algorithms, interconnection networks, performance evaluation)

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)

Frank G. Shi, Ph.D. California Institute of Technology, Professor of Chemical Engineering and Materials Science; Electrical Engineering and Computer Science (optoelectronic devices and materials, optoelectronic device packaging materials, optoelectronic medical devices and packaging, white LED technologies, high power LED packaging)
Andrei M. Shkel, Ph.D. University of Wisconsin-Madison, Professor of Mechanical and Aerospace Engineering; Biomedical Engineering; Electrical Engineering and Computer Science (design and advanced control of micro-electro-mechanical systems (MEMS), precision micro-sensors and actuators for telecommunication and information technologies, MEMS-based health monitoring systems, disposable diagnostic devices, prosthetic implants)

Jack Sklansky, Sc.D. Columbia University, Professor Emeritus of Electrical Engineering and Computer Science (digital radiology, pattern recognition, medical imaging, neural learning, computer engineering)

Keyue M. Smedley, Ph.D. California Institute of Technology, Professor of Electrical Engineering and Computer Science (power electronics and analog circuit design)

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 (communication and information theory, stochastic processes)

William C. Tang, Ph.D. University of California, Berkeley, Professor of Biomedical Engineering; Electrical Engineering and Computer Science (micro-electro-mechanical systems (MEMS) nanoscale engineering for biomedical applications, microsystems integration, microimplants, microbiomechanics, microfluidics)

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 (data communication networks, control systems)

H. Kumar Wickramasinghe, Ph.D. University of London, Henry Samueli 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)

Xiangmin Xu, Ph.D. Vanderbilt University, Assistant Professor of Anatomy and Neurobiology; Biomedical Engineering; Electrical Engineering and Computer Science; Microbiology and Molecular Genetics (local cortical circuits)

Homayoun Yousefi'zadeh, Ph.D. University of Southern California, Adjunct Professor of Electrical Engineering and Computer Science (communications networks)

**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.

Restriction: Computer Engineering and Electrical Engineering majors have first consideration for enrollment.

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

(Design units: 0)

Corequisite: MATH 2A.
Prerequisite: MATH 2A.

Overlaps with ENGR 10, ENGRMAE 10, EECS 12.

Restriction: School of Engineering majors have first consideration for enrollment.
EECS 12. Introduction to Programming. 4 Units.

(Design units: 0)
Corequisite: MATH 2A.
Overlaps with ENGR 10, EECS 10, ENGRMAE 10.
Restriction: School of Engineering majors have first consideration for enrollment.


(Design units: 1)
Prerequisite: EECS 12.
Restriction: 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: Computer Engineering and Electrical 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.

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. Course may be offered online.

(Design units: 2)
Prerequisite: CSE 41 or I&C SCI 31 or EECS 10 or EECS 12 or ENGRMAE 10 or CSE 21 or I&C SCI 21 or I&C SCI H21.
Same as CSE 31.
Restriction: Computer Engineering, Computer Science and Engineering, Electrical 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. Materials fee. Course may be offered online.

(Design units: 3)
Prerequisite: (EECS 31 or CSE 31) and (EECS 10 or EECS 12 or (CSE 22 or I&C SCI 22) or (CSE 42 or I&C SCI 32)).
Same as CSE 31L.
Restriction: Computer Engineering, Computer Science and Engineering, and Electrical Engineering majors have first consideration for enrollment.
EECS 40. Object-Oriented Systems and Programming. 4 Units.

(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 or CSE 70A.
Same as CSE 50.
Restriction: Computer Engineering, Computer Science and Engineering, and Electrical 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 and Electrical Engineering majors have first consideration for enrollment.

EECS 70A. Network Analysis I. 4 Units.

(Design units: 1)
Corequisite: MATH 3D.
Prerequisite: PHYSICS 7D and (EECS 10 or EECS 12 or ENGRMAE 10 or CSE 41 or I&C SCI 31).
Same as CSE 70A.
Overlaps with ENGRMAE 60.
Restriction: Aerospace Engineering, Biomedical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Environmental Engineering, Materials Science Engineering, and Mechanical Engineering majors have first consideration for enrollment.

EECS 70B. Network Analysis II. 4 Units.

(Design units: 1)
Corequisite: EECS 70LB.
Prerequisite: (EECS 10 or ENGRCEE 10 or ENGRMAE 10) and EECS 70A.
Restriction: Computer Engineering, Electrical Engineering, and Materials Science Engineering majors have first consideration for enrollment.

EECS 70LA. Network Analysis I Laboratory. 1 Unit.
Laboratory to accompany EECS 70A.
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: (EECS 10 or ENGRCEE 10 or ENGRMAE 10) and EECS 70A.

Restriction: Computer Engineering and Electrical 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 or CSE 50.

Restriction: Electrical Engineering, Computer Engineering, and Computer Science and 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 (CSE 46 or I&C SCI 46 or EECS 114).

Overlaps with COMPSCI 143A.

Restriction: Computer Engineering and Electrical 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 or CSE 31L.

Same as CSE 132.

Overlaps with COMPSCI 152.

Restriction: Computer Engineering, Computer Science and Engineering, and Electrical 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 or CSE 132.

Same as CSE 132L.

Restriction: Computer Engineering and Computer Science and 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 cover including local variable and register allocations, instruction dependence and scheduling, and code optimization.

(Design units: 3)

Prerequisite: EECS 112 or CSE 132.

Restriction: Computer Engineering, Electrical Engineering, and Computer Science and 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 23 or CSE 23 or I&C SCI H23 or I&C SCI 46 or CSE 46 or IN4MATX 45 or I&C SCI 33 or CSE 43 or EECS 114. I&C SCI 23 with a grade of C or better CSE 23 with a grade of C or better I&C SCI H23 with a grade of C or better I&C SCI 46 with a grade of C or better CSE 46 with a grade of C or better IN4MATX 45 with a grade of C or better 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: School of Information and Computer Sciences majors and Computer Engineering majors have first consideration for enrollment.

EECS 117. Parallel Computer Systems. 3 Units.
General introduction to parallel computing focusing on parallel algorithms and architectures. Parallel models: Flynn's taxonomy, dataflow models. Parallel architectures: systolic arrays, hypercube architecture, shared memory machines, dataflow machines, reconfigurable architectures. Parallel algorithms appropriate to each machine type area also discussed.

(Design units: 1)
Prerequisite: EECS 20 and EECS 112 or CSE 132.
Restriction: Computer Engineering and Computer Science and Engineering majors have first consideration for enrollment.

EECS 118. Introduction to Knowledge Management for Software and 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 programing, testing, maintenance, and connections between knowledge engineering and software engineering.

(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 or CSE 132) and EECS 170B.
Overlaps with CSE 112, EECS 170D.

EECS 129A. Computer Engineering Senior Design Project. 2 Units.
Conception, planning, implementation, programming, testing of an approved project. Options include: parallel processing, VLSI design, microprocessor-based design, among others.

(Design units: 2)
Grading Option: In progress only.
Restriction: Seniors only. Computer Engineering majors only.
EECS 129B. Computer Engineering Senior Design Project. 2 Units.
Conception, planning, implementation, programming, testing of an approved project. Options include: parallel processing, VLSI design, microprocessor-based design, among others. Materials fee.
(Design units: 2)
Prerequisite: EECS 129A.
Restriction: Seniors only. Computer Engineering majors only.

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, Electrical Engineering, and Computer Science and Engineering majors have first consideration for enrollment.

EECS 141B. Communication Systems II. 3 Units.
(Design units: 1)
Prerequisite: EECS 141A.
Restriction: Computer Engineering, Electrical Engineering, and Computer Science and Engineering majors have first consideration for enrollment.

EECS 144. Antenna Design for Wireless Communication Links. 4 Units.
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 and 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 and Computer Science and 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. Formerly EECS 150A.
(Design units: 0)
Prerequisite: (EECS 70A or CSE 70A) and EECS 145.
Restriction: Computer Engineering and Electrical 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 or CSE 50.

Same as CSE 135A.

Restriction: Computer Engineering, Electrical Engineering, and Computer Science and 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. Materials fee.

(Design units: 3)
Prerequisite: EECS 152A or CSE 135A.

Same as CSE 135B.

Restriction: Computer Engineering, Electrical Engineering, and Computer Science and 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.

Grading Option: In progress only.

Restriction: Electrical Engineering and Computer Engineering majors have first consideration for enrollment. EECS 159A-EECS 159B-EECS 159CW must be taken in the same academic year.

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: Electrical Engineering and Computer Engineering majors have first consideration for enrollment. EECS 159A-EECS 159B-EECS 159CW must be taken in the same academic year.

EECS 159CW. Senior Design Project III. 3 Units.
Completion, documentation, and presentation of senior design projects. Teaches engineering documentation and presentation skills. Students write comprehensive project reports individually and participate in a presentation of project results.

(Design units: 0)
Prerequisite: EECS 159A and EECS 159B. Satisfactory completion of Lower-Division Writing requirement.

Overlaps with CSE 181CW, ENGR 190W.

Restriction: Electrical Engineering and Computer Engineering majors have first consideration for enrollment. EECS 159A-EECS 159B-EECS 159CW must be taken in the same academic year.

(Ib)
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 160B. Sampled-Data and Digital Control Systems. 3 Units.
Sampled-data and digital control systems. Sampling process and theory of digital signals; z-transform and modeling; stability; z-plane, frequency response, state-space techniques of digital control system synthesis.

(Design units: 2)

Prerequisite: EECS 31 and EECS 160A and EECS 160LA.

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 161. Electric Machines and Drives. 3 Units.

(Design units: 2)

Corequisite: EECS 161L.
Prerequisite: EECS 70B.

Restriction: Electrical Engineering majors have first consideration for enrollment.

EECS 161L. Electric Machines and Drives Laboratory. 1 Unit.
Laboratory exercises supplementing the content of EECS 161.

(Design units: 0)

Corequisite: EECS 161.

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 166B. Advanced Topics in Industrial and Power Electronics. 3 Units.
Practical design of switching converters, electromagnetic compatibility, thermal management, and/or control methods.

(Design units: 1)
Prerequisite: EECS 166A.
Restriction: Electrical Engineering majors have first consideration for enrollment.

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 and 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, Electrical Engineering, and 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 and 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, Electrical Engineering, and 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 and 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 and 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 and 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: Biomedical Engineering and Electrical Engineering majors have first consideration for enrollment. Upper-division students only.
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, Electrical Engineering, and 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)
Restriction: Electrical Engineering majors have first consideration for enrollment.

EECS 189A. Electrical Engineering Senior Design Project I. 2 Units.
Design projects for seniors in the Electrical Engineering program. Each project is supervised by a faculty member. Materials fee.

(Design units: 2)
Prerequisite: EECS 150 and EECS 170C and EECS 180A.

Grading Option: In progress only.
Restriction: Electrical Engineering majors only.

EECS 189B. Electrical Engineering Senior Design Project II. 2 Units.
Design projects for seniors in the Electrical Engineering program. Each project is supervised by a faculty member. Materials fee.

(Design units: 2)
Prerequisite: EECS 189A.

Restriction: Electrical Engineering majors only.
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.

Prerequisite: PHYSICS 51B or PHYSICS 61B.
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.
Prerequisite: EECS 152A.
Restriction: Graduate students only.

EECS 210. Modeling and Rendering for Image Synthesis. 4 Units.
Provides the fundamental understanding of mathematical and physical models used in image synthesis applications: geometric models, physics of color image formation, polygon approximations, ray tracing, and radiosity.

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.
Prerequisite: EECS 111 and EECS 112.
Repeatability: Unlimited as topics vary.
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.
Prerequisite: EECS 112 and EECS 112L.
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.
Prerequisite: EECS 112.
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 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. Course may be offered online.

Restriction: Graduate students only.

EECS 226. Embedded System Software. 4 Units.
Embedded system software concepts, requirements, examples, for engineering applications such as multi-media 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.

(Design units: 0)

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 119 and 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.

Prerequisite: EECS 55.

Restriction: Graduate students only.
EECS 241A. Digital Communications I. 4 Units.
Concepts and applications of digital communication systems. Baseband digital transmission of binary, multi-amplitude, 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.
Introduction to wireless communications systems. Wireless channel modeling, Single carries, spread spectrum, and multi-carrier wireless modulation schemes. Diversity techniques. Multiple-access schemes. Transceiver design and system level tradeoffs. Brief overview of GSM, CDMA, (IS-95) and 2.5, 3G cellular schemes.

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 246. Network Coding: Theory and Applications. 4 Units.

Prerequisite: EECS 248A or NET SYS 201 or COMPSCI 232.

Same as NET SYS 256.

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.
Prerequisite: EECS 152A.
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.
Prerequisite: EECS 160A.
Restriction: Graduate students only.

EECS 261A. Linear Optimization Methods. 4 Units.
Prerequisite: MATH 3A.
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.
Prerequisite: EECS 160A and EECS 170C.
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.
Prerequisite: EECS 170C and EECS 170LC.
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 Electronic System Design. 4 Units.
New research results in electronic system design.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

EECS 273. Electronics Packaging. 4 Units.
Materials, processes, techniques, and principles in interconnect and packaging of electronic products after the device-containing semiconductor wafer is fabricated. The electronic, optical, thermal, mechanical, and reliability properties of the materials are evaluated in the context of modern electronics manufacturing processes.
Restriction: Graduate students only.

EECS 274. Biomedical Microdevices (MEMOS). 4 Units.
Construction of biomedical microdevices, lithographic patterning and etching of microdevices, sealing and connecting microdevices, molding of microdevices, testing of microdevices.
Prerequisite: EECS 179.
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.)
Prerequisite: EECS 119 or EECS 170D.
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.
Prerequisite: EECS 174.
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.
Prerequisite: EECS 174.
Restriction: Graduate students only.

EECS 277C. Nanotechnology. 4 Units.
Prerequisite: EECS 170A and PHYSICS 51A.
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.
Prerequisite: EECS 180A.
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.
Prerequisite: EECS 180A and EECS 182.
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.
Prerequisite: EECS 180A.

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. 3 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 290. 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 292. 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 293. 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 294. 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.