Electrical Engineering and Computer Sciences

Bachelor of Science (BS)

The Berkeley electrical engineering and computer sciences major (EECS), offered through the College of Engineering, combines fundamentals of computer science and electrical engineering in one major.

Note that students wishing to study computer science (http://www.eecs.berkeley.edu/Programs/two_ways.html) at UC Berkeley have two different major options: The EECS major leads to the Bachelor of Science (BS), while the the College of Letters & Sciences offers a Bachelor of Arts (BA) degree. An essential difference between the two majors is that the EECS program requires a greater number of math and science courses than the CS program, which requires a greater number of non-technical, or breadth, courses. For further information on the BA program, please see the Computer Science program page in this Guide (http://guide.berkeley.edu/undergraduate/degree-programs/computer-science).

After completing the required lower division courses, students in the EECS major are able to pursue coursework in computer science and/or electrical engineering based on their personal interests. As they approach graduation, students will be asked to select from one of two programs: electrical and computer engineering (ECE) or computer science and engineering (CSE), depending on their chosen area of concentration. This option is indicated on the student's transcript once their degree is conferred.

Accreditation

All UC Berkeley programs are accredited through the Accrediting Commission for Schools, Western Association of Schools and Colleges (ACSC WASC). Additionally, the EECS program is accredited by ABET through September 30, 2019. After that date, Berkeley EECS has decided to discontinue the ABET accreditation.

Honors Program

The EECS honors degree program is designed to provide very talented undergraduate students a greater connection to the department. Honors students pursue undergraduate research and select an academic concentration outside of EECS. In addition, students receive a special faculty adviser, engage in research, receive official notation of the honors degree on their Berkeley transcript, and are invited to special events with faculty and EECS honors alumni.

For more information regarding this program, please click here. (http://www.eecs.berkeley.edu/education/degrees.shtml#honors)

Admission to the Major

Prospective undergraduates interested in an EECS major must apply for admission to the College of Engineering.

Five-Year BS/MS Program

The Five-Year Bachelor/Master Program, called the 5th Year MS Program for short, offers qualified EECS and L&S computer science undergraduate students a unique opportunity to begin graduate study during their undergraduate years, thereby accelerating the master’s degree by requiring only one additional year beyond the bachelor's degree. This is not a concurrent degree program. Students earn their bachelor's degree first and then the master's. However, careful planning during the undergraduate program allows motivated students to begin a research project and complete some master's course requirements while still in undergraduate standing. Depending on how quickly a student progresses through the undergraduate program, the additional graduate year may come sooner than the fifth year at Berkeley. The Five-Year Program is not intended for those who wish to pursue a PhD. For further information regarding this program, please see the Five-Year BS/MS tab on this page, or the Department's website (http://www.eecs.berkeley.edu/FiveYearMS).

Minor Program

The EECS minor, offered through the College of Engineering, is an optional program for students interested in coherent EECS study outside of their major. It is open to any undergraduate who has declared a major other than EECS and has completed four of the course requirements. For further information regarding the requirements and declaration process, please see the Minor Requirements tab.

The EECS Department also offers a minor in computer science. For information regarding this program, please see the computer science program page in this Guide (http://guide.berkeley.edu/undergraduate/degree-programs/computer-science).

Joint Majors

The EECS Department also offers two joint majors with other departments in the College of Engineering. For further information on these programs, please click the links below:

- Electrical Engineering and Computer Sciences/Materials Science and Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/electrical-engineering-computer-sciences-materials) (Department of Materials Science and Engineering)
- Electrical Engineering and Computer Sciences/Nuclear Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/electrical-engineering-computer-sciences-nuclear-joint-major) (Department of Nuclear Engineering)

In addition to the University, campus, and college requirements, students must fulfill the below requirements specific to their major program.

General Guidelines

1. All technical courses taken in satisfaction of major requirements must be taken for a letter grade.

2. No more than one upper division course may be used to simultaneously fulfill requirements for a student's major and minor programs.

3. A minimum overall grade point average (GPA) of 2.0 is required for all work undertaken at UC Berkeley.
4. A minimum GPA of 2.0 is required for all technical courses taken in satisfaction of major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

For a detailed plan of study by year and semester, please see the Plan of Study tab.

**Summary of Major Requirements**

For more detailed curriculum options for the EECS major, please see the EECS Department website here (http://www.eecs.berkeley.edu/Programs/Notes), or College of Engineering site here. (https://engineering.berkeley.edu/academics/undergraduate-guide/degree-requirements)

Natural sciences: three courses

Mathematics: four courses

EECS lower division core: five courses

Upper division EECS electives: 20 units minimum

Technical Elective: 4 units minimum

Ethics requirement: one course

Technical engineering courses: 40 units minimum

Courses taken to satisfy the EECS lower division core and EECS upper division electives count toward this 40 units.

If courses in these two categories do not total at least 40 units, additional letter-graded engineering courses must be taken to fulfill this requirement.

**Natural Sciences**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 7A</td>
<td>Physics for Scientists and Engineers</td>
<td>8</td>
</tr>
<tr>
<td>&amp; PHYSICS 7B</td>
<td>and Physics for Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>or PHYSICS 5A</td>
<td>Introductory Mechanics and Relativity</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYSICS 5B</td>
<td>and Introductory Electromagnetism, Waves, and Optics</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYSICS 5BL</td>
<td>and Introduction to Experimental Physics I</td>
<td></td>
</tr>
</tbody>
</table>

Natural Science Elective - Select one course from the following: 3-5

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTRON 7A</td>
<td>Introduction to Astrophysics</td>
</tr>
<tr>
<td>ASTRON 7B</td>
<td>Introduction to Astrophysics</td>
</tr>
<tr>
<td>BIOLOGY 1A</td>
<td>General Biology Lecture</td>
</tr>
<tr>
<td>&amp; 1AL</td>
<td>and General Biology Laboratory</td>
</tr>
<tr>
<td>BIOLOGY 1B</td>
<td>General Biology Lecture and Laboratory</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>General Chemistry</td>
</tr>
<tr>
<td>&amp; 1AL</td>
<td>and General Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 1B</td>
<td>General Chemistry</td>
</tr>
<tr>
<td>CHEM 3A</td>
<td>Chemical Structure and Reactivity</td>
</tr>
<tr>
<td>&amp; 3AL</td>
<td>and Organic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 3B</td>
<td>Chemical Structure and Reactivity</td>
</tr>
<tr>
<td>&amp; 3BL</td>
<td>and Organic Chemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 4A</td>
<td>General Chemistry and Quantitative Analysis</td>
</tr>
<tr>
<td>CHEM 4B</td>
<td>General Chemistry and Quantitative Analysis</td>
</tr>
<tr>
<td>MCELLBI 32</td>
<td>Introduction to Human Physiology</td>
</tr>
<tr>
<td>&amp; 32L</td>
<td>and Introduction to Human Physiology Laboratory</td>
</tr>
<tr>
<td>PHYSICS 5C</td>
<td>Introductory Thermodynamics and Quantum Mechanics</td>
</tr>
<tr>
<td>&amp; 5CL</td>
<td>and Introduction to Experimental Physics II</td>
</tr>
<tr>
<td>PHYSICS 7C</td>
<td>Physics for Scientists and Engineers</td>
</tr>
</tbody>
</table>

Any upper division letter graded course of 3 units or more in astronomy, chemistry, earth and planetary science, integrative biology, molecular & cell biology, physics, or plant & microbial biology

**Mathematics**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1A</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1B</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>COMPSCI 70</td>
<td>Discrete Mathematics and Probability Theory</td>
<td>4</td>
</tr>
</tbody>
</table>

**EECS Lower Division Core**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL ENG 16A</td>
<td>Course Not Available</td>
</tr>
<tr>
<td>EL ENG 16B</td>
<td>Course Not Available</td>
</tr>
<tr>
<td>COMPSCI 61A</td>
<td>The Structure and Interpretation of Computer Programs</td>
</tr>
<tr>
<td>COMPSCI 61B</td>
<td>Data Structures</td>
</tr>
<tr>
<td>or COMPSCI 61BL</td>
<td>Data Structures and Programming Methodology</td>
</tr>
<tr>
<td>COMPSCI 61C</td>
<td>Great Ideas of Computer Architecture (Machine Structures)</td>
</tr>
<tr>
<td>or COMPSCI 61C</td>
<td>Machine Structures (Lab-Centric)</td>
</tr>
</tbody>
</table>

**Upper Division EECS Electives**

Select a minimum of 20 units of upper division EECS courses. At least one of the courses must be a design elective. Select from the following design courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL ENG C128</td>
<td>Feedback Control Systems</td>
</tr>
<tr>
<td>EL ENG 130</td>
<td>Integrated-Circuit Devices</td>
</tr>
<tr>
<td>EL ENG 140</td>
<td>Linear Integrated Circuits</td>
</tr>
<tr>
<td>EL ENG 143</td>
<td>Microfabrication Technology</td>
</tr>
<tr>
<td>EL ENG 192</td>
<td>Mechatronic Design Laboratory</td>
</tr>
<tr>
<td>COMPSCI 160</td>
<td>User Interface Design and Development</td>
</tr>
<tr>
<td>COMPSCI 162</td>
<td>Operating Systems and System Programming</td>
</tr>
<tr>
<td>COMPSCI 164</td>
<td>Programming Languages and Compilers</td>
</tr>
<tr>
<td>COMPSCI 169</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>COMPSCI 182</td>
<td>Designing, Visualizing and Understanding Deep Neural Networks</td>
</tr>
<tr>
<td>COMPSCI 184</td>
<td>Foundations of Computer Graphics</td>
</tr>
<tr>
<td>COMPSCI 186</td>
<td>Introduction to Database Systems</td>
</tr>
<tr>
<td>EECS C106A</td>
<td>Introduction to Robotics</td>
</tr>
<tr>
<td>EECS C106B</td>
<td>Robotic Manipulation and Interaction</td>
</tr>
<tr>
<td>EECS 149</td>
<td>Introduction to Embedded Systems</td>
</tr>
<tr>
<td>EECS 151</td>
<td>Introduction to Digital Design and Integrated Circuits and Application Specific Integrated Circuits Laboratory</td>
</tr>
<tr>
<td>or EECS 151</td>
<td>Introduction to Digital Design and Integrated Circuits and Field-Programmable Gate Array Laboratory</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 53</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>COMPSCI 186</td>
<td>Introduction to Database Systems</td>
<td>4</td>
</tr>
<tr>
<td>EECS C106B</td>
<td>Robotic Manipulation and Interaction</td>
<td>4</td>
</tr>
<tr>
<td>EECS 149</td>
<td>Introduction to Embedded Systems</td>
<td>4</td>
</tr>
<tr>
<td>EECS 151</td>
<td>Introduction to Digital Design and Integrated Circuits and Application Specific Integrated Circuits Laboratory</td>
<td></td>
</tr>
<tr>
<td>or EECS 151</td>
<td>Introduction to Digital Design and Integrated Circuits and Field-Programmable Gate Array Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

**Technical Elective: 4 units**

**Ethics Requirement**

Select one course from the following: 1-4

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO ENG 100</td>
<td>Ethics in Science and Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>
The Five-Year Bachelor/Master Program, called the 5th Year MS Program for short, offers qualified EECS and L&S Computer Science undergraduate students a unique opportunity to begin graduate study during their undergraduate years, thereby accelerating the master's degree by requiring only one additional year beyond the bachelor's degree. This is not a concurrent degree program. Students earn their bachelor's degree first and then the master's. However, careful planning during the undergraduate program allows motivated students to begin research projects and complete their master's coursework while still in undergraduate standing. Depending on how quickly a student progresses through the undergraduate program, the additional graduate year may come sooner than the fifth year at Berkeley. The five-year program is not intended for those who wish to pursue a PhD. For further information regarding this program, please see the Department's website (http://www.eecs.berkeley.edu/FiveYearMS).

This program is geared toward students who would like to pursue an education beyond the BS/BA, allowing them to achieve greater breadth and/or depth of knowledge, and who would like to try their hand at research as well. It is not intended for students who have definitely decided to pursue a PhD immediately following graduation. Those students are advised to apply for a PhD program at Berkeley or elsewhere during their senior year. Students who have been accepted into the five-year BA/MS or BS/MS are free to change their minds later and apply to enter the PhD program or apply to a PhD program at another university. Note that admission is competitive with all our PhD applicants.

The program is focused on interdisciplinary training at a graduate level; with at least 8 units of course work outside EECS required. Students will emerge as leaders in their technical and professional fields.

- Focused on interdisciplinary study and more experience in aligned technical fields such as physics, materials science, statistics, biology, etc., and/or professional disciplines such as management of technology, business, law and public policy.
- If admitted to the program, students must begin the graduate portion in the semester immediately following the conferral of the bachelor's degree.
- Only one additional year (two semesters) is permitted beyond the bachelor's degree.
- Only available to Berkeley EECS and L&S CS undergraduates.
- Participants in program may serve as graduate student instructors with approval from their faculty research adviser and the 5th Year MS Committee.
- Participants in program are self-funded.

Minor programs are areas of concentration requiring fewer courses than an undergraduate major. These programs are optional but can provide depth and breadth to a UC Berkeley education. Colleges typically do not offer additional time to complete a minor, but it is usually possible to finish within the allotted time with careful course planning. Students are encouraged to meet with their adviser to discuss the feasibility of completing a minor program.

Students do not need to be in the College of Engineering to pursue the EECS minor.

### General Guidelines

1. All courses taken to fulfill the minor requirements must be completed with a letter grade.
2. A minimum grade point average (GPA) of 2.0 is required for courses used to fulfill the minor requirements.
3. Completion of the minor program cannot delay a student’s graduation.
4. No more than one upper division course may be used to simultaneously fulfill requirements for a student’s major and minor programs.
5. L&S Computer Science majors are discouraged from pursuing the EECS minor due to redundancy in curriculum. They may only use EE or EECS upper division courses towards the EECS minor and may not overlap any upper division courses between their major and minor.
6. Student must submit the Minor Declaration Form (https://berkeley.app.box.com/s/cx67xfprparly62k8577bbakk0rur1w) once they have four or more of the minor requirements completed, and at least one semester prior to graduation.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPSCI 195</td>
<td>Social Implications of Computer Technology</td>
<td>1</td>
</tr>
<tr>
<td>COMPSCI H195</td>
<td>Honors Social Implications of Computer Technology</td>
<td>3</td>
</tr>
<tr>
<td>ENE, RES C100</td>
<td>Energy and Society</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 125</td>
<td>Ethics, Engineering, and Society</td>
<td>3</td>
</tr>
<tr>
<td>ENGIN 157AC</td>
<td>Engineering, The Environment, and Society</td>
<td>4</td>
</tr>
<tr>
<td>IAS 157AC</td>
<td>Engineering, The Environment, and Society</td>
<td>4</td>
</tr>
<tr>
<td>ISF 100D</td>
<td>Introduction to Technology, Society, and Culture</td>
<td>4</td>
</tr>
<tr>
<td>ISF 100G</td>
<td>Introduction to Science, Society, and Ethics</td>
<td>4</td>
</tr>
<tr>
<td>INFO 88A</td>
<td>Data and Ethics</td>
<td>2</td>
</tr>
</tbody>
</table>

1. Students must complete 4 units of Technical Elective(s) chosen from any lower or upper division course in the following departments: astronomy, chemistry, data science, earth and planetary science, integrative biology, mathematics, molecular cell biology, physics, plant & microbial biology, statistics or any engineering department (including EECS). The 4 units of technical elective(s) must be in addition to the natural science elective and the 20 units of required EECS upper division technical electives. If the 4 units of technical elective(s) are from an engineering department, the units can count toward the required 40 units of engineering coursework (see footnote 2). See footnote 2 for the list of excluded courses.

2. Technical engineering courses cannot include:
   - Any course taken on a Pass/No Pass basis
   - Courses numbered 24, 39, or 84
   - Any of the following courses: BIO ENG 100, COMPSCI 70, COMPSCI C79, COMPSCI 195, COMPSCI H195, DES INV courses (except DES INV 15, DES INV 22, DES INV 90E, DES INV 190E), ENGIN 125, ENGIN 157AC, ENGIN 180, IND ENG 95, IND ENG 172, IND ENG 185, IND ENG 186, IND ENG 190, IND ENG 191, IND ENG 192, IND ENG 195, and MEC ENG 191K. ENGIN 185 and ENGIN 187 cannot be used to fulfill engineering units.

3. CHEM 4A and CHEM 4B are intended for students majoring in chemistry or a closely-related field.

4. These courses also satisfy one upper division humanities/social sciences course.
7. All students must submit the EECS Minor Completion Form (https://eeecs.berkeley.edu/sites/default/files/media-inline/fillable_eecs_minor_completion_form_2017.pdf), signed by their Major or ESS Advisor, during their final semester.

Requirements

All students must submit the EECS Minor Completion Form.

Completion of the requirements of one engineering major program.

A minimum overall grade point average of 2.00 (C average) and the final 30 units and two semesters must be completed in residence.

Students in the College of Engineering must complete no fewer than 120 semester units, which must be completed to graduate.

One of the six courses must satisfy the campus American Cultures requirement. Two of the six courses must fulfill the college's Reading and Composition (R&C) requirement. A maximum of two exams (Advanced Placement, International Baccalaureate, or A-Level) may be used toward completion of the H/SS requirement. Test scores do not fulfill the second half of the R&C requirement. Note: Only the first half of R&C can be fulfilled with an AP or IB exam score. Test scores do not fulfill the second half of the R&C requirement for College of Engineering students. 

6. Adhere to all college policies and procedures (http://engineering.berkeley.edu/academics/undergraduate-guide) as they complete degree requirements.

7. Complete the lower division program before enrolling in upper division engineering courses.

Humanities and Social Sciences (H/SS) Requirement

To promote a rich and varied educational experience outside of the technical requirements for each major, the College of Engineering has a six-course Humanities and Social Sciences breadth requirement (http://engineering.berkeley.edu/student-services/degree-requirements/humanities-and-social-sciences), which must be completed to graduate. This requirement, built into all the engineering programs of study, includes two reading and composition courses (R&C), and four additional courses within which a number of specific conditions must be satisfied. Follow these guidelines to fulfill this requirement:

1. Complete a minimum of six courses from the approved Humanities' Social Sciences (H/SS) lists (http://engineering.berkeley.edu/hssreq).

2. Courses must be a minimum of 3 semester units (or 4 quarter units).

3. Two of the six courses must fulfill the college's Reading and Composition (R&C) requirement. These courses must be taken for a letter grade (C- or better required) and must be completed by no later than the end of the sophomore year (fourth semester of enrollment). The first half of R&C, the "A" course, must be completed by the end of the freshman year; the second half of R&C, the "B" course, must be completed by no later than the end of the sophomore year. Use the Class Schedule (http://classes.berkeley.edu) to view R&C courses offered in a given semester. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams) that can be applied toward the first half of the R&C requirement. Note: Only the first half of R&C can be fulfilled with an AP or IB exam score. Test scores do not fulfill the second half of the R&C requirement for College of Engineering students.

4. The four additional courses must be chosen within College of Engineering guidelines from the H/SS lists (see below). These courses may be taken on a Pass/Not Passed basis (P/NP).

5. Two of the six courses must be upper division (courses numbered 100-196).

6. One of the six courses must satisfy the campus American Cultures requirement. For detailed lists of courses that fulfill American Cultures requirements, visit the American Cultures (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/american-cultures-requirement) site.

7. A maximum of two exams (Advanced Placement, International Baccalaureate, or A-Level) may be used toward completion of the H/SS requirement. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams) that can be applied toward H/SS requirements.

8. Courses may fulfill multiple categories. For example, CY PLAN 118AC (http://guide.berkeley.edu/search/?P=CY%20PLAN%20118AC) satisfies both the American Cultures requirement and one upper division H/SS requirement.

9. No courses offered by any engineering department other than BIO ENG 100 (http://guide.berkeley.edu/search/?P=BIO%20ENG%20100), COMPSCI C79 (http://guide.berkeley.edu/search/?P=COMPSCI%20C79), ENGIN 125 (http://guide.berkeley.edu/search/?P=ENGIN%20125), ENGIN 157AC (http://guide.berkeley.edu/search/?P=ENGIN%20157AC),
外，工程学院还设置了五种国际研究、历史研究、外文课程，可能用于完成H/SS课程。学生必须达到最低2.00（C）平均绩点。课程编号97, 98, 99, 197, 198, 199或更高，允许进入120个单位。

外文课程可用于完成H/SS课程。学生必须达到最低2.00（C）平均绩点。

该学院还提供了五种国际研究、历史研究、外文课程，可能用于完成H/SS课程。学生必须达到最低2.00（C）平均绩点。

外语课程可用于完成H/SS课程。学生必须达到最低2.00（C）平均绩点。

所有技术课程（数学、科学、工程）必须在正常情况下每学期至少完成3个单位。此外，学生还必须在任何学期中至少完成两个技术课程（包括单学分课程）。

在上述规定中，选择课程时，可从任何领域的宽度课程中选择。请注意，你不能使用生物学科学或物理科学宽度课程。前往课程表（classes.berkeley.edu）和/或国际研究、历史研究、外文课程宽度列表来完成H/SS课程。查找课程选项时，输入相应的关键词。

校内课程要求

最小学分要求

- 每学期最低学分：12.0
- 每学期最大学分：20.5
- 最小技术课程：工程学院的本科生每学期至少需要在不超过两门技术课程（每门课程至少3个单位）中完成。学生必须是官方确认的。注意：对于大多数人，正常进步将要求在3-4门技术课程中每学期完成。
- 所有技术课程（数学、科学、工程）必须在正常情况下按学分计。如果只修学分课程

最小学术（成绩）要求

- 科学与人文课程的平均成绩为2.00（C）。
- 学生必须在上学期完成2.00（C）平均成绩的上学期课程。
- 学生的课程成绩必须在2.00（C）以上。
- 学生必须在上学期完成2.00（C）平均成绩的上学期课程。

学分要求

为了获得科学与工程学位，学生必须按照以下要求完成至少120个学分。

完成一个工程专业主修课程的要求（https://engineering.berkeley.edu/academics/undergraduate-guide/degree-requirements/major-programs）。
- 完成16门特殊课程的工作（课程编号97, 98, 99, 197, 198, 199）的120个单位。
- 完成4门物理课程的总学分（包括P/非学位学分）。

学生可以接收学分的课程，其内容包括普通课程（包括P/非学位学分）。

正常进度

学生必须在全日制程序中完成并正常每学期向学士学位迈进。如果没有达到最低平均绩点2.00（C），学生将被停学。

学生在任何学期期间，如果学分和/或正常进度低于2.00，必须向院长申请。院长有权力根据学生的情况决定是否同意。

加州大学要求

入学写作要求（http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/entry-level-writing-requirement）。

所有学生必须在入学时完成英语语言课程。

美国历史和机构要求（http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/americian-history-institutions-requirement）。

美国历史和机构要求基于美国原则，即美国大学的毕业生必须了解美国历史和政府机构。

校园要求

美国文化（http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/americian-cultures-requirement）。

美国文化（AC）是唯一一个要求所有学生在 UC 伯克利需要考虑并达成的课程。课程要求提供一个激动人心的环境，使研究者能够以高等院校的名义，研究复杂性。

对于更详细的课程列表（http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/american-cultures-requirement），请查看主要要求。

<table>
<thead>
<tr>
<th>科目</th>
<th>秋季</th>
<th>学分</th>
<th>春季</th>
<th>学分</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1A</td>
<td>4</td>
<td>MATH 1B</td>
<td>4</td>
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</tr>
<tr>
<td>COMPSCI 61A</td>
<td>4</td>
<td>COMPSCI 61E</td>
<td>4</td>
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<tr>
<td>自然科学选修</td>
<td>3-5</td>
<td>EL ENG 16A</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Reading and Composition course from List A | 4 | Reading and Composition course from List B | 4
---|---|---
15-17 | 16 | Sophomore
MATH 53 | Fall | Units | Spring | Units
| 4 | PHYSICS 7B or 5B | 4-5
PHYSICS 7A or 5A² | 3-4 | COMPSCI 61C
EL ENG 16B | 4 | COMPSCI 70
Humanities/Social Sciences course | 3-4 | Humanities/Social Sciences course

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14-16 | 15-17 | Junior
2 EECS Upper Division Electives² | 8 | 2 EECS Upper Division Electives³ | 8
Technical Elective⁴ | 4 | Humanities/ Social Sciences course | 3-4
Humansities/Social Sciences course | 3-4 | Ethics/Social Implications of Technology⁵ | 1-4

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15-16 | 12-16 | Senior
EECS Upper Division Elective³ | 4 | Free Electives⁶ | 17
Free Electives⁶ | 12 | 17

Total Units: 120-131

### Alternative and Accelerated Program Plans

Program plans are available from the EECS Department for students with various backgrounds (including junior transfer students) and for those considering graduating in less than four years. All program plans are provided as a sample and we encourage you to devise your own program with the help of an Adviser. Additional Program Plans: (https://eecs.berkeley.edu/resources/undergrads/eeecs/study-plans)

Students must complete one course from the following list: ASTRON 7A, ASTRON 7B, BIOLOGY 1A and BIOLOGY 1AL (must take both), BIOLOGY 1B, CHEM 1A and CHEM 1AL (must take both), CHEM 1B, CHEM 3A and CHEM 3AL (must take both), CHEM 3B and CHEM 3BL (must take both), CHEM 4A, CHEM 4B, MCELLBI 32 and MCELLBI 32L (must take both), PHYSICS 5C and PHYSICS 5CL (must take both), PHYSICS 7C, or an upper-division course of 3 units or more in astronomy, biology, chemistry, earth and planetary science, integrative biology, molecular cell biology, physics, or plant & microbial biology. This requirement is listed in the freshman year curriculum, but many of the options would not be appropriate for a first year student. Complete this requirement in the semester when it is most appropriate to do so (i.e., take PHYSICS 7C after completing PHYSICS 7B). Your ESS or faculty adviser can help guide your selection on this requirement.

Students may opt to take the Physics 5 series (5A, 5B & 5BL) or the Physics 7 series (Physics 7A & 7B) to fulfill this requirement. Students who have fulfilled the first half of the Physics requirement with an AP test score, transfer work, or with Physics 7A, may opt to fulfill the second half with Physics 7B, or Physics 5B & 5BL. Completion of Physics 5A and 7B will not fulfill the requirement.

Students must complete a minimum of 20 units of upper division EECS courses. One course must provide a major design experience, and be selected from the following list: EL EN 128, EN 130, EL ENG 140, EL ENG 143, EN 192, COMPSCI 160, COMPSCI 162, COMPSCI 164, COMPSCI 169, COMPSCI 182, COMPSCI 184, COMPSCI 186, EECS 106A, EECS 106B, EECS 149, EECS 151 and EECS 151A (must take both), EECS 151 and EECS 151LB (must take both). In addition to upper division EECS courses, the following courses can count toward the 20 units of upper division EECS: INFO 159, COMPSCI 270, COMPSCI 280, EL ENG 229A, COMPSCI 294-4 (Interactive Device Design), and COMPSCI 294-129 (Designing, Visualizing and Understanding Deep Neural Networks). Note that no more than two graduate level courses (courses numbered 200-294) can be used to fulfill requirements for your B.S. degree.

Students must complete 4 units of Technical Elective(s) chosen from any lower or upper division course in the following departments: astronomy, chemistry, data science, earth and planetary science, integrative biology, mathematics, molecular cell biology, physics, plant & microbial biology, statistics or any engineering department (including EECS). The 4 units of technical elective(s) must be in addition to the natural science elective and the 20 units of required EECS upper division technical electives. If the 4 units of technical elective(s) are from an engineering department, the units can count toward the required 40 units of engineering coursework (see footnote 6). See footnote 6 for the list of excluded courses.

Students must complete one course about engineering ethics or social implications of technology. This may be fulfilled by completing one of the following courses: BIO ENG 100*, COMPSCI 195, COMPSCI H195, ENE,RES C100*, ENGIN 125*, ENGIN 157AC*, IAS 157AC*, INFO 88A, ISF 100D*, ISF 100G*. Courses marked with an asterisk fulfill both a humanities/social science requirement and the EECS ethics/social implication of technology requirement.

Students must complete a minimum of 40 units of engineering coursework. The 40 units of engineering courses includes CS 61A/B/C, EE 16A/B, and the required 20 units of upper division. Students who do not meet 40 units through the above requirements must take additional engineering courses. These cannot include:
- Any course taken on a Pass/No Pass basis
- Courses numbered 24, 39, or 84
- Any of the following courses: BIO ENG 100, COMPSCI 70, COMPSCI C79, COMPSCI 195, COMPSCI H195, ENGIN 125, ENGIN 157AC, ENGIN 157AC*, INFO 88A, ISF 100D*, ISF 100G*, DES INV 15, DES INV 22, DES INV 23, DES INV 90E, DES INV 90E, ENGINEERING 190 series, IND ENG 191, IND ENG 192, IND ENG 195, and MEC ENG 191K; ENGIN 185 and ENGIN 187 cannot be used to fulfill engineering units.

### Mission

1. Preparing graduates to pursue postgraduate education in electrical engineering, computer science, or related fields.
2. Preparing graduates for success in technical careers related to electrical and computer engineering, or computer science and engineering.
3. Preparing graduates to become leaders in fields related to electrical and computer engineering or computer science and engineering.

Learning Goals for the Major

ECE
1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to configure, apply test conditions, and evaluate outcomes of experimental systems.
3. An ability to design systems, components, or processes that conform to given specifications and cost constraints.
4. An ability to work cooperatively, respectfully, creatively, and responsibly as a member of a team.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of the norms of expected behavior in engineering practice and their underlying ethical foundations.
7. An ability to communicate effectively by oral, written, and graphical means.
8. An awareness of global and societal concerns and their importance in developing engineering solutions.
9. An ability to independently acquire and apply required information, and an appreciation of the associated process of life-long learning.
10. A knowledge of contemporary issues.
11. An in-depth ability to use a combination of software, instrumentation, and experimental techniques practiced in circuits, physical electronics, communication, networks and systems, hardware, programming, and computer science theory.

CSE
1. An ability to apply knowledge of computing and mathematics appropriate to the program’s student outcomes and to the discipline.
2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution.
3. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.
4. An ability to function effectively on teams to accomplish a common goal.
5. An understanding of professional, ethical, legal, security and social issues and responsibilities.
6. An ability to communicate effectively with a range of audiences.
7. An ability to analyze the local and global impact of computing on individuals, organizations, and society.
8. Recognition of the need for and an ability to engage in continuing professional development.
9. An ability to use current techniques, skills, and tools necessary for computing practice.

Electrical Engineering and Computer Sciences

EECS 16A Designing Information Devices and Systems I 4 Units
Terms offered: Not yet offered
This course and its follow-on course EECS16B focus on the fundamentals of designing modern information devices and systems that interface with the real world. Together, this course sequence provides a comprehensive foundation for core EECS topics in signal processing, learning, control, and circuit design while introducing key linear-algebraic concepts motivated by application contexts. Modeling is emphasized in a way that deepens mathematical maturity, and in both labs and homework, students will engage computationally, physically, and visually with the concepts being introduced in addition to traditional paper/pencil exercises. The courses are aimed at entering students as well as non-majors seeking a broad foundation for the field.

Rules & Requirements

Prerequisites: Math 1A, Math 1B or equivalent (may be taken concurrently), CS 61A or equivalent (encouraged to be taken concurrently)
Credit Restrictions: Students will receive no credit for EECS 16A after completing EL ENG 20, or EL ENG 40.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 2 hours of discussion, and 3 hours of laboratory per week
Summer: 8 weeks - 6 hours of lecture, 4 hours of discussion, and 6 hours of laboratory per week

Additional Details
Subject/Course Level: Electrical Engin and Computer Sci/ Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Alon, Arcak, Ayazifar, Maharbiz, Niknejad, Ranade, Sahai, Subramanian, Tomlin
Formerly known as: Electrical Engineering 16A

Select a subject to view courses
- Electrical Engineering and Computer Sciences (p. 7)
- Computer Science (p. 13)
- Electrical Engineering (p. 36)
EECS 16B Designing Information Devices and Systems II 4 Units

Terms offered: Not yet offered
This course is a follow-on to EECS 16A, and focuses on the fundamentals of designing and building modern information devices and systems that interface with the real world. The course sequence provides a comprehensive introduction to core EECS topics in machine learning, circuit design, control, and signal processing while developing key linear-algebraic concepts motivated by application contexts. Modeling is emphasized in a way that deepens mathematical maturity, and in both labs and homework, students will engage computationally, physically, and visually with the concepts being introduced in addition to traditional paper exercises. The courses are aimed at entering students as well as non-majors seeking a broad introduction to the field.

Designing Information Devices and Systems II: Read More [+]

Rules & Requirements

Prerequisites: Electrical Engineering and Computer Science 16A, Designing Information Devices and Systems I

Credit Restrictions: Students will receive no credit for EECS 16B after completing EL ENG 20, or EL ENG 40.

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate

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

Instructors: Alon, Arcak, Ayazifar, Lustig, Maharbiz, Subramanian, Tomlin

Formerly known as: Electrical Engineering 16B

Designing Information Devices and Systems II: Read Less [-]

EECS 47D Completion of work in Electrical Engineering 16A 1 - 3 Units

Terms offered: Prior to 2007
This course allows students who have had a linear algebra and/or basic circuit theory course to complete the work in EE16A and be ready for EE16B or EE47E. The course focuses on the fundamentals of designing modern information devices and systems that interface with the real world and provides a comprehensive foundation for core EECS topics in signal processing, learning, control, and circuit design. Modeling is emphasized in a way that deepens mathematical maturity, and in both labs and homework, students will engage computationally, physically, and visually with the concepts being introduced in addition to traditional paper/pencil exercises.

Completion of work in Electrical Engineering 16A: Read More [+]

Rules & Requirements

Prerequisites: Math 1A, Math 1B or equivalent, CS 61A or equivalent (encouraged to be taken concurrently), College level courses in linear algebra and/or circuit theory, and consent of the instructor

Hours & Format

Fall and/or spring: 15 weeks - 2-8 hours of self-paced per week

Summer: 8 weeks - 4-13 hours of self-paced per week

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate

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

Instructors: Alon, Arcak, Ayazifar, Maharbiz, Niknejad, Ranade, Sahai, Subramanian, Tomlin

Completion of work in Electrical Engineering 16A: Read Less [-]
EECS 47E Completion of work in Electrical Engineering 16B 1 - 3 Units

Terms offered: Prior to 2007
This course allows students who have had a linear algebra and/or basic circuit theory course to complete the work in EE16B. The course focuses on the fundamentals of designing modern information devices and systems that interface with the real world and provides a comprehensive foundation for core EECS topics in signal processing (DFT), learning (SVD/PCA), feedback control, and circuit design. Modeling is emphasized in a way that deepens mathematical maturity, and in both labs and homework, students will engage computationally, physically, and visually with the concepts being introduced in addition to traditional paper/pencil exercises.
Completion of work in Electrical Engineering 16B: Read More [+]

Rules & Requirements

Prerequisites: Math 1A, Math 1B or equivalent, EE16A or EECS 47D or Math 54, CS 61A or equivalent, College level courses in linear algebra and/or circuit theory, and consent of the instructor

Hours & Format

Fall and/or spring: 15 weeks - 3-8 hours of self-paced per week
Summer: 8 weeks - 6-16 hours of self-paced per week

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate

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

Instructors: Alon, Arcak, Ayazifar, Maharbiz, Niknejad, Ranade, Sahai, Subramanian, Tomlin

Completion of work in Electrical Engineering 16B: Read Less [-]

EECS 47F Completion of work in Computer Science 70 1 - 3 Units

Terms offered: Prior to 2007
This course allows students who have had a discrete math and/or probability course to complete the work in CS70. Logic, infinity, and induction; applications include undecidability and stable marriage problem. Modular arithmetic and GCDs; applications include primality testing and cryptography. Polynomials; examples include error correcting codes and interpolation. Probability including sample spaces, independence, random variables, law of large numbers; examples include load balancing, existence arguments, Bayesian inference.
Completion of work in Computer Science 70: Read More [+]

Rules & Requirements

Prerequisites: Sophomore mathematical maturity, programming experience equivalent to that gained in 61A, a prior college level course on discrete math and/or probability, and consent of the instructor

Hours & Format

Fall and/or spring: 15 weeks - 3-8 hours of self-paced per week
Summer: 8 weeks - 6-16 hours of self-paced per week

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Instructors: Ranade, Rao, Sahai, Seshia, Vazirani, Walrand

Completion of work in Computer Science 70: Read Less [-]
EECS C106A Introduction to Robotics 4 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course covers forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and control. It presents elementary principles on proximity, tactile, and force sensing, vision sensors, camera calibration, stereo construction, and motion detection. The course concludes with current applications of robotics in active perception, medical robotics, and other areas.

Introduction to Robotics: Read More [+]

Rules & Requirements

Prerequisites: Electrical Engineering 120 or equivalent, consent of instructor

Credit Restrictions: Students will receive no credit for Electrical Engineering and Computer Science C106A/Bioengineering C106A after completing EE C106A/BioE C125, Electrical Engineering 206A, or Electrical Engineering and Computer Science 206A.

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/ Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Bajcsy

Also listed as: BIO ENG C106A

Introduction to Robotics: Read Less [-]

EECS C106B Robotic Manipulation and Interaction 4 Units
Terms offered: Spring 2019, Spring 2018
This course is a sequel to EECS C106A/Bioengineering C106A, which covers kinematics, dynamics and control of a single robot. This course will cover dynamics and control of groups of robotic manipulators coordinating with each other and interacting with the environment. Concepts will include an introduction to grasping and the constrained manipulation, contacts and force control for interaction with the environment. We will also cover active perception guided manipulation, as well as the manipulation of non-rigid objects. Throughout, we will emphasize design and human-robot interactions, and applications to applications in manufacturing, service robotics, tele-surgery, and locomotion.

Robotic Manipulation and Interaction: Read More [+]

Rules & Requirements

Prerequisites: Electrical Engineering and Computer Science C106A/Bioengineering C106A or consent of the instructor

Credit Restrictions: Students will receive no credit for Electrical Engineering and Computer Science C106B/Bioengineering C106B after completing Electrical Engineering C106B/Bioengineering C125B, Electrical Engineering 206B, or Electrical Engineering and Computer Science 206B.

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/ Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructors: Bajcsy, Sastry

Also listed as: BIO ENG C106B

Robotic Manipulation and Interaction: Read Less [-]
EECS 126 Probability and Random Processes
4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
Rules & Requirements
Prerequisites: CS 70 preferred but not required. Familiarity with linear algebra
Credit Restrictions: Students will receive no credit for EECS 126 after completing EE 126.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Ramchandran
Probability and Random Processes: Read Less [-]

EECS 127 Optimization Models in Engineering 4 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
This course offers an introduction to optimization models and their applications, ranging from machine learning and statistics to decision-making and control, with emphasis on numerically tractable problems, such as linear or constrained least-squares optimization. Optimization Models in Engineering: Read More [+]
Rules & Requirements
Prerequisites: EE 16A & 16B or consent of instructor
Credit Restrictions: Students will receive no credit for EECS 127 after taking EECS 227AT or Electrical Engineering 127/227AT.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: El Ghaoui
Formerly known as: Electrical Engineering 127
Optimization Models in Engineering: Read Less [-]
EECS 149 Introduction to Embedded Systems 4 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
This course introduces students to the basics of modeling, analysis, and design of embedded cyber-physical systems. Students learn how to integrate computation with physical processes to meet a desired specification. Topics include models of computation, control, analysis and verification, interfacing with the physical world, real-time behaviors, mapping to platforms, and distributed embedded systems. The course has a strong laboratory component, with emphasis on a semester-long sequence of projects.

Introduction to Embedded Systems: Read More [+]

Objectives

Course Objectives: To develop the skills to realize embedded systems that are safe, reliable, and efficient in their use of resources.
To learn how to model and design the joint dynamics of software, networks, and physical processes.
To learn to think critically about technologies that are available for achieving such joint dynamics.

Rules & Requirements

Prerequisites: EE 16A & B, or permission of instructor; CS 61C and CS 70

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructors: Seshia, Lee

Introduction to Embedded Systems: Read Less [-]

EECS 151 Introduction to Digital Design and Integrated Circuits 3 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
An introduction to digital and system design. The material provides a top-down view of the principles, components, and methodologies for large scale digital system design. The underlying CMOS devices and manufacturing technologies are introduced, but quickly abstracted to higher-levels to focus the class on design of larger digital modules for both FPGAs (field programmable gate arrays) and ASICs (application specific integrated circuits). The class includes extensive use of industrial grade design automation and verification tools for assignments, labs and projects.
The class has two lab options: ASIC Lab (EECS 151LA) and FPGA Lab (EECS 151LB). Students must enroll in at least one of the labs concurrently with the class.

Introduction to Digital Design and Integrated Circuits: Read More [+]

Objectives

Course Objectives: The Verilog hardware description language is introduced and used. Basic digital system design concepts, Boolean operations/combinational logic, sequential elements and finite-state-machines, are described. Design of larger building blocks such as arithmetic units, interconnection networks, input/output units, as well as memory design (SRAM, Caches, FIFOs) and integration are also covered. Parallelism, pipelining and other micro-architectural optimizations are introduced. A number of physical design issues visible at the architecture level are covered as well, such as interconnects, power, and reliability.

Rules & Requirements

Prerequisites: Electrical Engineering 16A & 16B
Credit Restrictions: Students must enroll concurrently in at least one the lab flavors EECS151LA or EECS151LB. Students wishing to take a second lab flavor next term can sign-up only for that Lab section and receive a Letter grade. The pre-requisite for “Lab-only” enrollment that term will be EECS151 from previous terms.

Hours & Format

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

Additional Details

Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Stojanovic, Wawrzynek

Introduction to Digital Design and Integrated Circuits: Read Less [-]
EECS 151LA Application Specific Integrated Circuits Laboratory 2 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
This lab lays the foundation of modern digital design by first presenting the scripting and hardware description language base for specification of digital systems and interactions with tool flows. The labs are centered on a large design with the focus on rapid design space exploration. The lab exercises culminate with a project design, e.g., implementation of a three-stage RISC-V processor with a register file and caches. The design is mapped to simulation and layout specification.

Course Objectives: Software testing of digital designs is covered leading to a set of exercises that cover the design flow. Digital synthesis, floorplanning, placement and routing are covered, as well as tools to evaluate timing and power consumption. Chip-level assembly is covered, including instantiation of custom blocks: I/O pads, memories, PLLs, etc.

Rules & Requirements
Prerequisites: Computer Science 61C, Electrical Engineering 16A & 16B, Electrical Engineering 105

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of laboratory per week

Additional Details
Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Instructors: Stojanovic, Wawrzynek

Application Specific Integrated Circuits Laboratory: Read Less [-]

EECS 151LB Field-Programmable Gate Array Laboratory 2 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
This lab covers the design of modern digital systems with Field-Programmable Gate Array (FPGA) platforms. A series of lab exercises provide the background and practice of digital design using a modern FPGA design tool flow. Digital synthesis, partitioning, placement, routing, and simulation tools for FPGAs are covered in detail. The labs exercises culminate with a large design project, e.g., an implementation of a full three-stage RISC-V processor system, with caches, graphics acceleration, and external peripheral components. The design is mapped and demonstrated on an FPGA hardware platform.

Course Objectives: Software testing of digital designs is covered leading to a set of exercises that cover the design flow. Digital synthesis, floorplanning, placement and routing are covered, as well as tools to evaluate timing and power consumption. Chip-level assembly is covered, including instantiation of custom blocks: I/O pads, memories, PLLs, etc.

Rules & Requirements
Prerequisites: Electrical Engineering 16A & 16B; Electrical Engineering 105 recommended and Computer Science 61C

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of laboratory per week

Additional Details
Subject/Course Level: Electrical Engin and Computer Sci/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Instructors: Stojanovic, Wawrzynek

Field-Programmable Gate Array Laboratory: Read Less [-]

Computer Science
Expand all course descriptions [+]Collapse all course descriptions [-]
COMPSCI C8 Foundations of Data Science 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019, Fall 2018, Summer 2018 8 Week Session, Spring 2018
Foundations of data science from three perspectives: inferential thinking, computational thinking, and real-world relevance. Given data arising from some real-world phenomenon, how does one analyze that data so as to understand that phenomenon? The course teaches critical concepts and skills in computer programming and statistical inference, in conjunction with hands-on analysis of real-world datasets, including economic data, document collections, geographical data, and social networks. It delves into social and legal issues surrounding data analysis, including issues of privacy and data ownership.

Foundations of Data Science: Read More [+]

Rules & Requirements
Prerequisites: This course may be taken on its own, but students are encouraged to take it concurrently with a data science connector course (numbered 88 in a range of departments)

Hours & Format
Fall and/or spring: 15 weeks - 3-3 hours of lecture and 2-2 hours of laboratory per week
Summer: 8 weeks - 6 hours of lecture and 4 hours of laboratory per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: INFO C8/STAT C8
Foundations of Data Science: Read Less [-]

COMPSCI C8R Introduction to Computational Thinking with Data 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Prior to 2007
An introduction to computational thinking and quantitative reasoning, preparing students for further coursework, especially Foundations of Data Science (CS/Info/Stat C8). Emphasizes the use of computation to gain insight about quantitative problems with real data. Expressions, data types, collections, and tables in Python. Programming practices, abstraction, and iteration. Visualizing univariate and bivariate data with bar charts, histograms, plots, and maps. Introduction to statistical concepts including averages and distributions, predicting one variable from another, association and causality, probability and probabilistic simulation. Relationship between numerical functions and graphs. Sampling and introduction to inference.

Introduction to Computational Thinking with Data: Read More [+]

Objectives Outcomes
Course Objectives: C8R also includes quantitative reasoning concepts that aren’t covered in Data 8. These include certain topics in: principles of data visualization; simulation of random processes; and understanding numerical functions through their graphs. This will help prepare students for computational and quantitative courses other than Data 8. C8R takes advantage of the complementarity of computing and quantitative reasoning to enliven abstract ideas and build students’ confidence in their ability to solve real problems with quantitative tools. Students learn computer science concepts and immediately apply them to plot functions, visualize data, and simulate random events.

Foundations of Data Science (CS/Info/Stat C8, a.k.a. Data 8) is an increasingly popular class for entering students at Berkeley. Data 8 builds students’ computing skills in the first month of the semester, and students rely on these skills as the course progresses. For some students, particularly those with little prior exposure to computing, developing these skills benefits from further time and practice. C8R is a rapid introduction to Python programming, visualization, and data analysis, which will prepare students for success in Data 8.

Student Learning Outcomes: Students will be able to perform basic computations in Python, including working with tabular data. Students will be able to understand basic probabilistic simulations. Students will be able to understand the syntactic structure of Python code. Students will be able to use good practices in Python programming. Students will be able to use visualizations to understand univariate data and to identify associations or causal relationships in bivariate data.

Rules & Requirements
Credit Restrictions: Students who have taken COMPSCI/INFO/STAT C8 will receive no credit for COMPSCI/STAT C8R.

Hours & Format
Summer: 6 weeks - 4 hours of lecture, 2 hours of discussion, and 4 hours of laboratory per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Adhikari
Also listed as: STAT C8R
Introduction to Computational Thinking with Data: Read Less [-]
COMPSCI 9A Matlab for Programmers 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Spring 2018
Introduction to the constructs in the Matlab programming language, aimed at students who already know how to program. Array and matrix operations, functions and function handles, control flow, plotting and image manipulation, cell arrays and structures, and the Symbolic Mathematics toolbox.
Matlab for Programmers: Read More [+]
Rules & Requirements
Prerequisites: Programming experience equivalent to that gained in Computer Science 10; familiarity with applications of matrix processing
Repeat rules: Course may be repeated for credit up to a total of 4 units.
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of self-paced per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam required.
Instructor: Hilfinger
Matlab for Programmers: Read Less [-]

COMPSCI 9D Scheme and Functional Programming for Programmers 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Fall 2015, Spring 2015
Self-paced course in functional programming, using the Scheme programming language, for students who already know how to program. Recursion; higher-order functions; list processing; implementation of rule-based querying.
Scheme and Functional Programming for Programmers: Read More [+]
Rules & Requirements
Prerequisites: Programming experience similar to that gained in Computer Science 10 or Engineering 7
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of self-paced per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam required.
Instructor: Hilfinger
Scheme and Functional Programming for Programmers: Read Less [-]

COMPSCI 9E Productive Use of the UNIX Environment 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Use of UNIX utilities and scripting facilities for customizing the programming environment, organizing files (possibly in more than one computer account), implementing a personal database, reformatting text, and searching for online resources.
Productive Use of the UNIX Environment: Read More [+]
Rules & Requirements
Prerequisites: Programming experience similar to that gained in Computer Science 61A or Engineering 7; DOS or UNIX experience
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of self-paced per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam required.
Instructor: Hilfinger
Productive Use of the UNIX Environment: Read Less [-]
**COMPSCI 9F C++ for Programmers 2 Units**
Offered through: Electrical Engin and Computer Sci  
Terms offered: Fall 2019, Spring 2019, Fall 2018  
Self-paced introduction to the constructs provided in the C++  
programming language for procedural and object-oriented programming,  
aimed at students who already know how to program.  
C++ for Programmers: Read More [+]

**Rules & Requirements**

**Prerequisites:** Programming experience equivalent to that gained in  
Computer Science 9B or 61A, or Engineering 7  

**Hours & Format**

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

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate  
**Grading/Final exam status:** Offered for pass/not pass grade only. Final  
exam required.  
**Instructor:** Hilfinger  

C++ for Programmers: Read Less [-]

**COMPSCI 9G JAVA for Programmers 2 Units**
Offered through: Electrical Engin and Computer Sci  
Terms offered: Fall 2019, Spring 2019, Fall 2018  
Self-paced course in Java for students who already know how to  
program. Applets; variables and computation; events and flow of control;  
classes and objects; inheritance; GUI elements; applications; arrays,  
strings, files, and linked structures; exceptions; threads.  
JAVA for Programmers: Read More [+]

**Rules & Requirements**

**Prerequisites:** 9C or 9F or 61A plus experience with object-oriented  
programming or C-based language  

**Hours & Format**

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

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate  
**Grading/Final exam status:** Offered for pass/not pass grade only. Final  
exam required.  
**Instructor:** Garcia  

JAVA for Programmers: Read Less [-]

**COMPSCI 9H Python for Programmers 2 Units**
Offered through: Electrical Engin and Computer Sci  
Terms offered: Fall 2019, Spring 2019, Fall 2018  
Introduction to the constructs provided in the Python programming  
language, aimed at students who already know how to program. Flow of  
control; strings, tuples, lists, and dictionaries; CGI programming; file input  
and output; object-oriented programming; GUI elements.  
Python for Programmers: Read More [+]

**Rules & Requirements**

**Prerequisites:** Programming experience equivalent to that gained in  
Computer Science 10  

**Hours & Format**

Fall and/or spring: 15 weeks - 1 hour of self-paced per week  

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate  
**Grading/Final exam status:** Offered for pass/not pass grade only. Final  
exam required.  
**Instructor:** Hilfinger  

Python for Programmers: Read Less [-]
COMPSCI 10 The Beauty and Joy of Computing 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
An introductory course for students with minimal prior exposure to computer science. Prepares students for future computer science courses and empowers them to utilize programming to solve problems in their field of study. Presents an overview of the history, great principles, and transformative applications of computer science, as well as a comprehensive introduction to programming. Topics include abstraction, recursion, algorithmic complexity, higher-order functions, concurrency, social implications of computing (privacy, education, algorithmic bias), and engaging research areas (data science, AI, HCI). Students will program in Snap! (a friendly graphical language) and Python, and will design and implement two projects of their choice.

Rules & Requirements

Credit Restrictions: Students will receive no credit for 10 after having taken W10, 61A, 61B, or 61C.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture, 1 hour of discussion, and 4 hours of laboratory per week
Summer: 8 weeks - 4 hours of lecture, 2 hours of discussion, and 8 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Garcia, Hug

The Beauty and Joy of Computing: Read Less [-]

COMPSCI W10 The Beauty and Joy of Computing 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2012
This course meets the programming prerequisite for 61A. An introduction to the beauty and joy of computing. The history, social implications, great principles, and future of computing. Beautiful applications that have changed the world. How computing empowers discovery and progress in other fields. Relevance of computing to the student and society will be emphasized. Students will learn the joy of programming a computer using a friendly, graphical language, and will complete a substantial team programming project related to their interests.

Rules & Requirements

Credit Restrictions: Students will receive no credit for W10 after taking 10, 61A, 61B or 61C. A deficient grade in 10 may be removed by taking W10.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of web-based lecture and 5 hours of web-based discussion per week
Summer: 8 weeks - 4 hours of web-based lecture and 10 hours of web-based discussion per week
Online: This is an online course.

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Garcia, Hug

The Beauty and Joy of Computing: Read Less [-]
COMPSCI 36 CS Scholars Seminar: The Educational Climate in CS & CS61A technical discussions 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Spring 2018
Computer Science 36 is a seminar for CS Scholars who are concurrently taking CS61A: The Structure and Interpretation of Computer Programs. CS Scholars is a cohort-model program to provide support in exploring and potentially declaring a CS major for students with little to no computational background prior to coming to the university. CS 36 provides an introduction to the CS curriculum at UC Berkeley, and the overall CS landscape in both industry and academia—through the lens of accessibility and its relevance to diversity. Additionally, CS36 provides technical instruction to review concepts in CS61A, in order to support CS Scholars’ individual learning and success in the CS61A course. CS Scholars Seminar: The Educational Climate in CS & CS61A technical discussions: Read More [+]

Objectives Outcomes

Student Learning Outcomes: Students will know where to find several support services including tutoring, advising, counseling, and career advice. Students will perform as well as possible in the CS61A prerequisite for the CS major. They will also have customized program plans for completing the major within four years.

Rules & Requirements

Prerequisites: Prerequisite satisfied Concurrently: Participating in the CS Scholars program, and concurrently taking Computer Science 61A

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Alternative to final exam.

Instructor: Hunn

CS Scholars Seminar: The Educational Climate in CS & CS61A technical discussions: Read Less [-]

COMPSCI 39 Freshman/Sophomore Seminar 1.5 - 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Fall 2017, Spring 2017
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.

Freshman/Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: Priority given to freshmen and sophomores

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final Exam To be decided by the instructor when the class is offered.

Freshman/Sophomore Seminar: Read Less [-]

COMPSCI 39J Freshman/Sophomore Seminar 1.5 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2010, Spring 2010, Fall 2009
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.

Freshman/Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: Priority given to freshmen and sophomores

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

Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of seminar per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]
COMPSCI 39K Freshman/Sophomore Seminar 1.5 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2013, Spring 2011, Spring 2010
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]
Rules & Requirements
Prerequisites: Priority given to freshmen and sophomores
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2-4 hours of seminar per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.
Freshman/Sophomore Seminar: Read Less [-]

COMPSCI 39M Freshman/Sophomore Seminar 1.5 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2008
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]
Rules & Requirements
Prerequisites: Priority given to freshmen and sophomores
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2-4 hours of seminar per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.
Freshman/Sophomore Seminar: Read Less [-]

COMPSCI 39N Freshman/Sophomore Seminar 1.5 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2010, Fall 2009
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]
Rules & Requirements
Prerequisites: Priority given to freshmen and sophomores
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2-4 hours of seminar per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.
Freshman/Sophomore Seminar: Read Less [-]

COMPSCI 39P Freshman/Sophomore Seminar 1.5 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2013, Spring 2013, Fall 2012
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]
Rules & Requirements
Prerequisites: Priority given to freshmen and sophomores
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2-4 hours of seminar per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.
Freshman/Sophomore Seminar: Read Less [-]
**COMPSCI 39Q Freshman/Sophomore Seminar 1.5 - 4 Units**
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2011
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]

**Rules & Requirements**

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

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

**Hours & Format**

Fall and/or spring: 15 weeks - 2-4 hours of seminar per week

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]

**COMPSCI 39R Freshman/Sophomore Seminar 1.5 - 4 Units**
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Spring 2013
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]

**Rules & Requirements**

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

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

**Hours & Format**

Fall and/or spring: 15 weeks - 2-4 hours of seminar per week

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]

**COMPSCI 47A Completion of Work in Computer Science 61A 1 Unit**
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Implementation of generic operations. Streams and iterators. Implementation techniques for supporting functional, object-oriented, and constraint-based programming in the Scheme programming language. Together with 9D, 47A constitutes an abbreviated, self-paced version of 61A for students who have already taken a course equivalent to 61B.
Completion of Work in Computer Science 61A: Read More [+]

**Rules & Requirements**

**Prerequisites:** 61B or equivalent, 9D, and consent of instructor

**Credit Restrictions:** Students will receive no credit for 47A after taking 61A.

**Hours & Format**

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

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

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

**Instructor:** Garcia

Completion of Work in Computer Science 61A: Read Less [-]

**COMPSCI 47B Completion of Work in Computer Science 61B 1 Unit**
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Iterators. Hashing, applied to strings and multi-dimensional structures. Heaps. Storage management. Design and implementation of a program containing hundreds of lines of code. Students with sufficient partial credit in 61B may, with consent of instructor, complete the credit in this self-paced course.
Completion of Work in Computer Science 61B: Read More [+]

**Rules & Requirements**

**Prerequisites:** A course in data structures, 9G or equivalent, and consent of instructor

**Credit Restrictions:** Students will receive no credit for 47B after taking 61B.

**Hours & Format**

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

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

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

**Instructor:** Garcia

Completion of Work in Computer Science 61B: Read Less [-]
COMPSCI 47C Completion of Work in Computer Science 61C 1 Unit
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
MIPS instruction set simulation. The assembly and linking process. Caches and virtual memory. Pipelined computer organization. Students with sufficient partial credit in 61C may, with consent of instructor, complete the credit in this self-paced course.
Completion of Work in Computer Science 61C: Read More [+]

Rules & Requirements
Prerequisites: Experience with assembly language including writing an interrupt handler, 9C or equivalent, and consent of instructor
Credit Restrictions: Students will receive no credit for 47C after taking 61C.

Hours & Format
Fall and/or spring: 15 weeks - 0 hours of self-paced per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Garcia
Completion of Work in Computer Science 61C: Read Less [-]

COMPSCI 61A The Structure and Interpretation of Computer Programs 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
An introduction to programming and computer science focused on abstraction techniques as means to manage program complexity. Techniques include procedural abstraction; control abstraction using recursion, higher-order functions, generators, and streams; data abstraction using interfaces, objects, classes, and generic operators; and language abstraction using interpreters and macros. The course exposes students to programming paradigms, including functional, object-oriented, and declarative approaches. It includes an introduction to asymptotic analysis of algorithms. There are several significant programming projects.
The Structure and Interpretation of Computer Programs: Read More [+]

Rules & Requirements
Prerequisites: Mathematics 1A (may be taken concurrently); programming experience equivalent to that gained from a score of 3 or above on the Advanced Placement Computer Science A course
Credit Restrictions: Students will receive no credit for Computer Science 61A after completing Computer Science 47A or Computer Science 61AS. A deficient grade in Computer Science 61AS may be removed by taking Computer Science 61A.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1.5 hours of discussion, and 1.5 hours of laboratory per week
Summer: 8 weeks - 6 hours of lecture, 3 hours of discussion, and 3 hours of laboratory per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Garcia, Hilfinger
The Structure and Interpretation of Computer Programs: Read Less [-]
COMPSCI 61AS The Structure and Interpretation of Computer Programs (Self-Paced) 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Fall 2015, Summer 2015 8 Week Session
Introductory programming and computer science. Abstraction as means to control program complexity. Programming paradigms: functional, object-oriented, client/server, and declarative (logic). Control abstraction: recursion and higher order functions. Introduction to asymptotic analysis of algorithms. Data abstraction: abstract data types, type-tagged data, first class data types, sequences implemented as lists and as arrays, generic operators implemented with data-directed programming and with message passing. Implementation of object-oriented programming with closures over dispatch procedures. Introduction to interpreters and compilers. There are several significant programming projects. Course may be completed in one or two semesters. Students must complete a minimum of two units during their first semester of 61AS.
The Structure and Interpretation of Computer Programs (Self-Paced):
Read More [+]

Rules & Requirements

Prerequisites: Mathematics 1A (may be taken concurrently). Programming experience equivalent to that gained in 10 or the Advanced Placement Computer Science A course is recommended, but is not essential; students without this experience will begin at an earlier point in the online course.

Credit Restrictions: Students will receive no credit for Computer Science 61AS after completing Computer Science 47A or Computer Science 61A. A deficient grade in Computer Science 61A may be removed by taking Computer Science 61AS.

Repeat rules: Course may be repeated for credit up to a total of 4 units.

Hours & Format

Fall and/or spring: 15 weeks - 6 hours of laboratory per week
Summer:
6 weeks - 15 hours of laboratory per week
8 weeks - 11 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Garcia, Harvey, Hilfinger

The Structure and Interpretation of Computer Programs (Self-Paced):
Read Less [-]

COMPSCI 61B Data Structures 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Fundamental dynamic data structures, including linear lists, queues, trees, and other linked structures; arrays strings, and hash tables. Storage management. Elementary principles of software engineering. Abstract data types. Algorithms for sorting and searching. Introduction to the Java programming language.
Data Structures:
Read More [+]

Rules & Requirements

Prerequisites: Computer Science 61A or Computer Science 88 or Engineering 7

Credit Restrictions: Students will receive no credit for Computer Science 61B after completing Computer Science 47B or 61BL. A deficiency in Computer Science 61BL may be removed by taking Computer Science 61B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week
Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, and 4 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Hilfinger, Shewchuk

Data Structures:
Read Less [-]
COMPSCI 61BL Data Structures and Programming Methodology 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Summer 2019 8 Week Session, Summer 2018 8 Week Session, Summer 2017 8 Week Session
The same material as in 61B, but in a laboratory-based format.
Data Structures and Programming Methodology: Read More [+]

Rules & Requirements

Prerequisites: COMPSCI 61A or COMPSCI 88 or ENGIN 7

Credit Restrictions: Students will receive no credit for 61BL after taking 47B or 61B. Deficiency in 61B may be removed by taking 61BL.

Hours & Format

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

Summer: 8 weeks - 2 hours of lecture and 12 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Hilfinger

Data Structures and Programming Methodology: Read Less [-]

COMPSCI 61C Great Ideas of Computer Architecture (Machine Structures) 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
The internal organization and operation of digital computers. Machine architecture, support for high-level languages (logic, arithmetic, instruction sequencing) and operating systems (I/O, interrupts, memory management, process switching). Elements of computer logic design. Tradeoffs involved in fundamental architectural design decisions.
Great Ideas of Computer Architecture (Machine Structures): Read More [+]

Rules & Requirements

Prerequisites: 61A, along with either 61B or 61BL, or programming experience equivalent to that gained in 9C, 9F, or 9G

Credit Restrictions: Students will receive no credit for 61C after taking 47C or 61CL. Deficiency in 61C may be removed by taking 61CL.

Hours & Format

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

Summer: 8 weeks - 6 hours of lecture, 2 hours of discussion, and 4 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Garcia, Katz, Stojanovic

Great Ideas of Computer Architecture (Machine Structures): Read Less [-]
COMPSCI 61CL Machine Structures (Lab-Centric) 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2008, Spring 2009, Fall 2008
The same material as in 61C but in a lab-centric format.
Machine Structures (Lab-Centric): Read More [+]

Rules & Requirements

Prerequisites: 61A, along with 61B or 61BL, or programming experience equivalent to that gained in 9C, 9F, or 9G
Credit Restrictions: Students will receive no credit for 61CL after taking 47C or 61C. Deficiency in 61C may be removed by taking 61CL.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture, 1 hour of discussion, and 4 hours of laboratory per week
Summer: 8 weeks - 4 hours of lecture, 2 hours of discussion, and 8 hours of laboratory per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Garcia, Patterson
Machine Structures (Lab-Centric): Read Less [-]

COMPSCI W61A The Structure and Interpretation of Computer Programs (Online) 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Summer 2019 8 Week Session
An introduction to programming and computer science focused on abstraction techniques as means to manage program complexity. Techniques include procedural abstraction; control abstraction using recursion, higher-order functions, generators, and streams; data abstraction using interfaces, objects, classes, and generic operators; and language abstraction using interpreters and macros. The course exposes students to programming paradigms, including functional, object-oriented, and declarative approaches. It includes an introduction to asymptotic analysis of algorithms. There are several significant programming projects.
The Structure and Interpretation of Computer Programs (Online): Read More [+]

Rules & Requirements

Prerequisites: Mathematics 1A (may be taken concurrently)
Credit Restrictions: Students will receive no credit for Computer Science W61A after completing Computer Science 47A or Computer Science 61A. A deficient grade in Computer Science W61A may be removed by taking Computer Science 61A.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of web-based lecture, 1.5 hours of laboratory, and 1.5 hours of web-based discussion per week
Summer: 8 weeks - 6 hours of web-based lecture, 3 hours of laboratory, and 3 hours of web-based discussion per week
Online: This is an online course.

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Denero
The Structure and Interpretation of Computer Programs (Online): Read Less [-]
COMPSCI W61B Data Structures (Online) 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Prior to 2007
Identical to CS61B, but in an online format. Fundamental dynamic
data structures, including linear lists, queues, trees, and other linked
structures; arrays strings, and hash tables. Storage management.
Elementary principles of software engineering. Abstract data types.
Algorithms for sorting and searching. Introduction to the Java
programming language.
Data Structures (Online): Read More [+]
Rules & Requirements
Prerequisites: Computer Science 61A or Computer Science W61A or
Computer Science 88 or Engineering 7
Credit Restrictions: Students will receive no credit for Computer
Science W61B after completing Computer Science 47B or or 61B or
61BL. A deficiency in Computer Science 61BL may be removed by taking
Computer Science W61B.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of web-based lecture, 2 hours of
laboratory, and 1 hour of web-based discussion per week
Summer: 8 weeks - 6 hours of web-based lecture, 4 hours of laboratory,
and 2 hours of web-based discussion per week
Online: This is an online course.

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Hug
Data Structures (Online): Read Less [-]

COMPSCI 70 Discrete Mathematics and Probability Theory 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
Logic, infinity, and induction; applications include undecidability and
stable marriage problem. Modular arithmetic and GCDs; applications
include primality testing and cryptography. Polynomials; examples
include error correcting codes and interpolation. Probability including
sample spaces, independence, random variables, law of large numbers;
examples include load balancing, existence arguments, Bayesian
inference.
Discrete Mathematics and Probability Theory: Read More [+]
Rules & Requirements
Prerequisites: Sophomore mathematical maturity, and programming
experience equivalent to that gained in 3 or the Advanced Placement
Computer Science A course
Credit Restrictions: Students will receive no credit for Computer
Science 70 after taking Mathematics 55.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of
discussion per week
Summer: 8 weeks - 6 hours of lecture and 4 hours of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Rao, Vazirani, Wagner, Sahai
Discrete Mathematics and Probability Theory: Read Less [-]

COMPSCI C79 Societal Risks and the Law 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2013
Defining, perceiving, quantifying and measuring risk; identifying risks and
estimating their importance; determining whether laws and regulations
can protect us from these risks; examining how well existing laws
work and how they could be improved; evaluating costs and benefits.
Applications may vary by term. This course cannot be used to complete
engineering unit or technical elective requirements for students in the
College of Engineering.
Societal Risks and the Law: Read More [+]
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of
discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Also listed as: POL SCI C79/STAT C79
Societal Risks and the Law: Read Less [-]
COMPSCI 88 Computational Structures in Data Science 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Development of Computer Science topics appearing in Foundations of Data Science (C8); expands computational concepts and techniques of abstraction. Understanding the structures that underlie the programs, algorithms, and languages used in data science and elsewhere. Mastery of a particular programming language while studying general techniques for managing program complexity, e.g., functional, object-oriented, and declarative programming. Provides practical experience with composing larger systems through several significant programming projects.
Computational Structures in Data Science: Read More [+]

Objectives Outcomes

Course Objectives: Develop a foundation of computer science concepts that arise in the context of data analytics, including algorithm, representation, interpretation, abstraction, sequencing, conditional, function, iteration, recursion, types, objects, and testing, and develop proficiency in the application of these concepts in the context of a modern programming language at a scale of whole programs on par with a traditional CS introduction course.

Student Learning Outcomes: Students will be able to demonstrate a working knowledge of these concepts and a proficiency of programming based upon them sufficient to construct substantial stand-alone programs.

Rules & Requirements

Prerequisites: Math 1A. Also, this course is a Data Science connector course and may only be taken concurrently with or after COMPSCI C8/INFO C8/STAT C8. Students may take more than one Data Science connector (88) course if they wish, concurrent with or after having taken the C8 course

Credit Restrictions: Students may receive no credit for Computer Science 88 after completing Computer Science 61A.

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Undergraduate

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

COMPSCI 94 Special Topics 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2015
Topics will vary semester to semester. See the Computer Science Division announcements.
Special Topics: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

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

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Undergraduate

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

Special Topics: Read Less [-]

COMPSCI 97 Field Study 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2015, Spring 2015, Fall 2014
Students take part in organized individual field sponsored programs with off-campus companies or tutoring/mentoring relevant to specific aspects and applications of computer science on or off campus. Note Summer CPT or OPT students: written report required. Course does not count toward major requirements, but will be counted in the cumulative units toward graduation.
Field Study: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor (see department adviser)

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

Hours & Format

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

Summer:
6 weeks - 2.5-10 hours of fieldwork per week
8 weeks - 2-7.5 hours of fieldwork per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Field Study: Read Less [-]
COMPSCI 98 Directed Group Study 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Fall 2016
Seminars for group study of selected topics, which will vary from year to year. Intended for students in the lower division.
Directed Group Study: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Study: Read Less [-]

COMPSCI 99 Individual Study and Research for Undergraduates 1 - 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2015, Fall 2014, Spring 2014
A course for lower division students in good standing who wish to undertake a program of individual inquiry initiated jointly by the student and a professor. There are no other formal prerequisites, but the supervising professor must be convinced that the student is able to profit by the program.
Individual Study and Research for Undergraduates: Read More [+]

Rules & Requirements
Prerequisites: GPA of 3.4 or better
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

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

COMPSCI C100 Principles & Techniques of Data Science 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019, Fall 2018
In this course, students will explore the data science lifecycle, including question formulation, data collection and cleaning, exploratory data analysis and visualization, statistical inference and prediction, and decision-making. This class will focus on quantitative critical thinking and key principles and techniques needed to carry out this cycle. These include languages for transforming, querying and analyzing data; algorithms for machine learning methods including regression, classification and clustering; principles behind creating informative data visualizations; statistical concepts of measurement error and prediction; and techniques for scalable data processing.
Principles & Techniques of Data Science: Read More [+]

Rules & Requirements
Prerequisites: Computer Science/Information/Statistics C8; and either Computer Science 61A, Computer Science 88 or Engineering 7. Corequisite: Mathematics 54 or Electrical Engineering 16A. Computer Science C8 Computer Science 61A Computer Science 88 Engineering 7 Mathematics 54 Electrical Engineering 16A

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week
Summer:
8 weeks - 6 hours of lecture, 2 hours of discussion, and 2 hours of laboratory per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: STAT C100
Principles & Techniques of Data Science: Read Less [-]
COMPSCI 146L Programmable Digital Systems Laboratory 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2015
Hardware description languages for digital system design and interactions with tool flows. Design, implementation, and verification of digital designs. Digital synthesis, partitioning, placement, routing, and simulation for Field-Programmable Gate Arrays. Large digital-system design concepts. Project design component – example, a full processor implementation with peripherals.
Programmable Digital Systems Laboratory: Read More [+]

Objectives Outcomes
Student Learning Outcomes: This course is a one-time offering to supplement the EE141 course offered in the Fall 2014, with a lab and project section that cover the design of larger digital systems on a programmable chip platform (FPGA). The EE141 lectures in the Fall 2014 already covered the necessary lecture material, so students who took the EE141 lab in the Fall of 2014 will have a chance to expand their skills into the area of FPGA Digital System Design. Hence the pre-requisite for this course is that a student has taken the EE141 course in the Fall 2014.

Rules & Requirements
Prerequisites: Computer Science 61C, Electrical Engineering 105 recommended and Electrical Engineering 141 (taken Fall 2014) - mandatory
Credit Restrictions: Students will receive no credit for Computer Science 146L after taking Fall 2014 version of Computer Science 150.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of laboratory and 1 hour of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.
Instructor: Stojanovic
Programmable Digital Systems Laboratory: Read Less [-]

COMPSCI 152 Computer Architecture and Engineering 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Fall 2016
Instruction set architecture, microcoding, pipelining (simple and complex). Memory hierarchies and virtual memory. Processor parallelism: VLIW, vectors, multithreading, Multiprocessors.
Computer Architecture and Engineering: Read More [+]

Rules & Requirements
Prerequisites: 61C

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructors: Asanovic, Culler, Kubiatowicz, Wawrzynek
Computer Architecture and Engineering: Read Less [-]

COMPSCI 160 User Interface Design and Development 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
The design, implementation, and evaluation of user interfaces. User-centered design and task analysis. Conceptual models and interface metaphors. Usability inspection and evaluation methods. Analysis of user study data. Input methods (keyboard, pointing, touch, tangible) and input models. Visual design principles. Interface prototyping and implementation methodologies and tools. Students will develop a user interface for a specific task and target user group in teams.
User Interface Design and Development: Read More [+]

Rules & Requirements
Prerequisites: Computer Science 61B or 61BL
Credit Restrictions: Students will receive no credit for Computer Science 160 after taking Computer Science 260A.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Agrawala, Canny, Hartmann, Paulos
User Interface Design and Development: Read Less [-]
COMPSCI 161 Computer Security 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
Introduction to computer security. Cryptography, including encryption, authentication, hash functions, cryptographic protocols, and applications. Operating system security, access control. Network security, firewalls, viruses, and worms. Software security, defensive programming, and language-based security. Case studies from real-world systems.
Computer Security: Read More [+]

Rules & Requirements

Prerequisites: 61C (Machine Structures), plus either 70 (Discrete Mathematics) or Mathematics 55

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Paxson, Song, Tygar, Wagner

COMPSCI 162 Operating Systems and System Programming 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
Operating Systems and System Programming: Read More [+]

Rules & Requirements

Prerequisites: Computer Science 61B, 61C, and 70

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Paxson, Song, Tygar, Wagner

COMPSCI 164 Programming Languages and Compilers 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Programming Languages and Compilers: Read More [+]

Rules & Requirements

Prerequisites: 61B and 61C

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Bodik, Hilfinger, Necula

COMPSCI 168 Introduction to the Internet: Architecture and Protocols 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2018, Fall 2017, Fall 2016
This course is an introduction to the Internet architecture. We will focus on the concepts and fundamental design principles that have contributed to the Internet's scalability and robustness and survey the various protocols and algorithms used within this architecture. Topics include layering, addressing, intradomain routing, interdomain routing, reliable delivery, congestion control, and the core protocols (e.g., TCP, UDP, IP, DNS, and HTTP) and network technologies (e.g., Ethernet, wireless).
Introduction to the Internet: Architecture and Protocols: Read More [+]

Rules & Requirements

Prerequisites: Computer Science 61B and 162

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Katz, Paxson, Ratnasamy, Shenker, Stoica
Introduction to the Internet: Architecture and Protocols: Read Less [-]
COMPSCI 169 Software Engineering 4 Units
Offered through: Electrical Engineering and Computer Sciences
Terms offered: Spring 2019, Fall 2017, Summer 2017 8 Week Session
Ideas and techniques for designing, developing, and modifying large software systems. Function-oriented and object-oriented modular design techniques, designing for re-use and maintainability. Specification and documentation. Verification and validation. Cost and quality metrics and estimation. Project team organization and management. Students will work in teams on a substantial programming project.
Software Engineering: Read More [+]

Rules & Requirements
Prerequisites: Computer Science 61B and 61C, and either Computer Science 70 or Mathematics 113

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Brewer, Fox, Necula, Sen

Software Engineering: Read Less [-]

COMPSCI 170 Efficient Algorithms and Intractable Problems 4 Units
Offered through: Electrical Engineering and Computer Sciences
Terms offered: Fall 2019, Spring 2019, Fall 2018
Concept and basic techniques in the design and analysis of algorithms; models of computation; lower bounds; algorithms for optimum search trees, balanced trees and UNION-FIND algorithms; numerical and algebraic algorithms; combinatorial algorithms. Turing machines, how to count steps, deterministic and nondeterministic Turing machines, NP-completeness. Unsolvable and intractable problems.
Efficient Algorithms and Intractable Problems: Read More [+]

Rules & Requirements
Prerequisites: Computer Science 61B and 70

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Papadimitriou, Seshia, Sinclair, Vazirani

Efficient Algorithms and Intractable Problems: Read Less [-]

COMPSCI 172 Computability and Complexity 4 Units
Offered through: Electrical Engineering and Computer Sciences
Terms offered: Spring 2019, Spring 2016, Fall 2015
Computability and Complexity: Read More [+]

Rules & Requirements
Prerequisites: 170

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

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Papadimitriou, Seshia, Sinclair, Vazirani

Computability and Complexity: Read Less [-]

COMPSCI 174 Combinatorics and Discrete Probability 4 Units
Offered through: Electrical Engineering and Computer Sciences
Terms offered: Fall 2019, Spring 2019, Spring 2018
Permutations, combinations, principle of inclusion and exclusion, generating functions, Ramsey theory. Expectation and variance, Chebychev's inequality, Chernov bounds. Birthday paradox, coupon collector's problem, Markov chains and entropy computations, universal hashing, random number generation, random graphs and probabilistic existence bounds.
Combinatorics and Discrete Probability: Read More [+]

Rules & Requirements
Prerequisites: 170

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

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Bartlett, Papadimitriou, Sinclair, Vazirani

Combinatorics and Discrete Probability: Read Less [-]
COMPSCI 176 Algorithms for Computational Biology 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2018, Fall 2017, Fall 2016
Algorithms and probabilistic models that arise in various computational biology applications: suffix trees, suffix arrays, pattern matching, repeat finding, sequence alignment, phylogenetics, genome rearrangements, hidden Markov models, gene finding, motif finding, stochastic context free grammars, RNA secondary structure. There are no biology prerequisites for this course, but a strong quantitative background will be essential.
Algorithms for Computational Biology: Read More [+]

Rules & Requirements
Prerequisites: Computer Science 70 and 170. Experience programming in a language such as C, C++, Java, or Python

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

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Song

Algorithms for Computational Biology: Read Less [-]

COMPSCI 182 Designing, Visualizing and Understanding Deep Neural Networks 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019
Deep Networks have revolutionized computer vision, language technology, robotics and control. They have growing impact in many other areas of science and engineering. They do not however, follow a closed or compact set of theoretical principles. In Yann Lecun's words they require “an interplay between intuitive insights, theoretical modeling, practical implementations, empirical studies, and scientific analyses.” This course attempts to cover that ground.
Designing, Visualizing and Understanding Deep Neural Networks: Read More [+]

Objectives Outcomes
Student Learning Outcomes: Students will come to understand visualizing deep networks. Exploring the training and use of deep networks with visualization tools. Students will learn design principles and best practices: design motifs that work well in particular domains, structure optimization and parameter optimization. Understanding deep networks. Methods with formal guarantees: generative and adversarial models, tensor factorization.

Rules & Requirements
Prerequisites: Math 53 and Math 54 or equivalent; CS70 or Stat 134; CS61B or equivalent; CS189 (recommended)

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

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructor: Canny

Designing, Visualizing and Understanding Deep Neural Networks: Read Less [-]
COMPSCI 184 Foundations of Computer Graphics 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Spring 2017
Rules & Requirements
Prerequisites: Computer Science 61B or 61BL; programming skills in C, C++, or Java; linear algebra and calculus
Credit Restrictions: Students will receive no credit for Comp Sci 184 after taking Comp Sci 284A.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: O'Brien, Sequin, Barsky, Ramamoorthi, Agrawala
Foundations of Computer Graphics: Read Less [-]

COMPSCI 186 Introduction to Database Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2018, Spring 2018, Fall 2017
Access methods and file systems to facilitate data access. Hierarchical, network, relational, and object-oriented data models. Query languages for models. Embedding query languages in programming languages. Database services including protection, integrity control, and alternative views of data. High-level interfaces including application generators, browsers, and report writers. Introduction to transaction processing. Database system implementation to be done as term project. Introduction to Database Systems: Read More [+]
Rules & Requirements
Prerequisites: 61B and 61C
Credit Restrictions: Students will receive no credit for Comp Sci 186 after taking Comp Sci 286A.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Franklin, Hellerstein
Introduction to Database Systems: Read Less [-]
COMPSCI W186 Introduction to Database Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019
Broad introduction to systems for storing, querying, updating and managing large databases. Computer science skills synthesizing viewpoints from low-level systems architecture to high-level modeling and declarative logic. System internals, including the complex details of query optimization and execution, concurrency control, indexing, and memory management. More abstract issues in query languages and data modeling – students are exposed to formal relational languages, SQL, full-text search, entity-relationship modeling, normalization, and physical database design. Recent technological trends in the field, including “Big Data” programming libraries like MapReduce, and distributed key-value stores with various consistency models.
Introduction to Database Systems: Read More [+]

Rules & Requirements
Prerequisites: Computer Science 61B and Computer Science 61C
Credit Restrictions: Students will receive no credit for Computer Science W186 after taking either Computer Science 186 or Computer Science 286A.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of web-based lecture and 2 hours of discussion per week

Online: This is an online course.

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Hellerstein
Introduction to Database Systems: Read Less [-]

COMPSCI 188 Introduction to Artificial Intelligence 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
Ideas and techniques underlying the design of intelligent computer systems. Topics include search, game playing, knowledge representation, inference, planning, reasoning under uncertainty, machine learning, robotics, perception, and language understanding.
Introduction to Artificial Intelligence: Read More [+]

Rules & Requirements
Prerequisites: Computer Science 61A; Computer Science 61B; Computer Science 70

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details
Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Abbeel, Klein, Russell
Introduction to Artificial Intelligence: Read Less [-]
COMPSCI 189 Introduction to Machine Learning 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Summer 2019 8 Week Session, Spring 2019
Theoretical foundations, algorithms, methodologies, and applications for machine learning. Topics may include supervised methods for regression and classification (linear models, trees, neural networks, ensemble methods, instance-based methods); generative and discriminative probabilistic models; Bayesian parametric learning; density estimation and clustering; Bayesian networks; time series models; dimensionality reduction; programming projects covering a variety of real-world applications.
Introduction to Machine Learning: Read More [+]

Rules & Requirements

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

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

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Abbeel, Bartlett, Darrell, El Ghaoui, Jordan, Klein, Malik, Russell

Introduction to Machine Learning: Read Less [-]

COMPSCI C191 Quantum Information Science and Technology 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2017, Fall 2014
This multidisciplinary course provides an introduction to fundamental conceptual aspects of quantum mechanics from a computational and informational theoretic perspective, as well as physical implementations and technological applications of quantum information science. Basic sections of quantum algorithms, complexity, and cryptography, will be touched upon, as well as pertinent physical realizations from nanoscale science and engineering.
Quantum Information Science and Technology: Read More [+]

Hours & Format

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

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Crommie, Vazirani, Whaley
Also listed as: CHEM C191/PHYSICS C191

Quantum Information Science and Technology: Read Less [-]

COMPSCI 194 Special Topics 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Topics will vary semester to semester. See the Computer Science Division announcements.

Special Topics: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

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

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of lecture per week
Summer: 8 weeks - 2-8 hours of lecture per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

Special Topics: Read Less [-]
COMPSCI 195 Social Implications of Computer Technology 1 Unit
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Topics include electronic community; the changing nature of work; technological risks; the information economy; intellectual property; privacy; artificial intelligence and the sense of self; pornography and censorship; professional ethics. Students will lead discussions on additional topics.
Social Implications of Computer Technology: Read More [+]
Rules & Requirements
Credit Restrictions: Students will receive no credit for 195 after taking C195/Interdisciplinary Field Study C155 or H195.

Hours & Format
Fall and/or spring: 15 weeks - 1.5 hours of lecture per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Instructor: Harvey

Social Implications of Computer Technology: Read Less [-]

COMPSCI H195 Honors Social Implications of Computer Technology 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2014, Fall 2013, Spring 2013
Topics include electronic community; the changing nature of work; technological risks; the information economy; intellectual property; privacy; artificial intelligence and the sense of self; pornography and censorship; professional ethics. Students may lead discussions on additional topics.
Honors Social Implications of Computer Technology: Read More [+]
Rules & Requirements
Credit Restrictions: Student will receive no credit for H195 after taking 195 or C195.

Hours & Format
Fall and/or spring: 15 weeks - 1.5 hours of lecture and 1.5 hours of discussion per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Instructor: Harvey

Honors Social Implications of Computer Technology: Read Less [-]

COMPSCI H196A Senior Honors Thesis Research 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2016, Fall 2010, Spring 2010
Thesis work under the supervision of a faculty member. To obtain credit the student must, at the end of two semesters, submit a satisfactory thesis to the Electrical Engineering and Computer Science department archive. A total of four units must be taken. The units may be distributed between one or two semesters in any way. H196A-H196B count as graded technical elective units, but may not be used to satisfy the requirement for 27 upper division technical units in the College of Letters and Science with a major in Computer Science.
Senior Honors Thesis Research: Read More [+]
Rules & Requirements
Prerequisites: Open only to students in the computer science honors program

Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate

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

Senior Honors Thesis Research: Read Less [-]

COMPSCI H196B Senior Honors Thesis Research 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2010, Spring 2009, Fall 2008
Thesis work under the supervision of a faculty member. To obtain credit the student must, at the end of two semesters, submit a satisfactory thesis to the Electrical Engineering and Computer Science department archive. A total of four units must be taken. The units may be distributed between one or two semesters in any way. H196A-H196B count as graded technical elective units, but may not be used to satisfy the requirement for 27 upper division technical units in the College of Letters and Science with a major in Computer Science.
Senior Honors Thesis Research: Read More [+]
Rules & Requirements
Prerequisites: Open only to students in the computer science honors program

Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Computer Science/Undergraduate

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

Senior Honors Thesis Research: Read Less [-]
COMPSCI 197 Field Study 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Students take part in organized individual field sponsored programs with off-campus companies or tutoring/mentoring relevant to specific aspects and applications of computer science on or off campus. Note Summer CPT or OPT students: written report required. Course does not count toward major requirements, but will be counted in the cumulative units toward graduation.
Field Study: Read More [+]
**Rules & Requirements**
**Prerequisites:** Consent of instructor (see department adviser)
**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**
Fall and/or spring: 15 weeks - 1-4 hours of fieldwork per week
Summer: 6 weeks - 2.5-10 hours of fieldwork per week
8 weeks - 2-7.5 hours of fieldwork per week

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Field Study: Read Less [-]

COMPSCI 198 Directed Group Studies for Advanced Undergraduates 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Group study of selected topics in Computer Sciences, usually relating to new developments.
Directed Group Studies for Advanced Undergraduates: Read More [+]
**Rules & Requirements**
**Prerequisites:** 2.0 GPA or better; 60 units completed
**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**
Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

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

COMPSCI 199 Supervised Independent Study 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Fall 2016
Supervised independent study. Enrollment restrictions apply.
Supervised Independent Study: Read More [+]
**Rules & Requirements**
**Prerequisites:** Consent of instructor and major adviser

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.
**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**
Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer: 6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

**Additional Details**

**Subject/Course Level:** Computer Science/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study: Read Less [-]

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

EL ENG 24 Freshman Seminar 1 Unit
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2017, Spring 2017, Spring 2016
The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman seminars are offered in all campus departments, and topics may vary from department to department and semester to semester.
Freshman Seminar: Read More [+]
**Rules & Requirements**
**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**
Fall and/or spring: 15 weeks - 1 hour of seminar per week

**Additional Details**

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

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman Seminar: Read Less [-]
EL ENG 25 What Electrical Engineers Do--Feedback from Recent Graduates 1 Unit
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2011
A Berkeley Electrical Engineering and Computer Sciences degree opens
the door to many opportunities, but what exactly are they? Graduation
is only a few years away and it's not too early to find out. In this seminar
students will hear from practicing engineers who recently graduated.
What are they working on? Are they working in a team? What do they
wish they had learned better? How did they find their jobs?
What Electrical Engineers Do--Feedback from Recent Graduates: Read
More [+]

Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final
exam not required.
Instructor: Boser
What Electrical Engineers Do--Feedback from Recent Graduates: Read
Less [-]

EL ENG 39 Freshman/Sophomore Seminar 2 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Fall 2017
Freshman and sophomore seminars offer lower division students the
opportunity to explore an intellectual topic with a faculty member and a
group of peers in a small-seminar setting. These seminars are offered in
all campus departments; topics vary from department to department and
from semester to semester. Enrollment limits are set by the faculty, but
the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]

Rules & Requirements
Prerequisites: Priority given to freshmen and sophomores
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of
discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per
week

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Introduction to Digital Electronics: Read More [+]

EL ENG 42 Introduction to Digital Electronics 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2013, Summer 2013 8 Week Session, Spring 2013
This course serves as an introduction to the principles of electrical
engineering, starting from the basic concepts of voltage and current and
circuit elements of resistors, capacitors, and inductors. Circuit analysis
is taught using Kirchhoff's voltage and current laws with Thevenin and
Norton equivalents. Operational amplifiers with feedback are introduced
as basic building blocks for amplification and filtering. Semiconductor
devices including diodes and MOSFETS and their IV characteristics
are covered. Applications of diodes for rectification, and design of
MOSFETS in common source amplifiers are taught. Digital logic gates
and design using CMOS as well as simple flip-flops are introduced.
Speed and scaling issues for CMOS are considered. The course includes
as motivating examples designs of high level applications including logic
circuits, amplifiers, power supplies, and communication links.
Introduction to Digital Electronics: Read More [+]

Rules & Requirements
Prerequisites: Mathematics 1B
Credit Restrictions: Students will receive no credit for 42 after taking 40
or 100.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of
discussion per week
Summer: 8 weeks - 6 hours of lecture and 2 hours of discussion per
week

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: The grading option will be decided by the
instructor when the class is offered. Final exam required.
Introduction to Digital Electronics: Read Less [-]
EL ENG 43 Introductory Electronics Laboratory 1 Unit
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2013, Summer 2013 8 Week Session, Spring 2013
Using and understanding electronics laboratory equipment such as oscilloscope, power supplies, function generator, multimeter, curve-tracer, and RLC-meter. Includes a term project of constructing and testing a robot or other appropriate electromechanical device.
Introductory Electronics Laboratory: Read More [+]

Rules & Requirements
Prerequisites: 42 (may be taken concurrently) or equivalent or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of laboratory per week
Summer: 8 weeks - 3.5 hours of laboratory per week

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Introductory Electronics Laboratory: Read Less [-]

EL ENG 49 Electronics for the Internet of Things 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Fall 2018, Spring 2018
Electronics has become pervasive in our lives as a powerful technology with applications in a wide range of fields including healthcare, environmental monitoring, robotics, or entertainment. This course teaches how to build electronic circuits that interact with the environment through sensors and actuators and how to communicate wirelessly with the internet to cooperate with other devices and with humans. In the laboratory students design and build representative samples such as solar harvesters, robots, that exchange information with or are controlled from the cloud.
Electronics for the Internet of Things: Read More [+]

Objectives Outcomes

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

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

Rules & Requirements
Prerequisites: Engineering 7 or Computer Science 10 or equivalent background in computer programming (including Computer Science 61A, Data Science 8) Math 1a or equivalent background in Calculus

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 2 hours of discussion, and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Boser

Electronics for the Internet of Things: Read Less [-]
EL ENG 84 Sophomore Seminar 1 or 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2018, Fall 2017, Spring 2016
Sophomore seminars are small interactive courses offered by faculty
members in departments all across the campus. Sophomore seminars
offer opportunity for close, regular intellectual contact between faculty
members and students in the crucial second year. The topics vary from
department to department and semester to semester. Enrollment limited
to 15 sophomores.
Sophomore Seminar: Read More [+]

Rules & Requirements

Prerequisites: At discretion of instructor
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format

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

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

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: The grading option will be decided by the
instructor when the class is offered. Final exam required.

Sophomore Seminar: Read Less [-]

EL ENG 97 Field Study 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Fall 2015, Spring 2015
Students take part in organized individual field sponsored programs with
off-campus companies or tutoring/mentoring relevant to specific aspects
and applications of computer science on or off campus. Note Summer
CPT or OPT students: written report required. Course does not count
toward major requirements, but will be counted in the cumulative units
toward graduation.
Field Study: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor (see department adviser)
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of fieldwork per week
Summer:
6 weeks - 2.5-10 hours of fieldwork per week
8 weeks - 2-7.5 hours of fieldwork per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final
exam not required.
Field Study: Read Less [-]

EL ENG 98 Directed Group Study for
Undergraduates 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2016, Spring 2016, Fall 2015
Group study of selected topics in electrical engineering, usually relating to
new developments.
Directed Group Study for Undergraduates: Read More [+]

Rules & Requirements

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

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per
week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final
exam not required.
Directed Group Study for Undergraduates: Read Less [-]
EL ENG 99 Individual Study and Research for Undergraduates 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Fall 2015, Spring 2015
Supervised independent study and research for students with fewer than 60 units completed.
Individual Study and Research for Undergraduates: Read More [+]
Rules & Requirements
Prerequisites: Freshman or sophomore standing and consent of instructor. Minimum GPA of 3.4 required
Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of independent study per week
Summer: 6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

EL ENG C106A Introduction to Robotics 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2017, Fall 2016, Fall 2015
An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course covers forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and control. It presents elementary principles on proximity, tactile, and force sensing, vision sensors, camera calibration, stereo construction, and motion detection. The course concludes with current applications of robotics in active perception, medical robotics, and other areas.
Introduction to Robotics: Read More [+]
Rules & Requirements
Prerequisites: EE 120 or equivalent, consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Bajcsy
Formerly known as: Electrical Engineering C125/Bioengineering C125
Also listed as: BIO ENG C125

EL ENG 105 Microelectronic Devices and Circuits 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
This course covers the fundamental circuit and device concepts needed to understand analog integrated circuits. After an overview of the basic properties of semiconductors, the p-n junction and MOS capacitors are described and the MOSFET is modeled as a large-signal device. Two port small-signal amplifiers and their realization using single stage and multistage CMOS building blocks are discussed. Sinusoidal steady-state signals are introduced and the techniques of phasor analysis are developed, including impedance and the magnitude and phase response of linear circuits. The frequency responses of single and multi-stage amplifiers are analyzed. Differential amplifiers are introduced.
Microelectronic Devices and Circuits: Read More [+]
Rules & Requirements
Prerequisites: EE 16A & B
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Microelectronic Devices and Circuits: Read Less [-]
EL ENG C106B Robotic Manipulation and Interaction 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2017, Spring 2016
This course is a sequel to Electrical Engineering C106A/Bioengineering C125, which covers kinematics, dynamics and control of a single robot. This course will cover dynamics and control of groups of robotic manipulators coordinating with each other and interacting with the environment. Concepts will include an introduction to grasping and the constrained manipulation, contacts and force control for interaction with the environment. We will also cover active perception guided manipulation, as well as the manipulation of non-rigid objects. Throughout, we will emphasize design and human-robot interactions, and applications to applications in manufacturing, service robotics, tele-surgery, and locomotion.
Robotic Manipulation and Interaction: Read More [+]
Rules & Requirements
Prerequisites: Electrical Engineering C106A/Bioengineering C125 or consent of the instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 3 hours of laboratory per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructors: Bajcsy, Sastry
Also listed as: BIO ENG C125B
Robotic Manipulation and Interaction: Read Less [-]

EL ENG 113 Power Electronics 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Spring 2018
Power conversion circuits and techniques. Characterization and design of magnetic devices including transformers, reactors, and electromagnetic machinery. Characteristics of bipolar and MOS power semiconductor devices. Applications to motor control, switching power supplies, lighting, power systems, and other areas as appropriate.
Power Electronics: Read More [+]
Rules & Requirements
Prerequisites: 105 or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Power Electronics: Read Less [-]

EL ENG 117 Electromagnetic Fields and Waves 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Spring 2017
Review of static electric and magnetic fields and applications; Maxwell's equations; transmission lines; propagation and reflection of plane waves; introduction to guided waves, microwave networks, and radiation and antennas. Minilabs on statics, transmission lines, and waves. Explanation of cellphone antennas, WiFi communication, and other wireless technologies.
Electromagnetic Fields and Waves: Read More [+]
Rules & Requirements
Prerequisites: Electrical Engineering 16B, Mathematics 53, 54, Physics 7B, or equivalent that covers AC circuits and electromagnetics up to Maxwell's equations
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Yablonovitch
Electromagnetic Fields and Waves: Read Less [-]

EL ENG 118 Introduction to Optical Engineering 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Fall 2017, Fall 2016
Introduction to Optical Engineering: Read More [+]
Rules & Requirements
Prerequisites: Math 53, and EE 16AB or Math 54
Credit Restrictions: Students will receive no credit for Electrical Engineering 118 after taking Electrical Engineering 218A. A deficient grade in Electrical Engineering 119 may be removed by taking Electrical Engineering 118.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Waller
Introduction to Optical Engineering: Read Less [-]
EL ENG 120 Signals and Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Signals and Systems: Read More [+]
Rules & Requirements
Prerequisites: EE 16A and 16B
Hours & Format
Fall and/or spring: 15 weeks - 4 hours of lecture and 1 hour of recitation per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Signals and Systems: Read Less [-]

EL ENG 121 Introduction to Digital Communication Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Fall 2014, Fall 2013
Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization. Applications to design of digital telephone modems, compact disks, and digital wireless communication systems. Concepts illustrated by a sequence of MATLAB exercises.
Introduction to Digital Communication Systems: Read More [+]
Rules & Requirements
Prerequisites: EE 16A & B; CS 70
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Introduction to Digital Communication Systems: Read Less [-]

EL ENG 122 Introduction to Communication Networks 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Spring 2017
This course focuses on the fundamentals of the wired and wireless communication networks. The course covers both the architectural principles for making these networks scalable and robust, as well as the key techniques essential for analyzing and designing them. The topics include graph theory, Markov chains, queuing, optimization techniques, the physical and link layers, switching, transport, cellular networks and Wi-Fi.
Introduction to Communication Networks: Read More [+]
Rules & Requirements
Prerequisites: Computer Science 70. Computer Science 70
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Introduction to Communication Networks: Read Less [-]

EL ENG 123 Digital Signal Processing 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Spring 2017
Digital Signal Processing: Read More [+]
Rules & Requirements
Prerequisites: 120
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 1 hour of laboratory per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Digital Signal Processing: Read Less [-]
EL ENG 126 Probability and Random Processes 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2017, Fall 2016, Spring 2016
Rules & Requirements
Prerequisites: EE 16A and 16B

EL ENG 129 Neural and Nonlinear Information Processing 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2010, Fall 2009, Spring 2009
Principles of massively parallel real-time computation, optimization, and information processing via nonlinear dynamics and analog VLSI neural networks. Applications selected from image processing, pattern recognition, feature extraction, motion detection, data compression, secure communication, bionic eye, auto waves, and Turing patterns. Neural and Nonlinear Information Processing: Read More [+]
Rules & Requirements
Prerequisites: 120 or consent of instructor

EL ENG C128 Feedback Control Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Analysis and synthesis of linear feedback control systems in transform and time domains. Control system design by root locus, frequency response, and state space methods. Applications to electro-mechanical and mechatronics systems. Feedback Control Systems: Read More [+]
Rules & Requirements
Prerequisites: EE 16A and either ME 132 or EE 120

EL ENG 130 Integrated-Circuit Devices 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Overview of electronic properties of semiconductor. Metal-semiconductor contacts, pn junctions, bipolar transistors, and MOS field-effect transistors. Properties that are significant to device operation for integrated circuits. Silicon device fabrication technology. Integrated-Circuit Devices: Read More [+]
Rules & Requirements
Prerequisites: EE 16A and 16B
Credit Restrictions: Students will receive no credit for El Eng 130 after taking El Eng 230A.
EL ENG 134 Fundamentals of Photovoltaic Devices 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Spring 2017
This course is designed to give an introduction to, and overview of, the fundamentals of photovoltaic devices. Students will learn how solar cells work, understand the concepts and models of solar cell device physics, and formulate and solve relevant physical problems related to photovoltaic devices. Monocrystalline, thin film and third generation solar cells will be discussed and analyzed. Light management and economic considerations in a solar cell system will also be covered.
Fundamentals of Photovoltaic Devices: Read More [+]

Rules & Requirements
Prerequisites: EE 16A and 16B

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Arias

Fundamentals of Photovoltaic Devices: Read Less [-]

EL ENG 137A Introduction to Electric Power Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Fall 2017
Overview of conventional electric power conversion and delivery, emphasizing a systemic understanding of the electric grid with primary focus at the transmission level, aimed toward recognizing needs and opportunities for technological innovation. Topics include aspects of a.c. system design, electric generators, components of transmission and distribution systems, power flow analysis, system planning and operation, performance measures, and limitations of legacy technologies.
Introduction to Electric Power Systems: Read More [+]

Rules & Requirements
Prerequisites: 16A & 16B or consent of instructor; Physics 7B

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: von Meier

Introduction to Electric Power Systems: Read Less [-]

EL ENG 137B Introduction to Electric Power Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Spring 2018, Spring 2017
Overview of recent and potential future evolution of electric power systems with focus on new and emerging technologies for power conversion and delivery, primarily at the distribution level. Topics include power electronics applications, solar and wind generation, distribution system design and operation, electric energy storage, information management and communications, demand response, and microgrids.
Introduction to Electric Power Systems: Read More [+]

Rules & Requirements
Prerequisites: Electrical Engineering 137A or consent of instructor

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: von Meier

Introduction to Electric Power Systems: Read Less [-]

EL ENG 140 Linear Integrated Circuits 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Spring 2018
Single and multiple stage transistor amplifiers. Operational amplifiers. Feedback amplifiers, 2-port formulation, source, load, and feedback network loading. Frequency response of cascaded amplifiers, gain-bandwidth exchange, compensation, dominant pole techniques, root locus. Supply and temperature independent biasing and references. Selected applications of analog circuits such as analog-to-digital converters, switched capacitor filters, and comparators. Hardware laboratory and design project.
Linear Integrated Circuits: Read More [+]

Rules & Requirements
Prerequisites: Electrical Engineering 105
Credit Restrictions: Students will receive no credit for El Eng 140 after taking El Eng 240A.

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Alon, Sanders

Linear Integrated Circuits: Read Less [-]
EL ENG 142 Integrated Circuits for Communications 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Fall 2017
Analysis and design of electronic circuits for communication systems, with an emphasis on integrated circuits for wireless communication systems. Analysis of noise and distortion in amplifiers with application to radio receiver design. Power amplifier design with application to wireless radio transmitters. Radio-frequency mixers, oscillators, phase-locked loops, modulators, and demodulators.
Integrated Circuits for Communications: Read More [+]
Rules & Requirements
Prerequisites: EE 16A & B; EE 105
Credit Restrictions: Students will receive no credit for El Eng 142 after taking El Eng 242A.

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

EL ENG 143 Microfabrication Technology 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Spring 2019, Fall 2018
Integrated circuit device fabrication and surface micromachining technology. Thermal oxidation, ion implantation, impurity diffusion, film deposition, exsition, lithography, etching, contacts and interconnections, and process integration issues. Device design and mask layout, relation between physical structure and electrical/mechanical performance. MOS transistors and poly-Si surface microstructures will be fabricated in the laboratory and evaluated.
Microfabrication Technology: Read More [+]
Rules & Requirements
Prerequisites: Physics 7B or equivalent

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

EL ENG 144 Fundamental Algorithms for Systems Modeling, Analysis, and Optimization 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2015, Fall 2014, Fall 2013
The modeling, analysis, and optimization of complex systems requires a range of algorithms and design software. This course reviews the fundamental techniques underlying the design methodology for complex systems, using integrated circuit design as example. Topics include design flows, discrete and continuous models and algorithms, and strategies for implementing algorithms efficiently and correctly in software. Laboratory assignments and a class project will expose students to state-of-the-art tools.
Fundamental Algorithms for Systems Modeling, Analysis, and Optimization: Read More [+]
Rules & Requirements
Prerequisites: EE 16A; Computer Science 70 or consent of instructor

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Keutzer, Lee, Roychowdhury, Seshia

Fundamental Algorithms for Systems Modeling, Analysis, and Optimization: Read Less [-]
EL ENG C145B Medical Imaging Signals and Systems 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2019, Fall 2018, Fall 2017
Biomedical imaging is a clinically important application of engineering, applied mathematics, physics, and medicine. In this course, we apply linear systems theory and basic physics to analyze X-ray imaging, computerized tomography, nuclear medicine, and MRI. We cover the basic physics and instrumentation that characterizes medical image as an ideal perfect-resolution image blurred by an impulse response. This material could prepare the student for a career in designing new medical imaging systems that reliably detect small tumors or infarcts.
Medical Imaging Signals and Systems: Read More [+]

Rules & Requirements
Prerequisites: Electrical Engineering 16A and 16B

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Conolly
Also listed as: BIO ENG C165

Medical Imaging Signals and Systems: Read Less [-]

EL ENG C145L Introductory Electronic Transducers Laboratory 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2013, Spring 2012, Spring 2011
Laboratory exercises exploring a variety of electronic transducers for measuring physical quantities such as temperature, force, displacement, sound, light, ionic potential; the use of circuits for low-level differential amplification and analog signal processing; and the use of microcomputers for digital sampling and display. Lectures cover principles explored in the laboratory exercises; construction, response and signal to noise of electronic transducers and actuators; and design of circuits for sensing and controlling physical quantities.
Introductory Electronic Transducers Laboratory: Read More [+]

Rules & Requirements
Prerequisites: EE 16A & 16B

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Derenzo
Also listed as: BIO ENG C145L

Introductory Electronic Transducers Laboratory: Read Less [-]

EL ENG C145M Introductory Microcomputer Interfacing Laboratory 3 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2013, Spring 2012, Spring 2011
Laboratory exercises constructing basic interfacing circuits and writing 20-100 line C programs for data acquisition, storage, analysis, display, and control. Use of the IBM PC with microprogrammable digital counter/timer, parallel I/O port. Circuit components include anti-aliasing filters, the S/H amplifier, A/D and D/A converters. Exercises include effects of aliasing in periodic sampling, fast Fourier transforms of basic waveforms, the use of the Hanning filter for leakage reduction, Fourier analysis of the human voice, digital filters, and control using Fourier deconvolution. Lectures cover principles explored in the lab exercises and design of microcomputer-based systems for data acquisitions, analysis and control.
Introductory Microcomputer Interfacing Laboratory: Read More [+]

Rules & Requirements
Prerequisites: EE 16A & 16B

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

Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Derenzo
Also listed as: BIO ENG C145M

Introductory Microcomputer Interfacing Laboratory: Read Less [-]
EL ENG C145O Laboratory in the Mechanics of Organisms 3 Units
Offered through: Electrical Engin and Computer Sci
Introduction to laboratory and field study of the biomechanics of animals and plants using fundamental biomechanical techniques and equipment. Course has a series of rotations involving students in experiments demonstrating how solid and fluid mechanics can be used to discover the way in which diverse organisms move and interact with their physical environment. The laboratories emphasize sampling methodology, experimental design, and statistical interpretation of results. Latter third of course devoted to independent research projects. Written reports and class presentation of project results are required.
Laboratory in the Mechanics of Organisms: Read More [+]
Rules & Requirements
Prerequisites: Integrative Biology 135 or consent of instructor; for Electrical Engineering and Computer Science students, Electrical Engineering 105, 120 or Computer Science 184
Credit Restrictions: Students will receive no credit for C135L after taking 135L.
Hours & Format
Fall and/or spring: 15 weeks - 6 hours of laboratory, 1 hour of discussion, and 1 hour of fieldwork per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Formerly known as: Integrative Biology 135L
Also listed as: BIO ENG C136L/INTEGBI C135L
Laboratory in the Mechanics of Organisms: Read Less [-]

EL ENG 146L Application Specific Integrated Circuits Laboratory 2 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2015
This is a lab course that covers the design of modern Application-Specific Integrated Circuits (ASICs). The labs lay the foundation of modern digital design by first setting-up the scripting and hardware description language base for specification of digital systems and interactions with tool flows. Software testing of digital designs is covered leading into a set of labs that cover the design flow. Digital synthesis, floorplanning, placement and routing are covered, as well as tools to evaluate design timing and power. Chip-level assembly is covered, instantiation of custom IP blocks: I/O pads, memories, PLLs, etc. The labs culminate with a project design – implementation of a 3-stage RISC-V processor with register file and caches.
Application Specific Integrated Circuits Laboratory: Read More [+]
Objectives Outcomes
Course Objectives: This course is a one-time offering to supplement the CS150 course offered in the Fall 2014, with a lab and project section that cover the Application-Specific Integrated Circuit Design. The CS150 lectures in the Fall 2014 already covered the necessary lecture material, so students who took the CS150 lab in the Fall of 2014 will have a chance to expand their skills into the area of Application-Specific Integrated Circuit design. Hence the pre-requisite for this course is that a student has taken the CS150 course in the Fall 2014.
Rules & Requirements
Prerequisites: Electrical Engineering 40; Electrical Engineering 105 recommended and Computer Science 150 (taken Fall 2014) - mandatory
Credit Restrictions: Students will receive no credit for Electrical Engineering 146L after taking Fall 2014 version of Electrical Engineering 141/241A.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of laboratory and 1 hour of discussion per week
Additional Details
Subject/Course Level: Electrical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.
Instructor: Stojanovic
Application Specific Integrated Circuits Laboratory: Read Less [-]
EL ENG 147 Introduction to Microelectromechanical Systems (MEMS) 3 Units  
Offered through: Electrical Engineering and Computer Science  
Terms offered: Fall 2019, Fall 2018, Fall 2017  
This course will teach fundamentals of micromachining and microfabrication techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are central to MEMS fabrication. It will pay special attention to teaching of fundamentals necessary for the design and analysis of devices and systems in mechanical, electrical, fluidic, and thermal energy/signal domains, and will teach basic techniques for multi-domain analysis. Fundamentals of sensing and transduction mechanisms including capacitive and piezoresistive techniques, and design and analysis of micromachined miniature sensors and actuators using these techniques will be covered.  
Introduction to Microelectromechanical Systems (MEMS): Read More [+]  
Rules & Requirements  
Prerequisites: Electrical Engineering 16A and 16B  
Credit Restrictions: Students will receive no credit for El Eng 147 after taking El Eng 247A.  
Hours & Format  
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week  
Additional Details  
Subject/Course Level: Electrical Engineering/Undergraduate  
Grading/Final exam status: Letter grade. Final exam required.  
Instructors: Maharbiz, Nguyen, Pister  
Introduction to Microelectromechanical Systems (MEMS): Read Less [-]

EL ENG 192 Mechatronic Design Laboratory 4 Units  
Offered through: Electrical Engineering and Computer Science  
Terms offered: Spring 2019, Spring 2018, Spring 2017  
Design project course, focusing on application of theoretical principles in electrical engineering to control of a small-scale system, such as a mobile robot. Small teams of students will design and construct a mechatronic system incorporating sensors, actuators, and intelligence.  
Mechatronic Design Laboratory: Read More [+]  
Rules & Requirements  
Prerequisites: EE120, EE16A+EE16B, CS61ABC  
Hours & Format  
Fall and/or spring: 15 weeks - 1.5 hours of lecture and 10 hours of laboratory per week  
Additional Details  
Subject/Course Level: Electrical Engineering/Undergraduate  
Grading/Final exam status: Letter grade. Final exam required.  
Instructor: Fearing  
Mechatronic Design Laboratory: Read Less [-]

EL ENG 194 Special Topics 1 - 4 Units  
Offered through: Electrical Engineering and Computer Science  
Terms offered: Fall 2019, Fall 2018, Spring 2018  
Topics will vary semester to semester. See the Electrical Engineering announcements.  
Special Topics: Read More [+]  
Rules & Requirements  
Prerequisites: Consent of instructor  
Repeat rules: Course may be repeated for credit when topic changes.  
Hours & Format  
Fall and/or spring: 15 weeks - 1-4 hours of lecture per week  
Additional Details  
Subject/Course Level: Electrical Engineering/Undergraduate  
Grading/Final exam status: Letter grade. Final exam required.  
Special Topics: Read Less [-]
EL ENG H196A Senior Honors Thesis Research 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Fall 2015, Spring 2015
Thesis work under the supervision of a faculty member. A minimum of four units must be taken; the units may be distributed between one and two semesters in any way. To obtain credit a satisfactory thesis must be submitted at the end of the two semesters to the Electrical and Engineering Computer Science Department archive. Students who complete four units and a thesis in one semester receive a letter grade at the end of H196A. Students who do not, receive an IP in H196A and must enroll in H196B.
Senior Honors Thesis Research: Read More [+]
Rules & Requirements
Prerequisites: Open only to students in the Electrical Engineering and Computer Science honors program

EL ENG H196B Senior Honors Thesis Research 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2016, Spring 2015, Spring 2014
Thesis work under the supervision of a faculty member. A minimum of four units must be taken; the units may be distributed between one and two semesters in any way. To obtain credit a satisfactory thesis must be submitted at the end of the two semesters to the Electrical and Engineering Computer Science Department archive. Students who complete four units and a thesis in one semester receive a letter grade at the end of H196A. Students who do not, receive an IP in H196A and must enroll in H196B.
Senior Honors Thesis Research: Read Less [-]

EL ENG 197 Field Study 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2018, Spring 2016, Fall 2015
Students take part in organized individual field sponsored programs with off-campus companies or tutoring/mentoring relevant to specific aspects and applications of computer science on or off campus. Note Summer CPT or OPT students: written report required. Course does not count toward major requirements, but will be counted in the cumulative units toward graduation.
Field Study: Read More [+]
Rules & Requirements
Prerequisites: Consent of instructor (see department adviser)
Repeat rules: Course may be repeated for credit without restriction.

EL ENG 198 Directed Group Study for Advanced Undergraduates 1 - 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Spring 2019, Fall 2018, Spring 2018
Group study of selected topics in electrical engineering, usually relating to new developments.
Directed Group Study for Advanced Undergraduates: Read More [+]
Rules & Requirements
Prerequisites: 2.0 GPA or better; 60 units completed
Repeat rules: Course may be repeated for credit without restriction.

Senior Honors Thesis Research: Read Less [-]
EL ENG 199 Supervised Independent Study 1
- 4 Units
Offered through: Electrical Engin and Computer Sci
Terms offered: Fall 2018, Spring 2018, Fall 2017
Supervised independent study. Enrollment restrictions apply.
Supervised Independent Study: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor and major adviser

Credit Restrictions: Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

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

Hours & Format

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

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Electrical Engineering/Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.