### 2016-2017 Academic Calendar

Note: Dates subject to change without notice.

<table>
<thead>
<tr>
<th>Event</th>
<th>Fall 2016</th>
<th>Winter 2017</th>
<th>Spring 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter begins</td>
<td>September 17, 2016</td>
<td>January 9, 2017</td>
<td>April 3, 2017</td>
</tr>
<tr>
<td>New Student Convocation</td>
<td>September 19, 2016</td>
<td>January 9, 2017</td>
<td>April 3, 2017</td>
</tr>
<tr>
<td>Pre-instruction Activities</td>
<td>September 19-21, 2016</td>
<td>January 9, 2017</td>
<td>April 3, 2017</td>
</tr>
<tr>
<td>First day of instruction</td>
<td>September 22, 2016</td>
<td>January 9, 2017</td>
<td>April 3, 2017</td>
</tr>
<tr>
<td>Last day of instruction</td>
<td>December 2, 2016</td>
<td>March 17, 2017</td>
<td>June 9, 2017</td>
</tr>
<tr>
<td>Final examinations</td>
<td>December 3-9, 2016</td>
<td>March 18-24, 2017</td>
<td>June 10-16, 2017</td>
</tr>
<tr>
<td>Quarter ends</td>
<td>December 9, 2016</td>
<td>March 24, 2017</td>
<td>June 16, 2017</td>
</tr>
<tr>
<td>Commencement</td>
<td></td>
<td></td>
<td>June 17-18, 2017</td>
</tr>
</tbody>
</table>

### 2016 - 2017 Campus Holidays

- **Labor Day**: Monday, September 5, 2016
- **Veterans’ Day**: Friday, November 11, 2016
- **Thanksgiving**: Thursday & Friday, November 24 & 25, 2016
- **Christmas**: Monday & Tuesday, December 26 & 27, 2016
- **New Year**: Friday & Monday, December 30, 2016 & January 2, 2017
- **Martin Luther King, Jr. Day**: Monday, January 16, 2017
- **Presidents’ Day**: Monday, February 20, 2017
- **Cesar Chavez Holiday**: Friday, March 31, 2017
- **Memorial Day**: Monday, May 29, 2017
- **Independence Day**: Tuesday, July 4, 2017

### EQUAL OPPORTUNITY AND NONDISCRIMINATION

The University of California, in accordance with applicable Federal and State law and University policy, does not discriminate on the basis of race, color, national origin, religion, sex, gender identity, pregnancy\(^1\), disability, age, medical condition (cancer related), ancestry, marital status, citizenship, sexual orientation, or status as a Vietnam-era veteran or special disabled veteran. The University also prohibits sexual harassment. This nondiscrimination policy covers admission, access, and treatment in University programs and activities.

Inquiries regarding the University’s student-related nondiscrimination policies may be directed to the Director of Equal Opportunity at (805) 893-3089.

\(^1\) Pregnancy includes pregnancy, childbirth, and medical conditions related to pregnancy or childbirth.

Produced by the College of Engineering, Student Advising Division

Glenn Beltz, Associate Dean for Undergraduate Studies

Peter Allen, Publications Director

Ian Barin, Multimedia Designer & Photography

This publication is available at:

www.engineering.ucsb.edu/current_undergraduates/publications

The information in this publication supersedes that in the UCSB General Catalog. All announcements herein are subject to revision without notice.
Welcome to the College of Engineering at UC Santa Barbara. There are many reasons we are one of the top engineering schools in the nation. We bring together an amazing faculty, the members of which are highly acclaimed in the scientific communities in which they work. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have six Nobel Prize winners on this campus, five of whom are faculty in engineering and the sciences. We’re also home to an amazing group of smart, accomplished, high-energy students. These more than 1,400 undergraduates, pursuing a variety of interests, contribute greatly to the quality of the learning environment as well as to the overall richness of campus life.

We have crafted courses that balance theory and applied science, so our students are well prepared for successful careers in academia and in industry. Students especially interested in engineering and industry can take advantage of our Technology Management Program. Through coursework and "real world" experiences, the program gives our students insight into the world of technology from a business perspective. We want our students to understand what transforms a good technical idea into a good business idea. We want to give them a head start at attaining leadership positions in the technology business sector.

With a thriving interdisciplinary environment, our campus culture fosters creativity and discovery. A truly interdisciplinary culture allows all sorts of ideas to cross-fertilize and makes it easy for faculty to work effectively between disciplines to tackle big questions. Visiting scholars tell us they don’t often see the kind of openness among departments and ease of collaboration that they find here.

As part of the prestigious and well-established University of California system, we have the resources as well as the breadth and depth of talent to pursue new fields of scientific inquiry. We also bring an entrepreneurial attitude to our research, focusing on applications as much as discovery. Our leading programs in areas as diverse as biotechnology, communications, computer security, materials, nanotechnology, networking, and photonic devices attest to the success of this approach.

At the core of this activity are our students, our central purpose. We encourage you to pursue every opportunity, both inside and outside the classroom, to enhance your education. We have a talented and wise faculty and staff, equipped with extensive knowledge and diverse experience, to help you make decisions about courses and other activities as you pursue your degree. We look forward to having you in our classes, laboratories, and offices as you discover where your interests lead you.

Glenn Beltz
Associate Dean for Undergraduate Studies
Members of the Society of Women Engineers (SWE) set up to welcome new students during Discover Engineering.

New engineering students mingle and enjoy their first free lunch as undergrads at Discover Engineering.

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College of Engineering

The College of Engineering at UCSB is noted for its excellence in teaching, research, and service to the community. The college has an enrollment of approximately 1,400 undergraduate students and 750 graduate students with a full-time, permanent faculty of 129. This results in an excellent student to faculty ratio and a strong sense of community in the college.

Our modern laboratory facilities are available to undergraduate as well as graduate students. UCSB has an unusually high proportion of undergraduates who are actively involved in faculty-directed research and independent study projects.

The college offers the bachelor of science degree in five disciplines: chemical engineering, computer engineering, computer science, electrical engineering, and mechanical engineering. The undergraduate programs in chemical, computer, electrical, and mechanical engineering are accredited by the Engineering Accreditation Commission of ABET, and the computer science bachelor of science program is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

The curriculum for the bachelor of science degree is designed to be completed in four years. Completion of the four-year program provides students with the background to begin professional careers or to enter graduate programs in engineering or computer science, or professional schools of business, medicine, or law. Our curricula are specifically planned to retain both of these options and to assure that our graduates are equally well prepared to enter industry and graduate study. The college and the university offer a wide variety of career counseling and job placement services.

The Office of Undergraduate Studies in Harold Frank Hall, Room 1006, provides academic advising for all undergraduates in the college. Faculty and academic advisors for the individual majors are also provided by the respective departments. This publication contains detailed information about the various programs and schedules and is published yearly. Copies may be obtained by writing to the College of Engineering, Harold Frank Hall, Room 1006, University of California, Santa Barbara, California 93106-5130. Alternatively, it is available on the web at: www.engineering.ucsb.edu/current_undergraduates.

Mission Statement

The mission of the College of Engineering is to provide its students a firm grounding in scientific and mathematical fundamentals; experience in analysis, synthesis, and design of engineer-

ing systems; and exposure to current engineering practice and cutting edge engineering research and technology. A spirit of entrepreneurship in education, scholarly activity and participation in engineering practice infuses UCSB’s College of Engineering.

College of Engineering Honors Program

The Honors Program in the College of Engineering is designed to enrich the educational opportunities of its best students. Students in the Honors Program will be encouraged to participate in early experiences in scholarship through special seminars and individualized work in regular courses and, in later years, as members of research teams. Students in the Honors Program will be provided opportunities to become peer mentors and tutors within the College.

Participation in the Honors Program offers preferential enrollment in classes for continuing students as well as graduate student library privileges. Housing is available to eligible first-year students in Scholars’ Halls located in several university-owned residence halls.

The College of Engineering invites approximately the top 10% of incoming freshmen into the Honors Program based on a combination of high school GPA and SAT or ACT scores. (Please note: eligibility criteria are subject to change at any time.) Transfer students with a UC transferable GPA of 3.6 or greater are invited to join the Honors Program. Students who do not enter the College of Engineering with honors at the time of admission to UCSB may petition to enter the program after attaining a cumulative GPA of 3.5 or greater after completing two regular quarters at UCSB. Students will not be permitted to join the Honors Program once they begin their senior curriculum year.

To graduate as an Honors Program Scholar, students must complete 6.0 total Honors units during their junior and senior years; comprised of coursework from departmental 196, 197, 199 or graduate level courses with grades of B or higher, complete a total of 10 hours of community service for each year they are program members and maintain a 3.5 or higher cumulative GPA at the end of each Spring quarter.

Continued participation in the College Honors Program is dependent on maintaining a cumulative GPA of 3.5 or greater and active participation in both the academic and community service components of the Program.

Dean’s Honors

The College of Engineering gives public recognition to its outstanding undergraduate students by awarding Dean’s Honors at the end of each regular academic term to students who have earned a 3.5 grade-point average for the quarter and have completed a program of 12 or more letter-graded units. (Grades of Incomplete or Not Passed automatically disqualify students for eligibility for Dean’s Honors.) The Dean’s Honors List is posted quarterly, and the award is noted quarterly on the student’s permanent transcript.

Graduating students of the College of Engineering who have achieved distinguished scholarship while at the university may qualify for Honors, High Honors, or Highest Honors at graduation.

Tau Beta Pi

Tau Beta Pi is the nation’s oldest and largest engineering honor society. Its purpose is to honor academic achievement in engineering. Election to membership is by invitation only. To be eligible for consideration, students must be in the top one-eighth of their junior class or the top one-fifth of the senior class. Graduate students and faculty also belong to this honor society. In addition to regular meetings on campus, the organization participates in regional and national activities and sponsors local events, such as tutoring and leadership training, to serve the campus and community.

Education Abroad Program (EAP)

Students are encouraged to broaden their academic experience by studying abroad for a year, or part of a year, under the auspices of the University of California Education Abroad Program. See the EAP web site for more information: www.eap.ucsb.edu

Student Organizations

Student chapters of a number of engineering professional organizations are active on the UCSB campus. Students interested in any of these organizations may contact the Office of Undergraduate Studies of the College of Engineering for more information.

- American Indians in Science and Engineering Society
- American Institute of Chemical Engineers
- American Society of Mechanical Engineers
- Association for Computing Machinery
- Engineering Student Council
- Engineers without Borders
- Entrepreneurs Association
- Institute of Electrical and Electronics Engineers
- Little Big Engineers
- Los Ingenieros (Mexican-American Engineering Society/Society of Hispanic Professional Engineers)
- National Society of Black Engineers
- out in Science, Technology, Engineering, and Mathematics
Change of Major and Change of College

Current UCSB students in a non-engineering major, as well as students wishing to change from one engineering major to another, are welcome to apply after the satisfactory completion of a pre-defined set of coursework. However, due to the current demand for engineering majors, students are cautioned that it is a very competitive process and not all applicants will be able to change their majors due to limited space availability. It is incumbent upon students to continue to make progress in a backup major while pursuing a new major in the College of Engineering, and to periodically consult academic advisors in both the desired major as well as the backup major regarding the viability of pursuing the change of major.

Students who enter UCSB as transfer students will not be able to change to an engineering major, if not initially accepted into one. Students who began as freshmen who plan to enter an engineering major or to change from one engineering major to another will be expected to complete at least 30 units at UCSB before petitioning for a change of major and usually must satisfy the prerequisites of the prospective major. Students who have completed more than 105 units will not be considered for a change of major/change of college in engineering or computer science.

Note: The College of Engineering will not accept students from the College of Creative Studies or the College of Letters and Science after they have completed 105 units, regardless of their expected unit total at graduation.

Notwithstanding any of the major-specific requirements described below, we caution that the capacity of any given program to accept new students changes, sometimes substantially, from year to year.

Chemical Engineering. Admission to the Chemical Engineering major is determined by a number of factors, including an overall UCSB grade point average of 3.0 or better, and satisfactory completion of the following courses or their equivalents: Math 3A-B, Math 4A, Chemistry 1A-1AL or 2A-2AC, 1B-1BL or 2B-2BC, 1C-1CL or 2C-2CC; Engineering 3; and Physics 1-2. Decisions involving factors beyond scores and grades are made exclusively by the chemical engineering faculty. Only a limited number of petitions will be approved.

Computer Engineering. Students may petition to enter the Computer Engineering major at any time both of the following requirements are met:
1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of any five classes, including at least two Electrical & Computer Engineering (ECE) classes and two Computer Science (CMPS) classes, from the following: Math 4B, ECE 2A-B-C, ECE 15A, CMPSC 16, 24, 32, 40.

Computer Science. Students may petition to enter the Computer Science major when the following requirements are met:
1. A cumulative grade point average of at least 3.0;
2. Satisfactory completion of Computer Science 16 and 24 with a cumulative GPA of 3.2 or higher; First takes only
3. Satisfactory completion of Math 3A, 3B, 4A, 4B and Computer Science 40 with a cumulative GPA of 3.0 or higher; First takes only

The selection process is highly competitive and these milestones are minimum requirements for consideration, achieving them does not guarantee admission to the Computer Science major. Any petitions denied will be automatically considered a second time in the next quarter. Petitions denied a second time will not be reconsidered. More information can be found at http://cs.ucsb.edu/undergraduate/admissions/.

Electrical Engineering. Students may petition to enter the Electrical Engineering major once both of the following requirements are met:
1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of at least five classes, including at least two mathematics classes, from the following: Math 4B, Math 6A, Math 6B, ECE 2A-B-C, ECE 15A. The calculation of the minimum GPA will be based on all classes completed from this list at the time of petitioning.

Mechanical Engineering. Before petitioning for a change of major to mechanical engineering, six (6) of the following core courses or their UC equivalents must be completed: Math 3A-B; Math 4A; Math 4B; Math 6A-B; Physics 1-2; ME 14-15 (at least one of the 6 courses must include ME 14 or ME 15). Acceptance into the major will be based on UC grade point averages, applicable courses completed, and space availability. All students considering changing into Mechanical Engineering are required to meet with the ME Academic Advisor during their first year.

Degree Requirements

To be eligible for a bachelor of science degree from the College of Engineering, students must meet three sets of requirements: general university requirements, college general education requirements, and major degree requirements.

General University Requirements

All undergraduate students must satisfy university academic residency, UC Entry Level Writing Requirement, American history and institutions, unit, and scholarship requirements. These requirements are described fully on page 10.

College General Education Requirements

All students must satisfy the general education requirements for the College of Engineering. These requirements are described on page 10 and includes a listing of courses which meet each requirement.

Major Degree Requirements

Preparation for the major and major requirements for each program must be satisfied, including unit and GPA requirements. These appear in subsequent sections of this publication.

Advanced Placement Credit

Students who complete special advanced placement courses in high school and who earn scores of 3, 4, or 5 on the College Board Advanced Placement taken before high school graduation will receive 2, 4, or 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided scores are reported to the Office of Admissions. The specific unit values assigned to each test, course equivalents, and the applicability of these credits to the General Education requirements are presented in the chart on page 8.

Note: Advanced Placement credit earned prior to entering the university will not be counted toward the minimum cumulative progress requirements (see General Catalog for more details).

International Baccalaureate Credit

Students completing the International Baccalaureate (IB) diploma with a score of 30 or above will receive 30 quarter units total toward their UC undergraduate degree. The university grants 8 quarter units for the following:

- Students completing the International Baccalaureate (IB) diploma with a score of 30 or above will receive 30 quarter units total toward their UC undergraduate degree. The university grants 8 quarter units for the following:
Minimal Progress Requirements

A student in the College of Engineering will be placed on academic probation if the total number of units passed at UCSB is fewer than what is prescribed by the prevailing academic Senate regulation regarding Minimum Cumulative Progress. At least three-fourths of the minimum number of academic units passed must include courses prescribed for the major.

The following courses may be counted toward the unit minimums: courses repeated to raise C-, D, or F grades; courses passed by examination; courses graded IP (In Progress); courses passed during summer session at UCSB or at another accredited college or university and transferred to UCSB.

Students must obtain the approval of the Associate Dean for Undergraduate Studies to deviate from these requirements. Approval normally will be granted only in cases of medical disability, severe personal problems, or accidents.

Students enrolled in dual-degree programs must submit their proposed programs of study to the Associate Dean for Undergraduate Studies in the College of Engineering for approval. The individual programs must contain comparable standards of minimal academic progress.

215–Unit and Quarter Enrollment Limitations

The college expects students to graduate within 12 regular quarters for students who are admitted as freshmen and 9 regular quarters for students admitted as junior transfers and with no more than 215 units. College credit earned before high school graduation does not count toward the 215-unit maximum. This includes credit for Advanced Placement and International Baccalaureate examinations, and also college or university credit earned while still in high school.

Students who are admitted as freshmen and remain continuously enrolled will be assessed after 12 regular quarters at UCSB, and transfer students admitted as juniors will be assessed after 9 regular quarters at UCSB. Summer session does not count as a regular quarter in this calculation, but units earned in summer session do apply toward the 215-unit maximum.

With the exception of summer sessions, if students leave UCSB and earn a large number of units at one or more other academic institutions while they are away, the number of quarters allowed at UCSB will be reduced in proportion to the number of terms completed elsewhere.

College policy requires students to secure specific approval to continue enrollment beyond the quarter and unit limits noted above. Students who think they may exceed both the quarter limitations and 215 units may submit a Proposed Schedule for Graduation (Study Plan) for consideration by the Associate Dean for Undergraduate Studies, but they should understand that approval is granted in limited circumstances.

Note: The College of Engineering will not accept students from the College of Creative Studies or the College of Letters and Science after they have completed 105 units, regardless of their expected unit total at graduation.

Five-Year B.S./M.S. Degree Programs

Five-Year B.S. / M.S. in Computer Science. A combined BS/MS Program in Computer Science provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information about this program is available from the Computer Science graduate advisor. Interested students should make their interest known to the department early in their junior year. Advising and application materials are also available in the Department of Computer Science office.

Five-Year B.S. in Computer Engineering / M.S. in Computer Science

The Computer Engineering Program incorporates the design of computer hardware and software to meet the needs for various career applications. Students are trained to work with systems ranging from small integrated circuits to worldwide communications networks, from digital watches to supercomputers, and from single-line programs to operating systems. For more information on the program, please consult the Computer Engineering department.

Five-Year B.S. / M.S. Programs

Five-Year B.S. / M.S. in Mechanical Engineering. A combined B.S./M.S. program in Mechanical Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information about this program is available from the Mechanical Engineering Undergrad Advising office. Interested students should contact the office fall quarter of their junior year. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework.
Students who earn scores of 5, 6, or 7 on International Baccalaureate (IB) Higher Level (HL) Examinations taken before high school graduation will receive 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided official scores are submitted to the Office of Admissions. Students who complete the IB diploma with a score of 30 or above will receive 30 quarter units total. The university does not grant credit for Standard Level (SL) exams. The application of this credit to the General Education requirements and course equivalents for these exams are listed below.

Students should be advised that college courses taken before or after attending UC may duplicate AP, IB and/or A Level examinations. Additionally, exams may duplicate each other (for example, an AP or IB exam in the same subject area). If the student does duplicate an exam with another exam of the same subject content, and/or an exam with a college course, we will award credit only once.

**Note:** International Baccalaureate credit earned prior to entering the university will not be counted toward maximum unit limitations either for selection of a major or for graduation.

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**International Baccalaureate Higher Level Exam**

(With Score of 6 or Higher)

<table>
<thead>
<tr>
<th>Exam</th>
<th>Units</th>
<th>GE Credit</th>
<th>UCSB Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>8</td>
<td>none</td>
<td>EEMB 20, MCDB 20</td>
</tr>
<tr>
<td>Business and Management</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Computer Science</td>
<td>8</td>
<td>none</td>
<td>Computer Science 8</td>
</tr>
<tr>
<td>Design Technology</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Economics</td>
<td>8</td>
<td>D: 2 courses</td>
<td>Econ 1,2</td>
</tr>
<tr>
<td>English A: Literature or English AL Language and Literature</td>
<td>8</td>
<td>Score of 5</td>
<td>Entry Level Writing Requirement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Score of 6</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Score of 7</td>
<td>A1, A2</td>
</tr>
<tr>
<td>Film</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Geography</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>History</td>
<td>8</td>
<td>Pending</td>
<td>none</td>
</tr>
<tr>
<td>History of Africa</td>
<td>8</td>
<td>Pending</td>
<td>none</td>
</tr>
<tr>
<td>History of the Americas</td>
<td>8</td>
<td>Pending</td>
<td>none</td>
</tr>
<tr>
<td>History of Asia and Oceania</td>
<td>8</td>
<td>Pending</td>
<td>none</td>
</tr>
<tr>
<td>History of Europe and the Middle East</td>
<td>8</td>
<td>Pending</td>
<td>none</td>
</tr>
<tr>
<td>Languages Other Than English Mathematics</td>
<td>8</td>
<td>none</td>
<td>See department for level placement</td>
</tr>
<tr>
<td>Mathematics, Further</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Music</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Philosophy</td>
<td>8</td>
<td>E: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Physics</td>
<td>8</td>
<td></td>
<td>Physics 10</td>
</tr>
<tr>
<td>Psychology</td>
<td>8</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Social &amp; Cultural Anthropology</td>
<td>8</td>
<td>D: 1 course</td>
<td>Anthropology 2</td>
</tr>
<tr>
<td>Theater</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Visual Arts</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
</tbody>
</table>

# course also satisfies the Quantitative Relationships Requirement
+ course also satisfies the World Cultures Requirement
^ course also satisfies the European Traditions Requirement
## College Board Advanced Placement Credit

Students who earn scores of 3, 4, or 5 on College Board Advanced Placement Examinations taken before high school graduation will receive 2, 4, or 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided official scores are submitted to the Office of Admissions. Students should be advised that college courses taken before or after attending UC may duplicate AP, IB and/or A Level examinations. Additionally, exams may duplicate each other (for example, and AP or IB exam in the same subject area). If the student does duplicate an exam with another exam of the same subject content, and/or an exam with a college course, we will award credit only once.

**Note:** Advanced Placement credit earned prior to entering the university will not be counted toward maximum unit limitations either for selection of a major or for graduation.

<table>
<thead>
<tr>
<th>Advanced Placement Exam with score of 3, 4, or 5</th>
<th>Units Awarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art History</td>
<td>8</td>
<td>F: 1 course</td>
<td>Art History 1</td>
</tr>
<tr>
<td>*Art Studio 2D Design</td>
<td>8</td>
<td>none</td>
<td>Art Studio 18</td>
</tr>
<tr>
<td>*Art Studio 3D Design</td>
<td>8</td>
<td>none</td>
<td>EEMB 22, MCDB 20, Natural Science 1C</td>
</tr>
<tr>
<td>*Art Studio Drawing</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Biology</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Chinese Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>A1</td>
<td>none</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>A1, A2</td>
<td>none</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>Writing 1, 1E, 1LK</td>
<td>none</td>
</tr>
<tr>
<td>Comparative Government and Politics</td>
<td>4</td>
<td>D: 1 course</td>
<td>Environmental Studies 2</td>
</tr>
<tr>
<td>+Computer Science A</td>
<td>2</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Economics – Macroeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>Economics – Microeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>*English – Composition and Literature or Language and Composition</td>
<td>8</td>
<td>Entry Level Writing Writing 1, 1E, 1LK</td>
<td></td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>A1</td>
<td>Writing 1, 1E, 1LK, 2E, 2LK</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>A1, A2</td>
<td>Writing 1, 1E, 1LK, 2E, 2LK, 50, 50E, 50LK</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>4</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>European History</td>
<td>8</td>
<td>E: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>French Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-3</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-4</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-5</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-3</td>
</tr>
<tr>
<td>German Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-4</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-5</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Human Geography</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Geog 5</td>
</tr>
<tr>
<td>Italian Language &amp; Culture</td>
<td>4</td>
<td>D: 1 course</td>
<td>Italian 1-3</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Italian 1-5</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Italian 1-6</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Japanese Language &amp; Culture</td>
</tr>
<tr>
<td>Japanese Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Mathematics 3A, 15, 34A, or equivalent</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Mathematics 3A, 3B, 15, 34A, 34B, or equivalent</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Mathematics 3A, 15, 34A, 34B, or equivalent</td>
</tr>
<tr>
<td>Latin</td>
<td>8</td>
<td>H: 1 course</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>*Mathematics – Calculus AB</td>
<td>4</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>(or AB subscore of BC exam)</td>
<td></td>
<td></td>
<td>none</td>
</tr>
<tr>
<td>**Music – Theory</td>
<td>8</td>
<td>F: 1 course</td>
<td>none</td>
</tr>
<tr>
<td>*Physics 1</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>*Physics 2</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>*Physics – B</td>
<td>8</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>*Physics – C (Mechanics)</td>
<td>4</td>
<td>none</td>
<td>Physics 10, Natural Science 1A</td>
</tr>
<tr>
<td>*Physics – C (Electricity &amp; Magnetism)</td>
<td>4</td>
<td>none</td>
<td>Physics 6A and 6AL</td>
</tr>
<tr>
<td>*Psychology</td>
<td>4</td>
<td>D: 1 course</td>
<td>Psychology 1</td>
</tr>
<tr>
<td>Spanish Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-3</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>Spanish Literature &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>*With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>*With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-6</td>
</tr>
<tr>
<td>*With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Communication 87</td>
</tr>
<tr>
<td>Statistics</td>
<td>4</td>
<td>none</td>
<td>PSTAT SAA-ZZ, Psychology 5</td>
</tr>
</tbody>
</table>
# College Board Advanced Placement Credit Cont.

<table>
<thead>
<tr>
<th>Advanced Placement Exam with score of 3, 4, or 5</th>
<th>Units Awarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Government and Politics</td>
<td>4</td>
<td>D: 1 course</td>
<td>Political Science 12</td>
</tr>
<tr>
<td>U.S. History</td>
<td>8</td>
<td>D: 1 course</td>
<td>no equivalent</td>
</tr>
<tr>
<td>World History</td>
<td>8</td>
<td>E: 1 course</td>
<td>no equivalent</td>
</tr>
</tbody>
</table>

* A maximum of 8 units EACH in art studio, English, Mathematics, and Physics is allowed. (The Physics B exam is no longer offered.)

# Also satisfies the quantitative relationship requirement in Area C.

+ Maximum credit for Computer Science A-AB exams is 4 units. (The AB exam is no longer offered.)

**Note:** Information on this chart is subject to change. For updates go to: [http://my.sa.ucsb.edu/catalog/current/UndergraduateEducation/APCreditandChart.aspx](http://my.sa.ucsb.edu/catalog/current/UndergraduateEducation/APCreditandChart.aspx).

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## A Level Examination Credit

Students who earn grades of A, B, or C on UC-approved GCE and Hong Kong A Level examinations will receive 12 units of credit toward graduation at UCSB for each exam, provided that official grades are submitted to the Office of Admissions. Any general education credit or UCSB course equivalents listed in the chart below will be awarded only for Cambridge International A Level exams taken in 2013 or later, not for exams administered by any other agency. (Student may petition for GE or course credit for Cambridge International exams taken prior to 2013 or for exams administered by other agencies.)

Students should be advised that college courses taken before or after attending UC may duplicate AP, IB and/or A Level examinations. Additionally, exams may duplicate each other (for example, an AP or IB exam in the same subject area). If the student does duplicate an exam with another exam of the same subject content, and/or an exam with a college course, we will award credit only once.

**Note:** A Level examination credit earned prior to entering the university will not be counted toward maximum unit limitation either for selection of a major or for graduation.

<table>
<thead>
<tr>
<th>A Level Exam With A Grade of A, B, or C</th>
<th>Units Awarded</th>
<th>General Ed. Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting</td>
<td>12</td>
<td></td>
<td>Economics 3A, 3B</td>
</tr>
<tr>
<td>Afrikaans</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arabic</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art and Design</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classical Studies</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computing</td>
<td>12</td>
<td></td>
<td>Computer Science 16</td>
</tr>
<tr>
<td>Economics</td>
<td>12</td>
<td>Area D: 2 courses</td>
<td>Economics 1, 2</td>
</tr>
<tr>
<td>English – Language</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English – Literature</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>French</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geography</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>German</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hindi</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marathi</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marine Science</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>12</td>
<td></td>
<td>Mathematics 3A, 3B, 15, 34A, 34B</td>
</tr>
<tr>
<td>Mathematics – Further</td>
<td>12</td>
<td></td>
<td>Mathematics 4A</td>
</tr>
<tr>
<td>Music</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>12</td>
<td></td>
<td>Physics 6A, 6AL, 6B, 6BL, 6C, 6CL</td>
</tr>
<tr>
<td>Portuguese</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychology</td>
<td>12</td>
<td>Area D: 1 course</td>
<td>Psychology 1, 3, 7</td>
</tr>
<tr>
<td>Putonghua</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sociology</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamil</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>Telugu</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urdu</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urdu – Pakistan only</td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
General University Requirements

UC Entry Level Writing Requirement

All students entering the University of California must demonstrate an ability to write effectively by fulfilling the Entry Level Writing requirement. The requirement may be met in one of the following ways prior to admission:

1. by achieving a score of 680 or higher on the SAT II: Subject Test in Writing;
2. by achieving a score of 680 or higher on the Writing Section of the SAT Reasoning Test;
3. by achieving a score of 30 or better on the ACT Combined English/Writing test;
4. by achieving a score of 3 or higher on the College Board Advanced Placement Examination in English Composition and Literature or English Language and Composition;
5. by passing the UC systemwide Analytical Writing Placement Examination while in high school;
6. by achieving a score of 6 or higher on the International Baccalaureate (standard level) English A1 Examination.
7. by achieving a score of 5 or higher on the International Baccalaureate (higher level) English A Examination;
8. by entering the university with transcripts showing the completion of an acceptable 3-semester unit or 4-quarter unit course in English composition equivalent to Writing 2 at UCSB, with a grade of C or better.

Students who have not taken the Analytical Writing Placement examination and who have not met the UC Entry Level Writing Requirement in one of the other ways listed above will be required to take the examination during their first quarter at UCSB (check with Writing Program for examination time and location). An appropriate score on the examination will satisfy the requirement. Only one UC examination may be taken – either the systemwide Entry Level Examination while in high school or the examination given at UCSB; and neither may be repeated.

Students who enter UCSB without having fulfilled the university’s Entry Level Writing requirement and (if they have not previously taken the systemwide examination) who do not achieve an appropriate score on the examination given on campus must enroll in Writing 1, 1E or Linguistics 12 within their first year at UCSB. A grade of C- or higher is needed to satisfy the requirement. Students who earn a grade of C- or lower in will be required to repeat the course in successive quarters until the requirement is satisfied.

Once students matriculate at UCSB, they may not fulfill the requirement by enrolling at another institution. Transfer courses equivalent to Writing 2 or 50 will not be accepted for unit or subject credit unless the UC Entry Level Writing requirement has already been met. Students will only be allowed to meet the Area A requirement of the General Education Requirements with courses taken after satisfying the UC Entry Level Writing requirement. The Entry Level Writing requirement must be completed by the end of the third quarter of matriculation. Students who do not meet this deadline will be blocked from further enrollment at UCSB; EMS students should consult with the Writing Program.

American History and Institutions Requirement

The American History and Institutions requirement is based on the principle that American students enrolled at an American university should have some knowledge of the history and government of their country. You may meet this requirement in any one of the following ways:

1. by achieving a score of 3 or higher on the College Board Advanced Placement Examination in American History or American Government and Politics; or
2. by passing a non-credit examination in American history or American institutions, offered in the Department of History during the first week of each quarter. Consult the department for further information; or
3. by achieving a score of 650 or higher on SAT II: Subject Test in American History; or
4. by completing one four-unit course from the following list of courses:
   - Anthropology 131
   - Art History 121A-B-C, 136H
   - Asian American Studies 1, 2
   - Black Studies 1, 6, 20, 60A-B, 103, 137E, 169AR-BR-CR
   - Chicano Studies 1A-B-C, 168B, 174, 188C
   - Economics 113A-B, 119
   - English 133AA-ZZ, 134AA-ZZ, 191
   - Environmental Studies 173
   - Feminist Studies 155A, 159B
   - Military Science 27
   - Political Science 12, 115, 127, 151, 153, 155, 157, 158, 162, 165, 167, 180, 185
   - Religious Studies 7, 14, 61A-B, 151A-B, 152
   - Sociology 137E, 140, 144, 155A, Theater 180A-B

Courses used to fulfill the American History and Institutions requirement may also be applied to General Education or major requirements, or both where appropriate. Equivalent courses taken at other accredited colleges or universities, in UC Extension, or in summer session may be acceptable. Students who transfer to UCSB from another campus of the University of California where the American History and Institutions Requirement has been considered satisfied will automatically fulfill the requirement at UCSB.

International students on a nonimmigrant visa may petition for a waiver of this requirement through the Director of International Students and Scholars.

College of Engineering General Education Requirements

The aims of the General Education Program in the College of Engineering are to provide a body of knowledge of general intellectual value that will give the student a broad cultural base and to meet the objectives of the engineering profession. An appreciation and understanding of the humanities and social sciences are important in making engineers aware of their social responsibilities and enabling them to consider related factors in the decision-making process.

Students in the College of Engineering must complete the General Education requirements in order to qualify for graduation. Students are reminded that other degree requirements exist and that they are responsible for familiarizing themselves with all bachelor’s degree requirements. Not all of the courses listed in this publication are offered every quarter. Please see the GOLD system for General Education courses offered during a particular quarter.

It should be noted that for College of Engineering transfers who completed IGEC (Intersegmental General Education Transfer Curriculum), it may be used to substitute for the lower division general education and breadth requirements only. To complete the depth and writing requirements, those students will still be required to complete at least two upper division general education courses from General Subject Areas D, E, F, G, or H at UCSB after transfer (unless the student completed a year-long sequence equivalent to one of the Depth Requirement sequences as part of the IGEC program).
Students who have questions about the General Education requirements should consult with the advisors in College of Engineering Office of Undergraduate Studies.

**GENERAL SUBJECT AREA REQUIREMENTS**

A total of 8 courses is required to satisfy the General Education requirements of the College of Engineering. All students must follow the pattern of distribution shown below:

I. **Area A: English Reading and Composition**
   
   Computer Science students will complete Writing 2; and Writing 50, 107T, or 109ST.
   
   All other engineering majors will complete Writing 2E and Writing 50E during their first year at UCSB. Students that are unable to meet this requirement must meet an advisor with the College of Engineering Office of Undergraduate Studies to discuss alternatives.
   
   NOTE: Students must complete the UC Entry Level Writing Requirement before enrolling in courses that fulfill the Area A requirement of the General Education program. Please refer to page 10 of this publication or the UCSB General Catalog for a list of ways to satisfy the UC Entry Level Writing requirement.

II. **Areas D, E, F, G & H: Social Sciences, Culture and Thought, the Arts, Literature and Foreign Language**
   
   At least 6 courses must be completed in these areas:
   
   Areas D and E: A minimum of 2 courses must be completed in areas D and E.
   
   Areas F and G: A minimum of 2 courses must be completed in areas F and G.
   
   The general provisions relating to General Education requirements, as listed on page 10, must be followed when completing courses in Areas D, E, F, G, and H.
   
   A complete listing of courses, which will satisfy all these requirements starts on page 13.

**SPECIAL SUBJECT AREA REQUIREMENTS**

In the process of fulfilling the General Education General Subject Areas D through H requirements, students must complete the following Special Subject Area requirements:

1. **Writing Requirement.** Objective: To study and practice with writing, reading, and critical analysis within specific disciplines. Students will demonstrate abilities by producing written work totaling at least 1,800 words that is independent of or in addition to written examinations. Assessment of written work must be a significant consideration in total assessment of student performance in the course. At least four designated General Education courses that meet the following criteria: (1) the courses require one to three papers totaling at least 1,800 words, exclusive of elements such as footnotes, equations, tables of contents, or references; (2) the required papers are independent of or in addition to written examinations; and (3) the paper(s) is a significant consideration in the assessment of student performance in the course. Courses marked with an asterisk (*) on the lists in this document apply to this requirement. The writing requirement may be met only with designated UCSB courses. Approved by the academic senate.
   
   NOTES: ENGR 101 may be used as a writing requirement class, even by those students for whom ENGR 101 is required.
   
   New transfer students should consult with the College Undergraduate Studies Office regarding this requirement.

2. **Depth Requirement.** At least two upper division General Education courses from two separate departments, in each of which a student has already successfully completed one General Education course.
   
   Alternatively, this entire depth requirement may be satisfied by option 2, completion of one of the following sequences: Chicano Studies 1A-B-C, Comparative Literature 30A-B-C, French 50AX-BX-CX, History 2A-B-C, History 2AH-BH-CH, History 4A-B-C, History 4AH-BH-CH, History 17A-B-C, History 17AH-BH-CH, Philosophy 20A-B-C, Religious Studies 80A-B-C or any three courses from Art History 6A-B-C-D-DS-DW-E-F-G-H-K. Students selecting this option must complete all three courses in the sequence. Selection of this option does not change the number of courses required.
   
   Only courses from General Subject Areas D, E, F, G, or H may be used to meet the depth requirement.
   
   Option three is to complete an approved minor or double major, in a discipline encompassed by areas D, E, F, or G (listed below). This can be done by petition only, and petitions must be submitted at least three quarters in advance of the student's expected graduation date.

**Approved Minors**

- American Indian and Indigenous Studies (Religious Studies)
- Anthropology
- Art History
- Asian American Studies
- Black Studies
- Chinese
- Classics
- Comparative Literature
- English
- Feminist Studies
- French
- German Studies
- Global Peace and Security
- History
- Italian Studies
- Japanese
- Jewish Studies (Religious Studies)
- Labor Studies (History)
- Latin American and Iberian Studies
- Lesbian, Gay, Bisexual, Transgender, and Queer Studies (Feminist Studies)
- Linguistics
- Music
- Philosophy
- Portuguese
- Russian
- Sociocultural Linguistics
- Spanish
- Theatre
- Theatre - Production and Design
- Women, Culture, and Development (Global Studies)

3. **Ethnicity Requirement.** Objective: To learn to identify and understand the philosophical, intellectual, historical, and/or cultural experiences of historically oppressed and excluded racial minorities in the United States. At least one course that focuses on the history and the cultural, intellectual, and social experience of one of the following groups: Native Americans, African Americans, Chicanos/Latinos, or Asian Americans. Alternatively, students may take a course that provides a comparative and integrative context for understanding the experience of oppressed and excluded racial minorities in the United States. Courses
that meet this requirement are marked with an ampersand (&) on the lists in this document.

4. **European Traditions Requirement.**
   Objective: To learn to analyze early and/or modern European cultures and their significance in world affairs. At least one course that focuses on European cultures or cultures within the European Tradition. Courses that meet this requirement are marked with a caret (^) on the lists in this document.

**Other Regulations:**

- No more than two courses from the same department may apply to the General Education areas D, E, F, G, and H. (Except if a student completes one of the specific course sequences, such as History 4A-B-C, listed above for the depth requirement.)

- A course listed in more than one general subject area can be applied to only one of these areas. (Example: Art History 6A cannot be applied to both areas E and F.) However, a course can be applied towards a single general subject area and any special subject areas which that course fulfills. (Example: Asian American Studies 4 can be applied to the Writing and Ethnicity requirements in addition to the Area F requirement.)

- Some courses taken to satisfy the General Education requirements may also be applied simultaneously to the American History and Institutions requirement. Such courses must be on the list of approved General Education courses and on the list of approved American History and Institutions courses.

- Courses taken to fulfill a General Education requirement may be taken on a P/NP basis, if the course is offered with that grading option (refer to GOLD for the grading option for a particular course).

**GENERAL EDUCATION COURSES**

NOTE: The course listing in this booklet reflects the courses accepted for use towards the General Education requirements at the time of this document's publication and is subject to change. Please refer to GOLD for a listing of acceptable courses during the given quarter. Information in GOLD supersedes the information given here. Only Academic Senate approved courses can apply to GE.

**Area A – English Reading and Composition**

Objective: To learn to analyze purposes, audiences, and contexts for writing through study of

2 courses required

Writing 2 or 2E and Writing 50, 50E, 107T or 109ST are required, and must be taken for letter grades.

**Areas D and E – Social Sciences, Culture & Thought**

2 course minimum
## Area D: Social Sciences

**Objective:** To apply perspectives, theories, and methods of social science research to understand what motivates, influences, and/or determines the behaviors of individuals, groups, and societies. Area D courses are based upon systematic studies of human behavior which may include observation, experimentation, deductive reasoning, and quantitative analysis.

<table>
<thead>
<tr>
<th>Department</th>
<th>Course Code</th>
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* This course applies toward the writing requirement.  
^ This course applies toward the American History & Institutions requirement.  
@ This course applies toward the American History & Institutions requirement.  
& This course applies toward the ethnicity requirement.
### Area E: Culture and Thought

**Objective:** To learn to situate and investigate questions about world cultures through the study of human history and thought and to learn about the roles that citizens play in the construction and negotiation of human history and cultures.

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* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.
@ This course applies toward the American History & Institutions requirement.
^ This course applies toward the European Traditions requirement.
AREA F AND G – ARTS AND LITERATURE

2 courses minimum

AREA F: ARTS

Objective: To develop an appreciation of fine and performing arts, popular arts, and visual culture and to express relationships between arts and historical or cultural contexts.

* Art 1A Visual Literacy
* Art 7A The Intersections of Art and Life
* Art 106W Introduction to 2D/3D Visualizations in Architecture
* Art 125 Art Since 1950
* Art History 1 Introduction to Art
* Art History 5A Introduction to Architecture and the Environment
* Art History 5B Introduction to Museum Studies
* Art History 6A Art Survey I: Ancient Art-Medieval Art
* Art History 6B Art Survey II: Renaissance Art-Baroque Art
* Art History 6C Art Survey III: Modern-Contemporary Art
* Art History 6DS Survey: History of Art in China
* Art History 6DW Survey: Art of Japan and Korea
* Art History 6E Survey: Arts in Africa, Oceania, and Native North America
* Art History 6F Survey: Architecture and Planning
* Art History 6G Survey: History of Photography
* Art History 6H Pre-Columbian Art
* Art History 6I Survey: Contemporary Architecture
* Art History 6J Islamic Art and Architecture
* Art History 6K Roman Architecture
* Art History 103A Roman Art: From the Republic to Empire (509 BC to AD 337)
* Art History 103B Greek Architecture
* Art History 103C Medieval Architecture: From Constantine to Charlemagne
* Art History 105E The Origins of Romanesque Architecture
* Art History 105G Late Romanesque and Gothic Architecture
* Art History 105L Art and Society in Late Medieval Tuscany
* Art History 107A Painting in Fifteenth-Century Netherlands
* Art History 107B Painting in Sixteenth-Century Netherlands
* Art History 109A Italian Renaissance Art 1400-1500
* Art History 109B Italian Renaissance Art 1500-1600
* Art History 109C Art as Technique, Labor, and Idea in Renaissance Italy
* Art History 109D Art and the Formation of Social Subjects in Early Modern Italy
* Art History 109E Michelangelo
* Art History 109F Italian Journeys
* Art History 109G Leonardo Da Vinci: Art, Science and Technology in Early Modern Italy
* Art History 111B Dutch Art in the Age of Rembrandt
* Art History 111C Dutch Art in the Age of Vermeer
* Art History 111D Rethinking Rembrandt
* Art History 113A Seventeenth-Century Art in Southern Europe
* Art History 113B Seventeenth-Century Art in Italy
* Art History 113C Bernini and the Age of the Baroque
* Art History 113D Eighteenth-Century British Art and Culture
* Art History 113E Eighteenth-Century Art in Italy: The Age of the Grand Tour
* Art History 113F Nineteenth-Century British Art and Culture
* Art History 113G Impressionism and Post-Impressionism
* Art History 113H Art in the Modern World
* Art History 113I Contemporary Art
* Art History 113J Expressionism to New Objectivity, Early Twentieth-Century German Art
* Art History 113K Art in the Post-Modern World
* Art History 113L Early Twentieth-Century European Art 1900-1945
* Art History 113M Art of the Postwar Period 1945-1968
* Art History 113N Critical Approaches to Visual Culture
* Art History 113O American Art from the Revolution to Civil War: 1700-1860

* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.
^ This course applies toward the European Traditions requirement.
16 • GENERAL EDUCATION

@ Art History 121B Reconstruction, Renaissance, and Realism in American Art 1860-1900
@ Art History 121C Twentieth-Century American Art: Modernism and Pluralism 1900-Present
& Art History 121D African-American Art and the African Legacy
Art History 127A-B African Art
* Art History 130A Pre-Columbian Art of Mexico
* Art History 130B Pre-Columbian Art of the Maya
Art History 130C The Arts of Spain and New Spain
Art History 130D Pre-Columbian Art of South America
Art History 132A Mediterranean Cities
Art History 132I Art of Empire
Art History 134A Buddhist Art
Art History 134B Early Chinese Art
Art History 134C Chinese Painting
Art History 134D Art and Modern China
Art History 134E The Art of the Chinese Landscape
Art History 134F The Art of Japan
Art History 134G Japanese Painting
Art History 134H Ukiyo-e: Pictures of the Floating World
Art History 134I Nineteenth-Century Architecture
Art History 134J Twentieth-Century Architecture
Art History 134K Architecture of the United States
Art History 134L Design & the American Architect
Art History 134M Modern Architecture in Early Twentieth-Century Europe
* Art History 136L From Modernism to Postmodernism in European Architecture
Art History 136M Revival Styles in Southern California
Art History 136N Sustainable Architecture: History and Aesthetics
Art History 136O Architecture of the Americas
Art History 136P Modern Indian Visual Culture
Art History 136Q Introduction to 2D/3D Visualizations in Architecture
Art History 136R Modern Architecture in Southern California
** Art History 141G The Architecture of Museums and Galleries from c. 1800 to the Present
Art History 144A The Avant-Garde in Russia
Art History 144B Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)
Art History 144C Russian Art
Art History 144D Contemporary Art History: 1960-2000
Art History 144E Global Art After 1980
& Asian American Studies 4 Introduction to Asian American Popular Culture
& Asian American Studies 118 Asian Americans in Popular Culture
& Asian American Studies 120 Asian American Documentary
& Asian American Studies 127 Asian American Film, Television, and Digital Media
& Asian American Studies 140 Theory & Production of Social Experience
& Asian American Studies 146 Racialized Sexuality on Screen and Scene
& Asian American Studies 170KK Special Topics in Asian American Studies
* Black Studies 14 History of Jazz
* Black Studies 45 Black Arts Expressions
* Black Studies 142 Music in Afro-American Culture: U.S.A.
* Black Studies 153 Black Popular Music in America
Black Studies 161 Third-World Cinema
Black Studies 162 African Cinema
& Black Studies 170 Afro-Americans in the American Cinema
& Black Studies 171 Africa in Film
& Black Studies 172 Contemporary Black Cinema
Black Studies 175 Black Diaspora Cinema
& Chicano Studies 125B Contemporary Chicano and Chicana Art
& Chicano Studies 135 Barrio Popular Culture
& Chicano Studies 148 Chicana Art and Feminism
@ Chicano Studies 188C Chicano Theater Workshop
* Chinese 40 Popular Culture in Modern Chinese Societies
* Chinese 170 New Taiwan Cinema
* Chinese 176 Chinese Cinema: Nationalism and Globalism
* Classics 102 Greek Tragedy in Translation
^ Classics 165 Greek Painting
^ Classics 170 Pompeii
Comparative Literature 186FF NOIR: 1940's Film and Fiction
Dance 35 History and Appreciation of World Dance
* Dance 36 History of Modern Dance
Dance 45 History and Appreciation of Dance
* Dance 145A-B Studies in Dance History
East Asian Cultural Studies 134A Buddhist Art
* Film & Media Studies 46 Introduction to Cinema
* Film & Media Studies 120 Japanese Cinema (Same as JAPAN 159)
* Film & Media Studies 121 Chinese Cinema
* Film & Media Studies 122AA-ZZ Topics in National Cinema
* Film & Media Studies 124 Indian Cinema
* Film & Media Studies 124V Modern Indian Visual Culture
* Film & Media Studies 125A-B Documentary Film
* Film & Media Studies 126 Cuban Cinema
& Film & Media Studies 127 Latin American Cinema
* Film & Media Studies 127M Mexican Film and Cinema
* Film & Media Studies 134 French and Francophone Cinema
* Film & Media Studies 136 British Cinema
* Film & Media Studies 144 The Horror Film (Same as GER 183)
* Film & Media Studies 163 Women and Film: Feminist Perspectives
Film & Media Studies 169 Film Noir
Film & Media Studies 175 Experimental Film
* Film & Media Studies 178Z Technology and Cinema (Same as FR 156D)
* French 156A French Cinema: History and Theory
* French 156B French and Francophone Cinema
* French 156C Modern Images of the Middle Ages: The Intersection of Text, History, and Film
* French 156D Technology and Cinema (Same as FLMST 178Z)
* German 55A Contemporary German Pop Culture
Italian 124X Italian Theatre
Italian 178B Italian Cinema
Italian 1792 Italian Film and Film in Italy
* Italian 180Z Italian Cinema
Japanese 134F Arts of Japan (Same as ARTHI 134F)
Japanese 134G Japanese Painting (Same as ARTHI 134G)
Japanese 134H Ukiyo-e: Pictures of the Floating World (Same as ARTHI 134H)
* Japanese 149 Traditional Japanese Drama
* Japanese 159 Japanese Cinema (Same as FLMST 120)
Korean 75 Introduction to Popular Culture in Korean Film
Korean 95 Fundamentals of Music
* Music 15 Music Appreciation
* Music 17 World Music
* Music 114 Music and Popular Culture in America
* Music 115 Symphonic Music
* Music 116 American Music History: Colonial to Present
* Music 118A History and Literature of Great Composers in Western Music
* Music 119A Music and Politics
* Music 119B Music in Political Films
Slavic 130A The Avantgarde in Russia
Slavic 130B Russian Cinema
Slavic 130C Contemporary Art in Russia and Eastern Europe (Same as ARTHI 144C)
Slavic 130D Russian Art
Slavic 130E Masters of Soviet Cinema
Spanish 126 Spanish Cinema
Spanish 128 Performance in Global Contexts
* Theater 2A-B Performance in Global Contexts: Europe
* Theater 2C Performance in Global Contexts: Europe
* Theater 3 Life of the Theater
* Theater 5 Introduction to Acting
* Theater 7 Performance of the Human Body
* Theater 9 Playwriting
* Theater 143 The People’s Voice
* Theater 180A-B Contemporary American Drama and Theater
* Theater 180C Culture Clash: Studies in U.S. Latino Theater
& Theater 180E Race, Gender, and Performance
& Theater 180G Ancient Theater and Drama
& Theater 182A Modern Theater and Drama
& Theater 182M Modern Contemporary
& Theater 182MC Modern Contemporary
& Theater 182N Neoclassical Theater and Drama
& Theater 184AA African American Performance
& Theater 184ACA Contemporary African Theater and Performance
& Theater 188S Shakespeare on Film and Stage

* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.
^ This course applies toward the European Traditions requirement.
@ This course applies toward the American History & Institutions requirement.
AREA G: LITERATURE
Objective: To learn to analyze texts using methods appropriate to literary study and to situate analysis within contexts where texts circulate.

* Black Studies 33A-B
* Comparative Literature 148
* Comparative Literature 147
* Comparative Literature 165
* Comparative Literature 140
* Comparative Literature 139
* Comparative Literature 138
* Comparative Literature 137
* Comparative Literature 136
* Comparative Literature 135
* Comparative Literature 134
* Comparative Literature 133
* Comparative Literature 132
* Comparative Literature 178
* English 75
* English 74
* English 73
* English 72
* English 71
* English 70
* English 69
* English 68
* English 67
* English 66
* English 65
* English 64
* English 63
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* English 9
* English 8
* English 7
* English 6
* English 5
* English 4
* English 3
* English 2
* English 1

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Literature Courses Taught in the Original Language

* Chinese 124A-B  Readings in Modern Chinese Literature
* Chinese 132A  Special Topics in Classical Chinese Poetry
* Chinese 142  Tang Poetry
* French 101A-B-C  Introduction to Literary and Cultural Analysis
* French 147A  Renaissance Poetry
* French 147B  French Theater
* French 148C  Women in the Middle Ages
* French 148E  The Age of Louis XIV
* French 149B  The Politics of Paradise
* French 149C  Paris in Nineteenth-Century Literature & Art
* French 149D  Post-War Avant-Gardes
* French 149E  Belgian Literature in French
* German 115A-B-C  Survey of German Literature
* German 115A-B-C  Introduction to Greek Prose
* Greek 100  Introduction to Greek Prose
* Greek 101  Modern Hebrew Prose and Poetry
* Greek 101  Modern Italy
* Hebrew 114A-B-C  Study of Modern Hebrew Prose and Poetry
* Italian 101  Italian Modern Italy
* Italian 102  Italian Medieval and Renaissance Italy
* Italian 101  Italian Short Fiction
* Italian 111  Italian Literature in Italian
* Italian 126-A-AA-AB-BB  Introduction to Latin Prose
* Latin 100  Introduction to Latin Prose
* Latin 101  Introduction to Latin Prose
* Portuguese 105A-B-C  Survey of Brazilian Literature
* Portuguese 106A-B-C  Religions of the Ancient Near East
* Religious Studies 129  Short Fiction by Major Russian Writers
* Religious Studies 131  Introduction to Hispanic Literature
* Religious Studies 137A-B  Short Fiction by Major Russian Writers
* Religious Studies 137A-B  Introduction to Hispanic Literature
* Religious Studies 140A-B  Spanish Golden Age Poetry I
* Religious Studies 140A-B  Golden Age Drama
* Religious Studies 140A-B  U.S. Latino Literature
* Religious Studies 140A-B  Cervantes: Don Quixote
* Religious Studies 140A-B  Hispanic Novel and Cinema

Area H: Foreign Language

Objective: To help students gain familiarity with a foreign language.

Chinese 2-3  Elementary Modern Chinese
Chinese 2NH-3NH  First Year Chinese Heritage
Chinese 4-5-6  Second Year Chinese Heritage
French 2-3  Elementary French
French 4-5-6  Intermediate French
French 6-8  Intermediate French: Global Studies- Political Sci.
German 2-3  Elementary German
German 4-5-6  Intermediate German
German 95B  Intermediate Yiddish
German 95C  Advanced Yiddish
Global Studies 60B-C-D-E-F  Punjabi (II-III-IV-V-VI)
Greek 2  Elementary Greek
Greek 12-13  Intermediate Greek
Greek 12-13  Modern Greek
Hebrew 2-3  Elementary Hebrew
Hebrew 4-5-6  Intermediate Modern Hebrew
Italian 2-3  Elementary Italian
Italian 4-5-6  Intermediate Italian
Japanese 2-3  First Year Japanese
Japanese 4-5-6  Second Year Japanese
Latin 2  Elementary Latin
Latin 3  Intermediate Latin
Portuguese 2-3  Elementary Portuguese
Portuguese 4-5-6  Intermediate Portuguese
Religious Studies 10B-C-D-E-F  Arabic (II-III-IV-V-VI)
Religious Studies 11B-C-D-E-F  Hindi (II-III-IV-V-VI)
Religious Studies 17B-C  Biblical Hebrew (II-III)
Religious Studies 30B-C-D-E-F  Tibetan (II-III-IV-V-VI)
Religious Studies 45B-C-D-E-F  Padish (II-III-IV-V-VI)
Religious Studies 57B-C-D-E-F  Persian (II-III-IV-V-VI)
Religious Studies 60B-C-D-E-F  Punjabi (II-III-IV-V-VI)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>Religious Studies 65B-C-D-E-F</td>
<td>Turkish (II-III)</td>
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<tr>
<td>Religious Studies 122B</td>
<td>Syriac (II-III)</td>
</tr>
<tr>
<td>Religious Studies 157A-B-C</td>
<td>Advanced Persian (I-II-III)</td>
</tr>
<tr>
<td>Religious Studies 159B-C</td>
<td>Elementary Sanskrit</td>
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<tr>
<td>Slavic 2-3</td>
<td>Elementary Russian</td>
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<tr>
<td>Slavic 4-5-6</td>
<td>Intermediate Russian</td>
</tr>
<tr>
<td>Spanish 2-3</td>
<td>Elementary Spanish</td>
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<tr>
<td>Spanish 2S-3S</td>
<td>Intensive Elementary Spanish</td>
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<tr>
<td>Spanish 4-5-6</td>
<td>Intermediate Spanish</td>
</tr>
<tr>
<td>Spanish 4SS-5SS-6SS</td>
<td>Intensive Intermediate Spanish</td>
</tr>
</tbody>
</table>

**Special Subject Area Supplementary List of Courses**

Note: These courses do not fulfill requirements for Areas D, E, F, G or H, and may not be used to fulfill the depth requirement; they satisfy the university and special subject area requirements listed only.

* * Anthropology 116A | Myth, Ritual, and Symbol |
* * Anthropology 116B | Anthropological Approaches to Religion |
* * Anthropology 143 | Comparative Ethnicity |
& * Anthropology 172 | Colonialism and Culture |
& * Art History 186AA-ZZ | Seminar in Advanced Studies in Art History |
& * Asian American Studies 100C | Filipino Americans |
& * Asian American Studies 100DD | Korean Americans |
& * Asian American Studies 109 | Asian American Women and Work |
& * Asian American Studies 113 | The Asian American Movement |
& * Asian American Studies 121 | Asian American Autobiographies and Biographies |
& * Asian American Studies 124 | Asian American Literature in Comparative Frameworks |
& * Asian American Studies 134 | Asian American Men and Contemporary Men’s Issues |
& * Asian American Studies 138 | Asian American Sexualities |
& * Asian American Studies 148 | Introduction to Video Production |
& * Asian American Studies 149 | Screenwriting |
& * Black Studies 50 | Blacks in the Media |
& * Black Studies 108 | Obama as a Political and Cultural Phenomenon |
& * Black Studies 137E | Sociology of the Black Experience |
& * Chicano Studies 168E | History of the Chicano Movement |
& * Chicano Studies 168F | Racism in American History |
& * Chicano Studies 171 | The Brown/Black Metropolis: Race, Class, & Resistance in the City |
& * Chinese 132B | Special Topics in Modern Chinese Poetry |
& * Chinese 150 | The Language of Vernacular Chinese Literature |
& * Chinese 166B | Taoist Traditions in China |
& * Chinese 166C | Confucian Tradition: The Classical Period |
& * Communication 130 | Political Communication |
& * Communication 137 | Global Communication, International Relations and the Media |
& * Communication 150 | Group Communication in Multiple Contexts |
& * Communication 153 | Communication and Global Advocacy |
& * Comparative Literature 36 | Global Humanities: The Politics and Poetics of Witnessing |
& * Comparative Literature 170 | Literary Translation: Theory and Practice |
& * Counseling, Clinical & School Psychology 101 | Introduction to Applied Psychology |
& * Earth Science 6 | Mountains, Boots and Backpacks: Field Study of the High Sierra |
& * Earth Science 104A | Field Studies in Geological Methods |
& * Earth Science 104B | Field Methods |
& * Earth Science 117 | Earth Surface Processes and Landforms |
& * Earth Science 123 | The Solar System |
& * Earth Science 130 | Global Warming - Science and Society |
& * East Asian Cultural Studies 178 | The Body Religious in Chinese Culture |
& * Economics 117A | Law and Economics |
* Education 20 | Introduction to the University Experience |
* EEBM 124 | Biochemical Ecology |
* EEBM 134 | Evolutionary Ecology |
* EEBM 135 | Ethology and Behavioral Ecology |
* EEBM 138 | Chemical and Physical Methods of Aquatic Environments |
* EEBM 142BL | Methods of Aquatic Biology |
* EEBM 149 | Mariculture for the Twenty-first Century |
* EEBM 179 | Modeling Environmental and Ecological Change |
* English 36 | Global Humanities |
* Engineering 101 | Ethics in Engineering |
* Environmental Studies 2 | Introduction to Environmental Science |
* Environmental Studies 20 | Shoreline Issues |
* Environmental Studies 110 | Disease and the Environment |
* Environmental Studies 143 | Endangered Species Management |
* Environmental Studies 146 | Animals in Human Society: Ethical Issues of Animal Use |
@* Environmental Studies 161 | Environmental Studies 173 |
&* Environmental Studies 189 | Environmental Studies 189 |
&* Feminist Studies 80 | Feminist Studies 80 |
&* Feminist Studies 142 | Feminist Studies 142 |
&* Feminist Studies 150 | Feminist Studies 150 |
&* Feminist Studies 154A | Feminist Studies 154A |
@* Feminist Studies 155A | Feminist Studies 162 |
@* Film Studies 101A-B-C | Film Studies 101A-B-C |
@* Film Studies 146 | Film Studies 146 |
@* Film Studies 191 | Film Studies 191 |
@* Geography 8 | Geography 8 |
@* Geography 148 | Geography 180 |
@* History 56 | History 56 |
@* History 123A | History 123A |
@* History 123B | History 123B |
@* History 123C | History 123C |
@* History 140A-B | History 140A-B |
@* History 155A-B | History 155A-B |
@* History 156A | History 156A |
@* History 156I | History 156I |
@* History 157A-B | History 157A-B |
&* History 160A-B | History 160A-B |
@* History 164C | History 164C |
@* History 164A-IB | History 164A-IB |
@* History 165 | History 165 |
@* History 166A-B-C | History 166A-B-C |
@* History 166LB | History 166LB |
&* History 168E | History 168E |
&* History 168M | History 168M |
&* History 168N | History 168N |
@* History 169M | History 169M |
@* History 177T | History 177T |
@* History 176A-B | History 176A-B |
@* History 177 | History 177 |
@* History 178A-B | History 178A-B |
@* History 179A | History 179A |
@* History 179B | History 179B |
@* Japanese 25 | Japanese 25 |
@* Japanese 167A | Japanese 167A |
@* Latin American and Iberian Studies 10 | Introduction to the Latin American and Iberian World |
@* Latin American and Iberian Studies 100 | Introduction to Latin American and Iberian Studies |
@* Linguistics 113 | Introduction to First Language Acquisition |
@* Linguistics 114 | Language Socialization |
@* Linguistics 131 | Materials in Sociology: The Stuff of Dreams |
@* Linguistics 137 | Native American History to 1838 |
@* Linguistics 138 | Native American History, 1838 to Present |
@* Materials 10 | Violence and the State in Japan |
@* Molecular, Cellular, and Developmental Biology 134H | Religion in Japanese Culture |
@* Molecular, Cellular, and Developmental Biology 149 | Women's Rights in Japan |
@* Music 12 | History of the Women's Rights Movement |
@* Music 112AB-C-D-E-F | History of Women's Rights Movement in the Americas |
@* Philosophy 7 | History of Women's Rights Movement in the Americas, 1838 to Present |
@* Physics 13AH | Animal Virology–Vaccines |
@* Physics 128AL-BL | American Environmental History |
@* Political Science 6 | American Environmental History, 1838 to Present |
@* Political Science 7 | American Environmental History, 1838 to Present |
@* Political Science 127 | American Environmental History, 1838 to Present |
@* Political Science 129 | American Environmental History, 1838 to Present |

* This course applies toward the writing requirement.  
& This course applies toward the American History & Institutions requirement.  
^ This course applies toward the European Traditions requirement.  
@ This course applies toward the American History & Institutions requirement.  
@ This course applies toward the American History & Institutions requirement.
@ Political Science 152 American Political Parties
@ Political Science 153 Political Interest Groups
@ Political Science 157 The American Presidency
@ Political Science 158 Power in Washington
@ Political Science 162 Urban Government and Politics
@ Political Science 165 Criminal Justice
@ Political Science 167 Constitutional Law: The Bill of Rights
@ Political Science 180 Bureaucracy and Public Policy
@ * Political Science 185 Government and the Economy
* Psychology 90A-B-C First-Level Honors Seminar
* Psychology 110L Laboratory in Perception
* Psychology 111L Laboratory in Biopsychology
* Psychology 112L Laboratory in Social Behavior
* Psychology 116L Laboratory in Animal Learning
* Psychology 117L Laboratory in Human Memory and Cognition
* Psychology 118L Laboratory in Attention
* Psychology 120L Advanced Research Laboratory
* Psychology 135A-B-C Field Experience in Psychological Settings
* Psychology 143S Seminar in Social Development
* Religious Studies 106 Modernity and the Process of Secularization
& * Religious Studies 110D Ritual Art and Verbal Art of the Pacific Northwest
& * Religious Studies 114D Religion and Healing in Native America
* Religious Studies 127B Christian Thought and Cultures of the Middle Ages
& * Religious Studies 131F The History of Anti-Semitism
* Religious Studies 131J Introduction to Japanese Literature
* Religious Studies 140A Islamic Traditions
* Religious Studies 140B Religion, Politics, and Society in the Persian Gulf Region
* Religious Studies 140C Islamic Mysticism and Religious Thought
& Religious Studies 140E Islam in America
* Religious Studies 145 Patterns in Comparative Religion
* Religious Studies 166C Confucian Traditions: The Classical Period
* Religious Studies 167A Religion in Japanese Culture
& * Religious Studies 193 Religion and Ecology of the Americas
& Sociology 128 Development and its Alternatives
* Sociology 130 Development and Social Change in Latin America
* Sociology 130LA Development and Social Change in the Middle East
* Sociology 130ME Development and Social Change in the Middle East
* Sociology 134R The Sociology of Revolutions
* Sociology 134RC Radical Social Change
@& * Sociology 137E Sociology of the Black Experience
& Sociology 139A Black and White Relations
@ Sociology 140 Aging in American Society
* Sociology 154A Sociology of the Family
& Sociology 154F The Chicano Family
@ Sociology 155A Women in American Society
& Sociology 155M Contemporary U.S. Women's Movements
& Sociology 155W Chicanas and Mexican Women in Contemporary Society
* Sociology 156A Introduction to Women, Culture, and Development
@ Sociology 157 Radicalism in Contemporary Life
* Sociology 170 Sociology of Deviant Behavior
* Sociology 176A Sociology of AIDS
& Spanish 109 Spanish in the United States: The Language and its Speakers
* Speech & Hearing Sciences 50 Introduction to Communication Disorders
* Theater 1 Play Analysis
* Theater 91 Summer Theater in Orientation
& Theater 180F Asian American Theater
* Theater 185TH Theory
@ Writing 110L Advanced Legal Writing
* Writing 110MK Professional Communications in Marketing and Public Relations
* Writing 160 Theory and Practice of Writing Center Consulting

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CHECKLIST OF GENERAL UNIVERSITY AND GENERAL EDUCATION REQUIREMENTS

GENERAL UNIVERSITY REQUIREMENTS

UC Entry Level Writing Requirement — (Must be fulfilled within three quarters of admission.)

Passed Exam ______ or Writing 1, 1E or Ling 12 ______ or transferred appropriate course _________

American History and Institutions* — (Refer to page 8 for the list of acceptable courses.)

One course ______ or Advanced Placement ______ or International waiver _____________

*This course may also apply to the General Education requirements, if appropriate.

GENERAL EDUCATION REQUIREMENTS

No more than two courses total from the same department may apply to the General Education Areas D, E, F, G, and H. A course listed in more than one General Subject Area can be applied to only one area. Course total in Areas D, E, F, G, and H must be at least 6.

General Subject Areas

1. Area A: English Reading and Composition
   Writing 2 or 2E ___________ and Writing 50, 50E, 107T or 109ST ___________

2. Areas D and E: Social Sciences, Culture and Thought (2 courses minimum)
   ___________________________ ___________________________

3. Areas F and G: Arts and Literature (2 courses minimum)
   ___________________________ ___________________________

4. Two additional courses from D, E, F, G or H (Foreign Language):
   ___________________________ ___________________________

Special Subject Areas

In the process of fulfilling the G.E. General Subject Area requirements, students must fulfill the following Special Subject Area requirements, as outlined on page 11. Only approved courses can be used to fulfill these requirements.

a. Writing Requirement — At least four courses which require the writing of one or more papers totaling at least 1,800 words.
   ___________________________ ___________________________

b. Depth Requirement — Choose one of the following options:
   Option 1: At least two upper division courses from two separate departments, in each of which a course has already been completed. (Only courses from Areas D, E, F, G or H may be used towards this requirement.)
   Course 1 (Lower or Upper Division) Course 2 (Upper Division)
   Department 1 ___________________________ ___________________________
   Department 2 ___________________________ ___________________________

   Option 2: Complete a Three Course Sequence from the approved list on page 11.
   ___________________________ ___________________________

   Option 3: Complete an approved minor or double major, see page 11 for more information about this option.
   ___________________________

c. Ethnicity Requirement — (1 course) ______________________

d. European Traditions Requirement — (1 course) ________________
Chemical Engineering

Department of Chemical Engineering, Engineering II, Room 3357; Telephone (805) 893-3412
Web site: www.chemeng.ucsb.edu
Chair: Rachel A. Segalman, Ph.D., UC Santa Barbara, Professor (polymer design, self-assembly, and properties) *1
M. Scott Shell, Ph.D. Princeton, Associate Professor (molecular simulation, statistical mechanics, complex materials, protein biophysics) *1
Todd M. Squires, Ph.D., Harvard, Associate Professor (fluid mechanics, microfluidics, microreaction, complex fluids) *1

Faculty
Bradley Chmelka, Ph.D., UC Berkeley, Professor (self-assembled materials, heterogeneous catalysis, surfactants and polymers, porous and composite solids, magnetic resonance) *1
Michael F. Doherty, Ph.D., Cambridge University, Professor (process design and synthesis, separations, crystal engineering) *1
Glen Fredrickson, Ph.D., Stanford University, Professor (polymer theory, block copolymers, phase transitions, statistical mechanics, glass transitions, composite media) *1
Michael J. Gordon, Ph.D., California Institute of Technology, Associate Professor (surface physics, scanning probe microscopy, nanoscale materials, plasmonics, laser spectroscopy) *1
Matthew E. Helgeson, Ph.D., University of Delaware, Assistant Professor (colloidal thermodynamics and rheology, polymer and surfactant self-assembly, nanomaterials, microfluidics) *1
Jacob Israelachvili, Ph.D., University of Cambridge, Professor (surface and interfacial phenomena, adhesion, colloidal systems, surface forces, bio-adhesion, friction) *1
L. Gary Leal, Ph.D., Stanford University, Schlinger Distinguished Professor in Chemical Engineering (fluid mechanics, physics of complex fluids, rheology) *1
Eric McFarland, Ph.D., Massachusetts Institute of Technology, M.D., Harvard, Professor (energy production, catalysis, reaction engineering, charge and energy transfer) *1
Samir Mitragotri, Ph.D., Massachusetts Institute of Technology, Professor (drug delivery and diagnostics, bio-membrane transport, membrane biophysics, biomedical ultrasound) *1
Michelle A. O’Malley, Ph.D., University of Delaware, Assistant Professor (genetic and cellular engineering, membrane protein characterization for drug discovery, protein biophysics, metagenomics, biofuel production) *1
Baron G. Peters, Ph.D., UC Berkeley, Associate Professor (molecular simulation, chemical kinetics, catalytic reaction mechanisms, nucleation, electron transfer) *1
Susannah Scott, Ph.D., Iowa State University, Professor (heterogeneous catalysis, surface organometallic chemistry; analysis of electronic structure and stoichiometric reactivity to determine catalytic function) *1
Rachel A. Segalman, Ph.D., UC Santa Barbara, Professor (polymer design, self-assembly, and properties) *1
M. Scott Shell, Ph.D. Princeton, Associate Professor (molecular simulation, statistical mechanics, complex materials, protein biophysics) *1
Todd M. Squires, Ph.D., Harvard, Associate Professor (fluid mechanics, microfluidics, microreaction, complex fluids) *1

Emeriti Faculty
Sanjoy Banerjee, Ph.D., University of Waterloo, Professor Emeritus (transport processes, multiphase systems, process safety) *2
Owen T. Hanna, Ph.D., Purdue University, Professor Emeritus (theoretical methods) *2
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor Emeritus (structural materials, mechanical properties) *2
Duncan A. Mellichamp, Ph.D., Purdue University, Professor Emeritus (process dynamics and control, digital computer control) *2
Robert G. Rinker, Ph.D., California Institute of Technology, Professor Emeritus (chemical kinetics, reaction engineering, catalysis) *2
Orville C. Sandall, Ph.D., UC Berkeley, Professor Emeritus (transport of mass, energy, and momentum, separation processes) *2
Dale E. Seborg, Ph.D., Princeton University, Professor Emeritus (process dynamics and control, monitoring and fault detection, system identification) *2
Theofanis G. TheoKanous, Ph.D., University of Minnesota, Professor, Center for Risk Studies and Safety Director (transport phenomena in multiphase systems, risk analysis) *2

Affiliated Faculty
Song-I Han, Ph.D. (Chemistry)
Philip Alan Pincus, Ph.D. (Materials)

Mission Statement
The program in Chemical Engineering has a dual mission:
• Education. Our program seeks to produce chemical engineers who will contribute to the process industries worldwide. Our program provides students with a strong fundamental technical education designed to meet the needs of a changing and rapidly developing technological environment.
• Research. Our program seeks to develop innovative scientific and technology that addresses the needs of industry, the scientific community, and society.

Objectives for the Undergraduate Program
Educational Objectives
• Our graduates will be innovative, competent, contributing chemical engineers.
• Our graduates will demonstrate their flexibility and adaptability in the workplace, so that they remain effective engineers, take on new responsibilities, and assume leadership roles.
• Our graduates will continually develop new skills and knowledge through formal and informal mechanisms.

Student Learning Outcomes
Upon graduation, students from the ChE program at UCSB are expected to have:

We live in a technological society which provides many benefits including a very high standard of living. However, our society must address critical problems that have strong technological aspects. These problems include: meeting our energy requirements, safeguarding the environment, ensuring national security, and delivering health care at an affordable cost. Because of their broad technical background, chemical engineers are uniquely qualified to make major contributions to the resolution of these and other important problems. Chemical engineers develop processes and products that transform raw materials into useful products.

The Department of Chemical Engineering offers the B.S., M.S., and Ph.D. degrees in chemical engineering. The B.S. degree is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.
Chemical Engineering Courses

LOWER DIVISION

1A. Engineering and the Scientific Method
(1) STAFF
Introduction and its relationship to basic science, with specific examples from engineering practice. Analysis and synthesis of engineering education. Career opportunities for chemical engineering graduates. Seminar format with guest lecturers and current experiences/issues from students’ other freshman engineering/science classes.

5. Introduction to Chemical Engineering Design
(3) DOHERTY
Introduction to the design and analysis of processes involving chemical change in the context of chemical and biomolecular engineering. Students learn mathematical, empirical, and conceptual strategies to analyze.

10. Introduction to Chemical Engineering
(3) HELGESON, GORDON
Prerequisites: Chemistry 1A-B-C or 2A-B-C; Mathematics 3A-B or Mathematics 4A; and Engineering 3; chemical engineering majors only.

99. Introduction to Research
(1-3) STAFF
Prerequisites: consent of instructor and undergraduates.

UPPER DIVISION

102. Biomaterials and Biosurfaces
(3) ISRAELACHVILI
Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.

107. Introduction to Biological Processing
(3) O’MALLEY
Prerequisites: Chemical Engineering 10
Familiarizes engineering students with biological processing and production at multiple scales. Chemical engineering principles will be infused with global/societal context; a knowledge of contemporary issues; an understanding of professional and ethical responsibility.

Undergraduate Program

Bachelor of Science—Chemical Engineering

A minimum of 194 units is required for graduation. A complete list of requirements for the major can be found on page 46. Schedules should be planned to meet both General Education and major requirements. Courses required for the major, inside or outside of the Department of Chemical Engineering, cannot be taken for the pass/not pass grading option. They must be taken for letter grades.

Twelve units of technical electives selected from a wide variety of upper-division science and engineering courses are also required. The list of approved technical electives is included on curriculum sheets. Prior approval of technical electives must be obtained from the department faculty advisor and the technical elective work sheet must be submitted to the department by fall quarter of the senior year.

Transfer students who have completed most of the lower-division courses listed above and are entering the junior year of the chemical engineering program may take Chemical Engineering 10 concurrently with Chemical Engineering 120A in the fall quarter.

110B. Chemical Engineering Thermodynamics
(3) STAFF
Prerequisite: Chemical Engineering 110A with a minimum grade of C-; Mathematics 4B; Engineering majors only.

Extension of Chemical Engineering 110A to cover mixtures and multiphase equilibrium. Liquid-vapor separations calculations are emphasized. Introduction to equations of state for mixtures.

119. Current Events in Chemical Engineering
(1) STAFF
Prerequisites: Chemical Engineering 110A-B.

Assigned readings in technical journals on current events of interest to chemical engineers. Student groups present oral reports on reading assignments pertaining to new technologies, discoveries, industry challenges, society/government issues, professional and ethical responsibilities.

120A. Transport Processes
(4) SQUIRES, MITAGOTRI
Prerequisites: Chemical Engineering 10 with a minimum grade of C- (may be taken concurrently); Mathematics 4B; Mathematics 6A-B.

Introductory course in conceptual understanding and mathematical analysis of problems in fluid dynamics of relevance to Chemical Engineering. Emphasis is placed on performing microscopic and macroscopic mathematical analysis to understand fluid motion in response to forces.

120B. Transport Processes
(3) STAFF
Prerequisite: Chemical Engineering 10 with minimum grade of C-; Chemical Engineering 110A with minimum grade of C- (may be taken concurrently); Chemical Engineering 120A.

Introductory course in the mathematical analysis of conductive, convective and radiative heat transfer with practical applications to design of heat exchange equipment and use.

120C. Transport Processes
(3) PETERS
Prerequisite: Chemical Engineering 10 with a minimum grade of C-; Chemical Engineering 110A with minimum grade of C-; Chemical Engineering 110B (may be taken concurrently) and Chemical Engineering 120B.

Introductory course in the fundamentals of mass transfer with applications to the design of mass transfer equipment.

121. Colloids and Biosurfaces
(3) ISRAELACHVILI
Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.

Not open for credit to students who have completed Chemical Engineering 121.

124. Advanced Topics in Transport Phenomena/Safety
(3) THEOFANOUS
Prerequisite: Chemical Engineering 120A-B-C or Mechanical Engineering 151A-B; and Mechanical Engineering 152A.

Same course as ME 124.

125. Principles of Bioengineering
(3) MITAGOTRI
Applications of engineering to biological and medical systems. Introduction to drug delivery, tissue engineering, and modern biomedical devices. Design and applications of these systems are discussed.
126. Non-Newtonian Fluids, Soft Materials and Chemical Products
(3) SOURCES, HELGESON
Prerequisite: Chemical Engineering 120C
Overview of soft materials (suspensions, gels, polymers, surfactants, emulsions, powders and granules) that arise in diverse industries including consumer products, foods, advanced materials, biotechnology, and mineral and energy production. Influence of non-Newtonian rheology (shear-thickening and thinning, viscoelasticity, extension-thickening, yield stresses, normal stress differences, and metastability) upon handling, processing, production, and performance of chemical products. Strategies to design chemical products that meet performance targets, and to scale-up production. Real-world case studies and classroom demonstrations.

128. Separation Processes
(3) SCOTT
Prerequisite: Chemical Engineering 10 and 110A-B; open to College of Engineering majors only.
Basic principles and design techniques of equilibrium-stage separation processes. Emphasis is placed on binary distillation, liquid-liquid extraction, and multicomponent distillation.

132A. Analytical Methods in Chemical Engineering
(4) FREDRICKSON, GORDON
Prerequisite: Mathematics 4B; Mathematics 6A.
Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation of variables, Laplace transforms, Sturm–Liouville theory, generalized Fourier analysis, and computer math tools.

132B. Computational Methods in Chemical Engineering
(4) FREDRICKSON, GORDON
Prerequisite: Mathematics 4B; Mathematics 6A.

132C. Statistical Methods in Chemical Engineering
(3) PETERS
Prerequisites: Mathematics 4B; Mathematics 6A-B.
Probability concepts and distributions, random variables, error analysis, point estimation and confidence intervals, hypothesis testing, development of empirical chemical engineering models using regression techniques, design of experiments, process monitoring based on statistical quality control techniques.

140A. Chemical Reaction Engineering
(3) MCFARLAND, SCOTT
Prerequisites: Chemical Engineering 10 with minimum grade of C-; Chemical Engineering 110A with a minimum grade of C-; Chemical Engineering 110B (may be taken concurrently). Chemical Engineering 120A-B.
Fundamentals of chemical reaction engineering with emphasis on kinetics of homogeneous and heterogeneous reacting systems. Reaction rates and reaction design are linked to chemical conversion and selectivity. Batch and continuous reactor designs with and without catalysts are examined.

140B. Chemical Reaction Engineering
(3) CHMELKA, MCFARLAND
Prerequisites: Chemical Engineering 110A-B, 120A-B and 140A.
Thermodynamics, kinetics, mass and energy transport considerations associated with complex homogeneous and heterogeneous reacting systems. Catalysts and catalytic reaction rates and mechanisms. Adsorption and reaction at solid surfaces, including effects of diffusion in porous materials. Chemical reactors using heterogeneous catalysts.

141. The Science and Engineering of Energy Conversion
Computer Engineering

Computer Engineering Major,
Trailer 380, Room 101;
Telephone (805) 893-5615
E-mail: info@ce.ucsb.edu
Web site: www.ce.ucsb.edu
Director: Li-C. Wang
Associate Director: Forrest Brewer

Faculty
Kevin Almeroth, Ph.D., Georgia Institute of Technology, Professor (computer networks and protocols, large-scale multimedia systems, performance evaluation and distributed systems)
Kau斯塔邦Banerjee, Ph.D., UC Berkeley, Professor (high performance VLSI and mixed signal system-on-chip designs and their design automation methods; single electron transistors; 3D and optoelectronic integration)
Forest Brewer, Ph.D., University of Illinois at Urbana-Champaign, Professor (VLSI and computer system design automation, theory of design and design representations, symbolic techniques in high level synthesis)
Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (specification and automated analysis of concurrent systems, computer-aided verification, model checking)
Alberto Giovanni G. Busetto, Ph.D., ETH Zurich, Switzerland, Assistant Professor (machine learning, adaptive systems, experimental design, systems biology)
Kwang-Ting (Tim) Cheng, Ph.D., UC Berkeley, Professor (design automation, VLSI testing, design synthesis, design verification, algorithms)
Chandra Krintz, Ph.D., University of California, San Diego, Professor (dynamic and adaptive compilation systems, high-performance internet (mobile) computing, runtime and compiler optimizations for Java/CIL, efficient mobile program transfer formats)
Malgorzata Marek-Sadowska, Ph.D., Technical University of Warsaw, Poland, Professor (design automation, computer-aided design, integrated circuit layout, logic synthesis)
Behrooz Parhami, Ph.D., UC Los Angeles, Professor (parallel architectures and algorithms, computer arithmetic, computer design, dependable and fault-tolerant computing)
Tim Sherwood, Ph.D., UC San Diego, Professor (computer architecture, dynamic optimization, network and security processors, embedded systems, program analysis and characterization, and hardware support of software systems)
Dmitri B. Strukov, Ph.D., Stony Brook University, Assistant Professor (hybrid circuits, nanoelectronics, resistance switching devices, memristors, digital memories, programmable circuits, bio-inspired computing)
Li-C. Wang, Ph.D., University of Texas at Austin, Professor (design verification, testing, computer-aided design of microprocessors)
Richard Wolski, Ph.D., UC Davis/Livermore, Professor (high-performance distributed computing, computational grids, computational economies for resource allocation and scheduling)
Yuan Xie, Ph.D., Princeton University, Professor (EDA, VLSI design, computer architecture, embedded systems, high-performance computing)
Ben Zhao, Ph.D., University of California, Berkeley, Associate Professor (computer/overlay/mobile networking, large-scale distributed systems, operating systems, network simulation and modeling)
Heather Zheng, Ph.D., University of Maryland, College Park, Associate Professor (wireless/mobile/ad hoc networking, cognitive radio and dynamic spectrum networks, multimedia communications, security, game theory, algorithms, network simulation and modeling)

Institute of Technology, Associate Professor (low-power analog VLSI, biomimetic nanosystems, neural prostheses, biosensors, block copolymer synthesis, self-assembly, and microfabrication)

Li-C. Wang, Ph.D., University of Texas at Austin, Professor (design verification, testing, computer-aided design of microprocessors)
Richard Wolski, Ph.D., UC Davis/Livermore, Professor (high-performance distributed computing, computational grids, computational economies for resource allocation and scheduling)
Yuan Xie, Ph.D., Princeton University, Professor (EDA, VLSI design, computer architecture, embedded systems, high-performance computing)
Ben Zhao, Ph.D., University of California, Berkeley, Associate Professor (computer/overlay/mobile networking, large-scale distributed systems, operating systems, network simulation and modeling)
Heather Zheng, Ph.D., University of Maryland, College Park, Associate Professor (wireless/mobile/ad hoc networking, cognitive radio and dynamic spectrum networks, multimedia communications, security, game theory, algorithms, network simulation and modeling)

The Computer Engineering major’s objective is to educate broadly based engineers with an understanding of digital electronics, computer architecture, system software and integrated circuit design. These topics bridge traditional electrical engineering and computer science curricula. The Computer Engineering degree program is conducted jointly with faculty from the Department of Computer Science and the Department of Electrical and Computer Engineering. Computer engineers emerging from this program will be able to design and build integrated digital hardware and software systems in a wide range of applications areas. Computer engineers will work alone and in teams, and manage project and team management tasks. The undergraduate major in Computer Engineering prepares students for a variety of positions in business, government and private industrial research, development and manufacturing organizations.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are provided by advisors in the College of Engineering, as well as advisors in the department. Faculty advisors are also available to help with academic program planning. Students who hope to change to this major should consult the department advisor.

Mission Statement
To prepare our students to reach their full potential in computer engineering research and industrial practice through a curriculum emphasizing the mathematical tools, scientific basics, fundamental knowledge, engineering principles, and practical experience in the field.

Educational Objectives
The Computer Engineering Program seeks to produce graduates who:
1) Make positive contributions to society by applying their broad knowledge of computer engineering theories, techniques, and tools.
2) Create processes and products, involving both hardware and software components, that solve societal and organizational problems effectively, reliably, and economically.
3) Are committed to the advancement of science, technical innovation, lifelong learning, professionalism, and mentoring of future generations of engineers.
4) Understand the ethical, social, business, technical, and human contexts of the world in which their engineering contributions will be utilized.

Program Outcomes
Upon completion of this program, students will have:
1) Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and engineering necessary to facilitate specialized professional training at an advanced level. Developed a recognition of the need for and the ability to engage in lifelong learning.
2) Experienced in-depth training in state-of-the-art specialty areas in computer engineering.
3) Benefited from hands-on, practical laboratory experiences where appropriate throughout the program. The laboratory experiences will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students will have completed both hardware-oriented and software-oriented assignments.
4) Experienced designated-oriented challenges that exercise and integrate skills and knowledge acquired during their course of study. These challenges may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and test a system, analyze experimental results, and draw logical conclusions from them.
5) Learned to function well in multidisciplinary teams and collaborative environments. To this end, students must develop communication skills, both written and oral, through teamwork and classroom participation. Teamwork and individual originality will be evidenced through written reports, webpage preparation, and public presentations.
6) Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This outcome provides for the ability to understand the impact of engineering solutions in a global and societal context. A required course in engineering ethics will have prepared
students for making professional contributions while maintaining institutional and individual integrity.

**Undergraduate Program**

**Bachelor of Science—Computer Engineering**

A minimum of 189 units is required for graduation. A complete list of requirements for the major can be found on page 48. Schedules should be planned to meet both General Education and major requirements.

The curriculum contains a core required of all computer engineers, a choice of at least 40 units of senior year elective courses including completion of two out of ten elective sequences and a senior year capstone design project.

Because the Computer Engineering degree program is conducted jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering, several of the upper-division courses have equivalent versions offered by ECE or CMPSC. These courses are considered interchangeable, but only one such course of a given equivalent ECE/CMPSAC pair may be taken for credit.

Courses required for the major, whether inside or outside of the Departments of Electrical and Computer Engineering or Computer Science, must be taken for letter grades. They cannot be taken for the passed/not passed grading option.

The upper-division requirements consist of a set of required courses and a minimum of 40 units (10 classes) of additional departmental elective courses comprised of at least two sequences chosen from a set of eight specialty sequences. Each sequence must consist of two or more courses taken from the same course/sequence group. The department electives must also include a capstone design project (CMPSC 189A-B/ECE 189A-B). Upper-division courses required for the major are: Computer Science 130A, 170; ECE 152A, 154, 156A; either ECE 139 or PSTAT 120A; Engineering 101.

The required departmental electives are taken primarily in the senior year; they permit students to develop depth in specialty areas of their choice. A student’s elective course program and senior project must be approved by a departmental faculty advisor. A variety of elective programs will be considered acceptable. Sample programs include those with emphasis in: computer-aided design (CAD); computer systems design; computer networks; distributed systems; programming languages; real-time computing and control; multimedia; and very large-scale integrated (VLSI) circuit design.

The defined sequences from which upper-division departmental electives may be chosen are:
- Computer Systems Design: ECE/CMPSC 153A, ECE 153B
- Computer Networks: ECE 155A/CMPSC 176A, ECE 155B/CMPSC 176B
- Distributed Systems: ECE 151/CMPSC 171 and one or both of the Computer Networks courses
- Programming Languages: CMPSC 160, 162
- Real-Time Computing & Control: ECE 147A-B, 157
- Multimedia: ECE 178, ECE/CMPSC 181B, ECE 160/CMPSC 182
- VLSI: ECE 124A, 124D
- Signal Processing: ECE 130A-B

**Satisfactory Progress and Prerequisites**

A majority of Computer Science and Electrical and Computer Engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite classes requires a grade of C or better in Mathematics 3A-B-C and a grade of C- or better in ECE classes. Students will not be permitted to take any ECE or CMPSC course if they received a grade of F in one or more of its prerequisites. Students who fail to maintain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major.

**Computer Science Courses**

See listings for Computer Science courses starting on page 28 and Electrical and Computer Engineering starting on page 33.

**Computer Science**

Department of Computer Science, Harold Frank Hall, Room 2104; Telephone (805) 893-4321
Web site: www.cs.ucsb.edu

Chair: Ambuj Singh
Vice Chair: Elizabeth Belding

**Faculty**

Divyakant Agrawal. Ph.D., State University of New York at Stony Brook, Professor (distributed systems and databases)

Kevin Almeroth. Ph.D., Georgia Institute of Technology, Professor (computer networks and protocols, large-scale multimedia systems, performance evaluation and distributed systems)

Elizabeth Belding. Ph.D., University of California, Santa Barbara, Professor (mobile wireless networking, network performance evaluation, advanced service support, solutions for developing and under-developed regions)

Tevfik Bultan. Ph.D., University of Maryland, College Park, Professor (distributed systems and databases)

Peter R. Cappello. Ph.D., Princeton University, Professor (JAVA/im-net based parallel computing, multiprocessor scheduling, market-based resource allocation, self-directed learning)

Phillip Conrad. Ph.D., University of Delaware, Lecturer LSOE (computer science education, web technologies, computer networks and communication, transport protocols, multimedia computing)

Amr El Abbadi. Ph.D., Cornell University, Professor (Information and data management; distributed systems, cloud computing)

Frederic Gibou. Ph.D., University of California, Los Angeles, Professor (High resolution multiscale simulation, scientific computing, tools and software for computational science and engineering, engineering applications)

John R. Gilbert. Ph.D., Stanford University, Professor (combinatorial scientific computing, high-performance graph algorithms, tools and software for computational science and engineering, numerical linear algebra)

Teofilo Gonzalez. Ph.D., University of Minnesota, Professor (approximation algorithms; parallel computing multicores; scheduling theory; placement and routing; computational geometry; analysis of algorithms)
Ben Hardekopf, Ph.D., University of Texas at Austin, Assistant Professor (programming languages: design, analysis and implementation)

Tobias Höllerer, Ph.D., Columbia University, Professor (human computer interaction: augmented reality; virtual reality; visualization; computer graphics; 3D displays and interaction; wearable and ubiquitous computing)

Chandra Krintz, Ph.D., University of California, San Diego, Professor (programming language implementations, dynamic and adaptive program analysis and optimization, mobile and distributed program analysis, cloud computing platforms (AppScale))

Christopher Kruegel, Ph.D., Vienna University of Technology, Associate Professor (computer security, program analysis, operating systems, network security, malicious code analysis and detection)

Huijia Lin, PhD, Cornell University, Assistant Professor (cryptography, theory of computing, security)

Linda R. Petzold, Ph.D., University of Illinois at Urbana–Champaign, Professor (modeling, simulation and analysis of multiscale systems in systems biology and engineering)2

Tim Sherwood, Ph.D., University of California, San Diego, Professor (computer architecture, secure processors, embedded systems, program analysis and characterization)

Ambuj Singh, Ph.D., University of Texas at Austin, Professor (network science, cheminformatics & bioinformatics, graph querying and mining, databases)3

Jianwen Su, Ph.D., University of Southern California, Professor (database systems, Web services, workflow management and BPM)

Subhash Suri, Ph.D., Johns Hopkins University, Professor (algorithms, networked sensing, data streams, computational geometry, game theory)

Stefano M. Tersario, PhD, ETH Zurich, Assistant Professor (cryptography, computer security, complexity theory, information theory)

Matthew Turk, Ph.D., Massachusetts Institute of Technology, Professor (computer vision, human computer interaction, perceptual computing, artificial intelligence)

Wim van Dam, Ph.D., University of Oxford and University of Amsterdam, Associate Professor (quantum computation, quantum algorithms, quantum communication, quantum information theory)4

Giovanni Vigna, Ph.D., Politecnico di Milano, Professor (computer and network security, intrusion detection, vulnerability, analysis and security testing, web security, malware detection)

Yuan-Fang Wang, Ph.D., University of Texas at Austin, Professor (computer vision, computer graphics, artificial intelligence)

Richard Wolski, Ph.D., University of California, Davis/Livermore, Professor (cloud computing, high-performance distributed computing, computational grids, and computational economies for resource allocation and scheduling)

Xifeng Yan, Ph.D., University of Illinois at Urbana Champaign, Associate Professor (data mining, data management, machine learning, bioinformatics, information networks)

Tao Yang, Ph.D., Rutgers University, Professor (parallel and distributed systems, Internet search, and high performance computing)

Ben Zhao, Ph.D., University of California, Berkeley, Associate Professor (online social networks, data-intensive computing, cloud computing, dynamic spectrum networks, anonymity and privacy, distributed systems)

Heather Zheng, Ph.D., University of Maryland, College Park, Associate Professor (wireless/mobile/ad hoc networking, cognitive radio and dynamic spectrum networks, multimedia communications, security, game theory, algorithms, network simulation and modeling)

Emeriti Faculty

Oscar H. Ibarra, Ph.D., University of California, Berkeley, Professor (design and analysis of algorithms, theory of computation, computational complexity, parallel computing)

Richard A. Kemmerer, Ph.D., University of California, Los Angeles, Professor (specification and verification of systems, computer system security and reliability, programming and specification language design, software engineering)

Alan G. Konheim, Ph.D., Cornell University, Professor Emeritus (computer communications, computer systems, modeling and analysis, cryptography)

Marvin Marcus, Ph.D., University of California, Berkeley, Professor Emeritus (linear and multilinear algebra, scientific computation, numerical algorithms)

Terence R. Smith, Ph.D., Johns Hopkins University, Professor Emeritus (spatial databases, techniques in artificial machine intelligence)5

Affiliated Faculty

B.S. Manjunath, Ph.D. (Electrical and Computer Engineering)

P. Michael Melliar-Smith, Ph.D. (Electrical and Computer Engineering)

Kenneth Rose, Ph.D. (Electrical and Computer Engineering)

Martin Raubal, Ph.D. (Geography)

Many of the greatest challenges facing our world today are increasingly reliant on computing for their solutions — from conquering disease to eliminating hunger, from improving education to protecting the climate and environment. Information is key to all of these efforts, and computer scientists make it possible to visualize, secure, explore, transmit, and transform this information in ways never before thought possible. Solving problems through computation means teamwork, collaboration, and gaining the interdisciplinary skills that modern careers demand. Our goal with the Computer Science curriculum at UCSB is to impart to students the knowledge and experience required for them to participate in this exciting and high-impact discipline.

Mission Statement

The Computer Science Department seeks to prepare undergraduate and graduate students for productive careers in industry, academia, and government, by providing an outstanding environment for teaching and research in the core and emerging areas of the discipline. The department places high priority on establishing and maintaining innovative research programs that enhance educational opportunity.

The Department of Computer Science offers programs leading to the degrees of Bachelor of Arts and Bachelor of Science in computer science, and the M.S. and Ph.D. in computer science. The B.A. is a College of Letters and Science major; the B.S. is a College of Engineering major. The B.S. degree program in computer science is accredited by the Computing Accreditation Commission of ABET, http://www.abet.org.

One of the most important aspects of the Computer Science program at UCSB is the wealth of “hands-on” opportunities for students. UCSB has excellent computer facilities. Campus Instructional Computing makes accounts available to all students. Computer Science majors and premajors use the workstations in the Computer Science Instructional Lab and Engineering Computing Infrastructure computer facilities. Students doing special projects can gain remote access to machines at the NSF Supercomputing Centers.

Additional computing facilities are available for graduate students in the Graduate Student Laboratory. Students working with faculty have access to the specialized research facilities within the Department of Computer Science.

The undergraduate major in computer science has a dual purpose: to prepare students for advanced studies and research and to provide training for a variety of careers in business, industry, and government.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering and as well as advisors in the department. A faculty advisor is also available to help with academic program planning.

Program Goals for Undergraduate Programs

The goal of the computer science undergraduate program is to prepare future generations of computer professionals for long-term careers in research, technical development, and applications. Graduates of the B.S. and B.A. programs that
wish to seek immediate employment are prepared for a wide range of computer science positions in industry and government. Outstanding graduates interested in highly technical careers, research, and/or academia, might consider furthering their education in graduate school.

The primary computer science departmental emphasis is on problem solving using computer program design, analysis, and implementation, with both a theoretical foundation and a practical component.

Program Outcomes for Undergraduate Programs
The program enables students to achieve, by the time of graduation:
1. An ability to apply knowledge of computing and mathematics appropriate to computer science.
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, and social responsibilities.
6. An ability to communicate effectively.
7. An ability to analyze the impact of computing on individuals, organizations, and society, including ethical, legal, security, and global policy issue.
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.
10. An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the trade-offs involved in design choices.
11. An ability to apply design and development principles in the construction of software systems of varying complexity.

Admission to the Major
Students interested in computer science who apply to UCSB should declare the computer science major when they apply. UCSB students in majors other than computer science major can petition to the Department of Computer Science for consideration for admission via change-of-major once they complete the minimum requirements (specified on the departmental web pages) for doing so. Computer Science majors have priority when registering for all Computer Science courses.

Students admitted to the computer science major are responsible for satisfying major requirements in effect when they declare their major. Upper and lower division courses required for the major that are offered by the Department of Computer Science or any other department must be taken for letter grades.

Undergraduate Program
Bachelor of Science—Computer Science
A minimum of 184 units is required for graduation. A complete list of requirements for the major can be found on page 50. Schedules should be planned to meet both General Education and major requirements.

Students with no previous programming background should take CMPSC 8 before taking CMPSC 16. CMPSC 8 is not included in the list of preparation for the major courses but may be counted as a free elective.

Students applying for major status in the BS program who have completed more than 105 units will not be considered for a change of major/change of college.

Students may petition to enter the Computer Science major when the following requirements are met:
1. A cumulative grade point average of at least 3.0;
2. Satisfactory completion of Computer Science 16 and 24 with a cumulative GPA of 3.2 or higher; First takes only
3. Satisfactory completion of Math 3A, 3B, 4A, 4B and Computer Science 40 with a cumulative GPA of 3.0 or higher; First takes only

The selection process is highly competitive and these milestones are minimum requirements for consideration, achieving them does not guarantee admission to the Computer Science major. Any petitions denied will be automatically considered a second time in the next quarter. Petitions denied a second time will not be reconsidered.

More information can be found at http://cs.ucsb.edu/undergraduate/admissions/.

Bachelor of Science—Computer Engineering
This major is offered jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering. For information about this major, see page 25.

Computer Science Courses
LOWER DIVISION
1. Seminar on the Field of Computer Science
(1) FRANKLIN
Overview the potential of, and opportunities available from, the field of computer science. Topics include an overview of how computers work and the interesting ways in which computers can be applied to solve important and high-impact technological, social, and cutting-edge research problems.

8. Introduction to Computer Science
(4) CONRAD, FRANKLIN
Not open for credit to students who have completed Computer Science 16 or Engineering 3.
Legal repeat for CMPSC 5AA-5Z.
Introduction to computer program development for students with little to no programming experience. Basic programming concepts, variables and expressions, data and control structures, algorithms, debugging, program design, and documentation.

11AA-ZZ. Programming Language Laboratory
(1) FRANKLIN
Different sections may be repeated. Sections not always offered.
Recommended preparation: knowledge of at least one programming language.
A self-paced course to allow a student who already possesses a working knowledge of at least one programming language an opportunity to learn other languages of interest.

16. Problem Solving with Computers I
(4) CONRAD, FRINTZ
Prerequisite: Math 3A with a C or better (may be taken concurrently) CS 8 with a C or better, Engineering 3, AP CS, or an intro to programming course.
Legal repeat for CMPSC 16.
Fundamental building blocks for solving problems using computers. Topics include basic computer organization and programming constructs: memory CPU, binary arithmetic, variables, expressions, statements, conditionals, iteration, functions, parameters, recursion, primitive and composite data types, and basic operating system and debugging tools.

24. Problem Solving with Computers II
(4) FRANKLIN, COSTANZO
Prerequisite: Computer Science 16 with a grade of C or better; and Math 3B (may be taken concurrently).
Not open for credit to students who have completed Computer Science 20.
Intermediate building blocks for solving problems using computers. Topics include data structures, object-oriented design and development, algorithms for manipulating these data structures and their runtime analyses. Data structures introduced include stacks, queues, lists, trees, and sets.

32. Object Oriented Design and Implementation
(4) HOLLERER
Prerequisite: Computer Science 24 with a grade of C or better.
Advanced topics in object-oriented computing. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging; recent advances in design and development tools, practices, libraries, and operating system support.

40. Foundations of Computer Science
(5) VAN DAM, SU
Prerequisites: Computer Science 16 with a grade of C or better; and Mathmatics 4A with a grade of C or better.
Introduction to the theoretical underpinnings of computer science. Topics include propositional predicate logic, set theory, functions and relations, counting, mathematical induction and recursion (generating functions).
48. Computer Science Project

(4) CAPPELLO
Prerequisite: Computer Science 32 with a grade of C or better.

Team-based project development. Topics include software engineering and professional development practices, software project management, advanced library support; techniques for team-oriented design and development, testing and test-driven development, and software reliability and robustness. Students present and demonstrate their final projects.

56. Advanced Applications Programming

(4) CONRAD
Prerequisite: Computer Science 24 and 32 with a grade of C or better.

Not open for credit to students who have completed Computer Science 20. Advanced application programming using a high-level, virtual-machine-based language. Topics include generic programming, exception handling, programming language implementation; automatic memory management, and application development, management, and maintenance tools; event handling, concurrency and threading, and advanced library use.

64. Computer Organization and Logic Design

(4) ZHENG, FRANKLIN
Prerequisite: Computer Science 16 with a grade of C or better, and Mathematics 3C or 4A with a grade of C or better.

Not open for credit to students who have completed ECE 15 or ECE 15B or Computer Science 30. Course counts as a legal repeat of CMPSC 30. Assembly language programming and advanced computer organization; Digital logic design topics including gates, combinational circuits, flip-flops, and the design and analysis of sequential circuits.

95AA-2Z. Undergraduate Seminar in Computer Science

(1-4) STAFF
Prerequisites: Open to pre-computer science and pre-computer engineering majors only; consent of instructor.

Seminars on introductory topics in computer science. These seminars provide an overview of the history, technology, applications, and impact in various areas of computer science, including: A. Foundations, B. Software Systems, C. Programming languages and software engineering, D. Information management, E. Architecture, F. Networking, G. Security, H. Scientific computing, I. Intelligent and interactive systems, J. History, N. General.

99. Independent Studies in Computer Science

(1-4) STAFF
Must have a minimum 3.0 grade point average. May be repeated. Students are limited to 5 units per quarter and 30 units total in all 99/198/199 courses combined.

Independent studies in computer science for advanced students.

UPPER DIVISION

111. Introduction to Computational Science

(4) PETZOLD
Prerequisite: Mathematics 5A or 4B with a grade of C or better; Mathematics 5B or 6A with a grade of C or better; Computer Science 24 with a grade of C or better.

Not open for credit to students who have completed Computer Science 110A. Introduction to computational science, emphasizing basic numerical algorithms and the informed use of mathematical software. Matrix computation, systems of linear and nonlinear equations, interpolation and zero finding, differential equations, numerical integration. Students learn and use the Matlab language.

130A. Data Structures and Algorithms I

(4) GONZALEZ
Prerequisites: Computer Science 40 with a grade of C or better; Computer Science 32 with a grade of C or better; Computer Science 48 with a grade of C or better (can be taken concurrently); PSTAT 120A or ECE 139; open to computer science, computer engineering, and electrical engineering majors only.

The study of data structures and their applications. Correctness proofs and techniques for the design of correct programs. Internal and external searching. Hashing and height balanced trees. Analysis of sorting algorithms. Memory management. Graph traversal techniques and their applications.

130B. Data Structures and Algorithms II

(4) GONZALEZ, SURI
Prerequisite: Computer Science 130A.

Design and analysis of computer algorithms. Correctness proofs and solution of recurrence relations. Design techniques; divide and conquer, greedy strategies, dynamic programming, branch and bound, backtracking, and local search. Applications of techniques to problems from several disciplines. NP - completeness.

138. Automata and Formal Languages

(4) EGEICHOGLU
Prerequisite: Computer Science 40 with a grade of C or better; open to computer science and computer engineering majors only.

Formal languages; finite automata and regular expressions; properties of regular languages; pushdown automata and context-free grammars; properties of context-free languages; introduction to computability and unsolvability. Introduction to Turing machines and computational complexity.

140. Parallel Scientific Computing

(4) GILBER
Prerequisite: Mathematics 4B or 5A with a grade of C or better; Mathematics 6A or 5B with a grade of C or better; Computer Science 130A.

Not open for credit to students who have completed Computer Science 110B. Fundamentals of high performance computing and parallel algorithm design for numerical computation. Topics include parallel architecture and clusters, parallel programming with message-passing libraries and threads, program parallelization methodologies, parallel performance evaluation and optimization, parallel algorithms and applications with different performance trade-offs.

153A. Hardware/Software Interface

Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering.

Same course as ECE 153A.

Issues in interfacing computing systems and software to practical hardware. Rapid response, real-time events and management of tasks, threads, and scheduling required for efficient design of embedded software and systems is discussed. Techniques for highly constrained systems.

154. Computer Architecture

(4) SHERWOOD
Prerequisite: Computer Science 32 and Computer Science 64.

Not open for credit to students who have received credit for ECE 154, ECE 154A, or ECE 154B.

Introduction to the architecture of computer systems. Topics include: central processing units, memory systems, channels and controllers, peripheral devices, interrupt systems, software versus hardware trade-offs.

160. Translation of Programming Languages

(4) SHERWOOD
Prerequisite: Computer Science 64 or Electrical Engineering 154 or Electrical Engineering 154A; Computer Science 130A, and Computer Science 138; open to computer science and computer engineering majors only.

Study of the structure of compilers. Topics include: lexical analysis; syntax analysis including LL and LR parsers; type checking; run-time environments; intermediate code generation; and compiler-construction tools.

162. Programming Languages

(4) HARDEKOPP, KRINTZ
Prerequisite: Computer Science 130A and Computer Science 138; open to computer science and computer engineering majors only.

Concepts of programming languages: scopes, parameter passing, garbage management, control flow, exception handling; encapsulation and modularization mechanisms; reusability through generality and inheritance; type systems; programming paradigms (procedural, object-oriented, functional, and others). Emerging programming languages and their development infrastructures.

165A. Artificial Intelligence

(4) TURK
Prerequisite: Computer Science 130A.

Introduction to the field of artificial intelligence, which seeks to understand and build intelligent computational systems. Topics include intelligent agents, problem solving and heuristic search, knowledge representation and reasoning, uncertainty, probabilistic reasoning, and applications of AI.

165B. Machine Learning

(4) SINGH
Prerequisite: Computer Science 130A.

Covers the most important techniques of machine learning (ML) and includes discussions of well-posed learning problems; artificial neural networks; concept learning and general to specific ordering; decision tree learning; genetic algorithms; Bayesian learning; analytical learning; and others.

170. Operating Systems

(4) KRUEGEL, ZHAO
Prerequisite: Computer Science 130A and, Computer Science 154 or ECE 154 (may be taken concurrently), open to computer science, computer engineering or electrical engineering majors only.

Basic concepts of operating systems. The notion of a process; interprocess communication and synchronization; input-output, file systems, memory management.

171. Distributed Systems

(4) EL ABBADI
Prerequisite: Computer Science 130A.

Not open for credit to students who have completed ECE 151.

Distributed systems architecture, distributed programming, network of computers, message passing, remote procedure calls, group communication, naming and membership problems, asynchrony, logical time, consistency, fault-tolerance, and recovery.

174A. Fundamentals of Database Systems

(4) SU
Prerequisite: Computer Science 130A

Recommended Preparation: Students are strongly encouraged to complete Computer Science 56 prior to enrolling in Computer Science 174A.

Database system architectures, relational data model, relational algebra, relational calculus, SQL, QBE, query processing, integrity constraints (key constraints, referential integrity), database design, ER and object-oriented data model, functional dependencies, lossless join and dependency preserving decompositions, Boyce-Codd and Third Normal Form.

176A. Introduction to Computer Communication Networks

(4) ALMERTH, BELDING
Prerequisite: CMPSC 32 with a grade of C or better; PSTAT 120A or ECE 139; open to computer science, electrical engineering, and computer engineering majors only.

Not open for credit to students who have completed Computer Science 176 or ECE 155 or ECE 155A.

Recommended preparation: PSTAT 120B. Basic concepts in networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks.

176B. Network Computing

(4) ZHAO, VIGNA
Prerequisite: Computer Science 176A.

Not open for credit to students who have completed ECE 155B or 194W.

Focus on networking and web technologies.
used in the Internet. The class covers socket programming and web-based techniques that are used to build distributed applications.

176C. Advanced Topics in Internet Computing
(4) BELLING, ZHENG
Prerequisite: Computer Science 176B.
General overview of wireless and mobile networking, multimedia, security multicast, quality of service, IPv6, and web caching. During the second half of the course, one or more of the above topics are studied in greater detail.

177. Computer Security
(4) KEMMERER
Prerequisite: Computer Science 170 (may be taken concurrently).
Introduction to the basics of computer security and privacy. Analysis of technical difficulties of producing secure computer information systems that provide guaranteed controlled sharing. Examination and critique of current systems, methods, certification.

178. Introduction to Cryptography
(4) EGECIOGLU
Prerequisites: Computer Science 24 and Computer Science 40 with a grade of C or better, and PSTAT 120B or 121A or ECE 139 or permission of instructor.
An introduction to the basic concepts and techniques of cryptography and cryptanalysis. Topics include: The Shannon Theory, classical systems, the Enigma machine, the data encryption standard, public key systems, digital signatures, file security.

180. Computer Graphics
(4) WANG
Prerequisite: Computer Science 130A or consent of instructor.
Overview of OpenGL graphics standard, OpenGL state machine, other 3D graphics libraries, 3D graphics pipeline, 3D transformations and clipping, color model, shading model, shadow algorithms, texturing, curves and curved surfaces, graphics hardware, interaction devices and techniques.

181B. Introduction to Computer Vision
(4) WANG, TURK
Prerequisite: Upper-division standing.
Same course as ECE 181B.
Overview of computer vision problems and techniques for analyzing the content images and video. Topics include image formation, edge detection, image segmentation, pattern recognition, texture analysis, optical flow, stereo vision, shape representation and recovery techniques, issues in object recognition, and case studies of practical vision systems.

185. Human-Computer Interaction
(4) HOLLERER
Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering majors.
Recommended preparation: Students are strongly encouraged to complete Computer Science 56 prior to enrolling in Computer Science 185.
Proficiency in the Java/C++ programming language, some experience with user interface programming.
The study of human-computer interaction enables system architects to design useful, efficient, and enjoyable computer interfaces. This course teaches the theory, design guidelines, programming practices, and evaluation procedures behind effective human interaction with computers.

189A. Senior Computer Systems Project
(4) BULTAN
Prerequisite: Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.
Not open for credit to students who have completed Computer Science 172 or ECE 189A.
Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings. Project for follow-up course may be different.

189B. Senior Computer Systems Project
(4) BULTAN
Prerequisite: CMPSC 189A; Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.
Not open for credit to students who have completed ECE 189A or ECE 189B.
Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings.
Project for course may be different from that in first course.

190AA-ZZ. Special Topics in Computer Science
(4) STAFF
Prerequisite: consent of instructor.
May be repeated with consent of the department chair.
Courses provide for the study of topics of current interest in computer science: A. Foundations; B. Software Systems; C. Programming languages and software engineering; D. Information management; E. Architecture; F. Networking; G. Security; H. Scientific computing; I. Artificial intelligence and interactive systems; N. General

192. Projects in Computer Science
(1-5) STAFF
Prerequisite: consent of instructor.
Students must have a minimum 3.0 GPA.
May be repeated to a maximum of 8 units with consent of the department chair but only 4 units may be applied to the major.
Projects in computer science for advanced undergraduate students.

193. Internship in Industry
(1-4) STAFF
Prerequisites: consent of instructor and department chair.
Not more than 4 units per quarter; may not be used as a field elective and may not be applied to science electives. May be repeated with faculty/chair approval to a maximum of 4 units.
Special projects for selected students. Offered in conjunction with selected industrial and research firms under direct faculty supervision. Prior departmental approval required. Written proposal and final report required.

196. Undergraduate Research
(1-4) STAFF
Prerequisites: upper-division standing; must have a minimum 3.0 grade-point average for preceding three quarters, (2) have a minimum 3.0 GPA, (3) have consent of instructor.
May be repeated for up to 12 units. No more than 4 units may be applied to departmental electives.
Research opportunities for undergraduate students. Students will be expected to give regular oral presentations, actively participate in a weekly seminar, and prepare at least one written report on their research.

199. Independent Studies in Computer Science
(1-4) STAFF
Prerequisites: upper-division standing; must have completed at least two upper-division courses in computer science.
Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated with consent of chair. Students are limited to 5 units per quarter and 30 units total in all 198/199 courses combined. May not be used for credit towards the major.
Independent study in computer science for advanced undergraduate students.

Graduate Courses
Graduate courses for the major can be found in the UCSB General Catalog.

Electrical & Computer Engineering
Department of Electrical and Computer Engineering, Building 380, Room 101; Telephone (805) 893-2269 or (805) 893-3821
Web site: www.ece.ucsb.edu
Chair: Joao Hespanha
Vice Chair: B.S. Manjunath

Faculty
Rod C. Alferness, Ph.D., University of Michigan, Professor and Dean (integrated optoelectronics, optical switching technology and switched optical networks)
Kauat Banerjee, Ph.D., UC Berkeley, Professor (high performance VLSI and mixed signal system-on-chip designs and their design automation methods; single electron transistors; 3D and optoelectronic integration)
Daniel J. Blumenthal, Ph.D., University of Colorado at Boulder, Professor (fiber-optic networks, wavelength and subcarrier division multiplexing, photonic packet switching, signal processing in semiconductor optical devices, wavelength conversion, microwave photonics)
John E. Bowers, Ph.D., Stanford University, Professor (high-speed photonic and electronic devices and integrated circuits, fiber optic communication, semiconductors, laser physics and mode-locking phenomena, compound semiconductor materials and processing)

ECE department Chair Joao Hespanha delivers Starbucks during finals week to hardworking students outside the new wing of the campus library during a #coffeemecoe event.
Forrest D. Brewer, Ph.D., University of Illinois at Urbana-Champaign, Professor (VLSI and computer system design automation, theory of design and design representations, symbolic techniques in high level synthesis)

James Buckwalter, Ph.D., California Institute of Technology, Professor (RF and mixed-signal CMOS integrated circuits, high-speed communications systems)

Alberto Giovanni G. Busetto, Ph.D., ETH Zurich, Switzerland, Assistant Professor (machine learning, adaptive systems, experimental design, systems biology)

Katie A. Byl, Ph.D., Massachusetts Institute of Technology, Associate Professor (robotics, autonomous systems, dynamics, control, manipulation, locomotion, machine learning)

Shivkumar Chandrasekaran, Ph.D., Yale University, Professor (numerical analysis, numerical linear algebra, scientific computation)

Kwang-Ting (Tim) Cheng, Ph.D., UC Berkeley, Professor (design automation, VLSI testing, design synthesis, design verification, algorithms)

Larry A. Coldren, Ph.D., Stanford University, Kavli Professor in Optoelectronics and Sensors, Director of Optoelectronics Technology Center (semiconductor integrated optoelectronics, vertical-cavity lasers, widely-tunable lasers, optical fiber communication, growth and planar processing techniques) *1

Nadir Dagli, Ph.D., Massachusetts Institute of Technology, Professor (design, fabrication, and modeling of photonic integrated circuits, ultrafast electrooptic modulators, solid state microelectromechanical systems, millimeter wave devices, experimental study of ballistic transport in quantum confined structures)

Steven P. DenBaars, Ph.D., University of Southern California, Professor (metalorganic vapor phase epitaxy, optoelectronic materials, compound semiconductors, indium phosphide and gallium nitride, photonic devices) *1

Jerry Gibson, Ph.D., Southern Methodist University, Professor (digital signal processing, data, speech, image and video compression, and communications via multi-use networks, data embedding, adaptive filtering)

Joao Hespanha, Ph.D., Yale University, Professor (hybrid and switched systems, supervisory control, control of computer networks, probabilistic games, the use of vision in feedback control)

Jonathan Klamkin, Ph.D., UC Santa Barbara, Associate Professor

Hua Lee, Ph.D., UC Santa Barbara, Professor (image system optimization, high-performance image formation algorithms, synthetic-aperture radar and sonar systems, acoustic microscopy, microwave nondestructive evaluation, dynamic vision systems)

Michael Liebling, Ph.D., École Polytechnique Fédérale de Lausanne, Associate Professor (image processing, optical microscopy, In Vivo biological imaging)

Upamanyu Madhow, Ph.D., University of Illinois, Professor (spread-spectrum and multiple-access communications, space-time coding, and internet protocols)

B.S. Manjunath, Ph.D., University of Southern California, Professor (image processing, computer vision, pattern recognition, neural networks, learning algorithms, content-based search in multimedia databases)

Jason R. Marden, Ph.D., UC Los Angeles Assistant Professor

Malgorzata Marek-Sadowska, Ph.D., Technical University of Warsaw, Poland, Professor (design automation, computer-aided design, integrated circuit layout, logic synthesis)

Unmesh Mishra, Ph.D., Cornell University, Professor (high-speed transistors, semiconductor device physics, quantum electronics, wide band gap materials and devices, design and fabrication of millimeter-wave devices, in situ processing and integration techniques)

Yasamin Mostofi, Ph.D., Stanford University, Associate Professor (mobile sensor networks, wireless systems, networked control systems)

Behrooz Parhami, Ph.D., UC Los Angeles, Professor (parallel architectures and algorithms, computer arithmetic, computer design, dependable and fault-tolerant computing)

Lawrence Rabiner, Ph.D., Massachusetts Institute of Technology, Professor (digital signal processing: intelligent human-machine interaction, digital signal processing, speech processing and recognition; telecommunication)

Volkan Rodoplu, Ph.D., Stanford University, Associate Professor (wireless networks, energy-efficient and device-adaptive communications)

Mark J.W. Rodwell, Ph.D., Stanford University, Professor, Director of Compound Semiconductor Research Laboratories, Director of National Nanofabrication Users Network (heterojunction bipolar transistors, high frequency integrated circuit design, electronics beyond 100 GHz)

Kenneth Rose, Ph.D., California Institute of Technology, Professor, Co-Director of Center for Information Processing Research (information theory, source and channel coding, image coding, communications, pattern recognition)

Clint Schow, PhD, University of Texas, Austin, Professor (optoelectronic/electronic co-design and integration, equalization techniques for high-speed optical links, photonic switching, optoelectronic devices, integrated transceiver packaging)

Jon A. Schuller, Ph.D., Stanford University, Assistant Professor (nanophotonics, organic optoelectronics, plasmonics, metamaterials)

Pradeep Sen, Ph.D., Stanford University, Associate Professor (computer graphics and imaging)

John J. Shynk, Ph.D., Stanford University, Professor (hybrid circuits, nanoelectronics, resistance switching devices, memristors, digital memories, programmable circuits, bio-inspired computing)

Andrew Teel, Ph.D., UC Berkeley, Professor (control design and analysis for nonlinear dynamical systems, input-output methods, actuator nonlinearities, applications to aerospace problems)

Luke Theogarajan, Ph.D., Massachusetts Institute of Technology, Associate Professor (low-power analog VLSI, biomimetic nanosystems, neural prostheses, biosensors, block co-polymer synthesis, self-assembly, and microfabrication)

Li C. Wang, Ph.D., University of Texas, Austin, Professor (design verification, testing, computer-aided design of microprocessors)

Yuan Xie, Ph.D., Princeton University, Professor (EDA, VLSI design, computer architecture, embedded systems, high-performance computing)

Robert York, Ph.D., Cornell University, Professor (high-power/high-frequency devices and circuits, quasi-optics, antennas, electromagnetic theory, nonlinear circuits and dynamics, microwave photonics)

Emeriti Faculty

Steven E. Butner, Ph.D., Stanford University, Professor (computer architecture, VLSI design of CMOS and gallium-arsenide ICs with emphasis on distributed organizations and fault-tolerant structures)

Jorge R. Fontana, Ph.D., Stanford University, Professor Emeritus (quantum electronics, particularly lasers, interaction with charged particles)

Allen Gersho, Ph.D., Cornell University, Professor Emeritus, Director of Center for Information Processing Research (speech, audio, image, and video compression, quantization and signal compression techniques, and speech processing)

Arthur C. Gossard, Ph.D., UC Berkeley, Professor Emeritus, (epitaxial crystal growth, artificially structured materials, semiconductor structures for optical and electronic devices, quantum confinement structures) *1

Glenn R. Heidbreder, D. Eng., Yale University, Professor Emeritus (communication theory, signal processing in radar and digital communication systems; digital image processing)

Evelyn Hu, Ph.D., Columbia University, Professor Emeritus, (high-resolution fabrication techniques for semiconductor device structures, process-related materials damage, contact/interface studies, superconductivity) *1

Ronald Itilis, Ph.D., UC San Diego, Professor (digital spread spectrum communications, spectral estimation and adaptive filtering)

Petrar V. Kokotovic, Ph.D., USSR Academy of Sciences, Professor Emeritus, Director of Center for Control Engineering and Computation, Director of Center for Robust Nonlinear Control of Aeroengines (sensitivity analysis, singular perturbations, large-scale systems, non-linear systems, adaptive control, automotive and jet engine control)

Robert Kremser, Dr. rer. nat., University of Göttingen, Donald W. Whittier Professor in Electrical Engineering, 2000 Physics Nobel
Laureate (general solid-state and device physics, heterostructures, molecular beam epitaxy, compound semiconductor materials and devices, superconductivity)

Stephen Long, Ph.D., Cornell University, Professor Emeritus (microwave devices and integrated circuits for high speed digital and RF analog applications)

George L. Mattheai, Ph.D., Stanford University, Professor Emeritus (circuit design techniques for passive and active microwave, millimeter-wave and optical integrated circuits, circuit problems of high-speed digital integrated circuits)

P. Michael Melliar-Smith, Ph.D., University of Cambridge, Professor Emeritus (fault tolerance, formal specification and verification, distributed systems, communication networks and protocols, asynchronous systems)

James L. Merz, Ph.D., Harvard University, Professor Emeritus (optical properties of semiconductors, including guided-wave and integrated optical devices, semiconductor lasers, optoelectronic devices, native defects in semiconductors, low-dimensional quantum structures)

Sanjit K. Mitra, Ph.D., UC Berkeley, Professor Emeritus, (digital signal and image processing, computer-aided design and optimization)

Louise E. Moser, Ph.D., University of Wisconsin, Professor (distributed systems, computer networks, software engineering, fault-tolerance, formal specification and verification, performance evaluation)

Venkatesh Narayamurti, Ph.D., Cornell University, Professor Emeritus (transport, semiconductor heterostructures, nanostructures, scanning tunneling microscopy and ballistic electron emission microscopy, phonon physics)

Pierre M. Petroff, Ph.D., UC Berkeley, Professor (self assembling nanostructures in semiconductors and ferromagnetic materials, spectroscopy of nanostructures, nanostructure devices, semiconductor device reliability)

Ian B. Rhodes, Ph.D., Stanford University, Professor Emeritus (mathematical system theory and its applications with emphasis on stochastic control, communication, and optimization problems, especially those involving decentralized information structures or parallel computational structures)

John G. Skalnik, D. Eng., Yale University, Professor Emeritus (solar cells, general device technology, effects of non-ideal structures)

Pochi Yeh, Ph.D., California Institute of Technology, Professor (phase conjugation, nonlinear optics, dynamic holography, optical computing, optical interconnection, neural networks, and image processing)

Francesco Bullo, Ph.D. (Mechanical Engineering)
Frederick Chong, Ph.D. (Computer Science)
Francis Doyle, Ph.D., (Chemical Engineering)
Chandra Krintz, Ph.D. (Computer Science)
Eric McFarland, Ph.D., (Chemical Engineering)
Shuji Nakamura, Ph.D. (Materials)
Bradley E. Paden, Ph.D. (Mechanical Engineering)
Tim Sherwood, Ph.D. (Computer Science)
Hyongsok Tom Soh, Ph.D. (Mechanical Engineering)
Matthew Turk, Ph.D. (Computer Science)
Haitao (Heather) Zheng, Ph.D. (Computer Science)

Electrical and Computer Engineering is a broad field encompassing many diverse areas such as computers and digital systems, control, communications, computer engineering, electronics, signal processing, electromagnetics, electro-optics, physics and fabrication of electronic and photonic devices. As in most areas of engineering, knowledge of mathematics and the natural sciences is combined with engineering fundamentals and applied to the theory, design, analysis, and implementation of devices and systems for the benefit of society.

The Department of Electrical and Computer Engineering offers programs leading to the degrees of bachelor of science in electrical engineering or bachelor of science in computer engineering. (Please see the “Computer Engineering” section for further information.) The undergraduate curriculum in electrical engineering is designed to provide students with a solid background in mathematics, physical sciences, and traditional electrical engineering topics as presented above. A wide range of program options, including computer engineering; microwaves; communications, control, and signal processing; and semiconductor devices and applications, is offered. The department’s Electrical Engineering undergraduate program is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. It is one of the degrees recognized in all fifty states as leading to eligibility for registration as a professional engineer.

The undergraduate major in Electrical Engineering prepares students for a wide range of positions in business, government, and private industrial research, development, and manufacturing organizations.

Students who complete a major in electrical engineering may be eligible to pursue a California teaching credential. Interested students should consult the credential advisor in the Graduate School of Education.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Students who plan to change to a major in the department should consult the ECE student office. Departmental faculty advisors are assigned to students to assist them in choosing senior elective courses.

Counseling is provided to graduate students through the ECE graduate advisor. Individual faculty members are also available for help in academic planning.

Mission Statement
The Department of Electrical and Computer Engineering seeks to provide a comprehensive, rigorous and accredited educational program for the graduates of California’s high schools and for postgraduate students, both domestic and international. The department has a dual mission:

1. Education: We will develop and produce excellent electrical and computer engineers who will support the high-tech economy of California and the nation. This mission requires that we offer a balanced and timely education that includes not only strength in the fundamental principles but also experience with the practical skills that are needed to contribute to the complex technological infrastructure of our society. This approach will enable each of our graduates to continue learning throughout an extended career.

2. Research: We will develop relevant and innovative science and technology through our research that addresses the needs of industry, government, and the scientific community. This technology can be transferred through our graduates, through industrial affiliations, and through publications and presentations.

We provide a faculty that is committed to education and research, is accessible to students, and is highly qualified in their areas of expertise.

Educational Objectives
The educational objectives of the Electrical Engineering Program identify what we hope that our graduates will accomplish within a few years after graduation.

1. We expect our graduates to make positive contributions to society in fields including, but not limited to, engineering.
2. We expect our graduates to have acquired the ability to be flexible and adaptable, showing that their educational background has given them the foundation needed to remain effective, take on new responsibilities and assume leadership roles.
3. We expect some of our graduates to pursue their formal education further, including graduate study for master’s and doctoral degrees.

Program Outcomes
The EE program expects our students upon graduation to have:

1. Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and electrical engineering that are required to support specialized professional training at the
advanced level and to provide necessary breadth to the student’s overall program of studies. This provides the basis for lifelong learning.

2. Experience in-depth training in state-of-the-art specialty areas in electrical engineering. This is implemented through our senior electives. Students are required to take two sequences of at least two courses each at the senior level.

3. Benefited from imaginative and highly supportive laboratory experiences where appropriate throughout the program. The laboratory experience will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students should experience both hardware-oriented and simulation-oriented exercises.

4. Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired in several courses. These may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and conduct experiments as well as analyze the results.

5. Learned to function well in teams. Also, students must develop communication skills, written and oral, both through team and classroom experiences. Skills including written reports, webpage preparation, and public presentations are required.

6. Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This provides for the ability to understand the impact of engineering solutions in a global and societal context. A course in engineering ethics is also required of all undergraduates.

Senior Capstone Design/Project course sequence. A student’s elective course program must be approved by a departmental faculty advisor. The advisor will check the program to ensure satisfaction of the departmental requirements. A wide variety of elective programs will be considered acceptable.

Three matters should be noted: (1) students who fail to attain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major, (2) a large majority of electrical and computer engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B, Mathematics 4A-B and Mathematics 6A and 6B which require a grade of C or better to apply to these courses as prerequisites, (3) courses required for the pre-major or major, inside or outside of the Department of Electrical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

Bachelor of Science—Computer Engineering

This major is offered jointly by the Department of Computer Science and the Department of Electrical and Computer Engineering. For information about this major, see page 25.

Electrical & Computer Engineering Courses

Many of the ECE courses are restricted to ECE majors only. Instructor and quarter offered are subject to change.

Lower Division

1A. Computer Engineering Seminar

Prerequisite: Open to computer engineering majors only. Seminar: 1 hour

Introductory seminar to expose students to a broad range of topics in Computer Engineering.

1B. Ten Puzzling Problems in Computer Engineering

Prerequisite: Open to pre-computer engineering and computer engineering majors only. Not open for credit for those who have taken ECE 1.

Gaining familiarity with, and motivation to study, the field of computer engineering, through puzzle-like problems that represent a range of challenges facing computer engineers in their daily problem-solving efforts and at the frontiers of research.

2A. Circuits, Devices, and Systems

Prerequisites: Mathematics 3A-B, and Mathematics 4A or 4C with a minimum grade of C; and, Mathematics 5A or 5B with a minimum grade of C (may be taken concurrently); Physics 3 or 23 (may be taken concurrently); open to electrical engineering, computer engineering, and pre-computer engineering majors. Lecture: 3 hours; laboratory: 4 hours.

Introduction to basic circuit analysis. KCL, KVL, nodal analysis, superposition, independent and dependent sources; diodes and I-V characteristics; basic op-amp circuits; first-order transient analysis; AC analysis and phasors. Introduction to the use of test instruments.

2B. Circuits, Devices, and Systems

Prerequisites: ECE 2A with a grade of C- or better; open to electrical engineering, computer engineering, and pre-computer engineering majors only. Lecture, 3 hours; laboratory, 4 hours.

Second order circuits. Laplace transform and solution of steady state and transient circuit problems in the s-domain: Bode plots; Fourier series and transforms; filters. Transistor as a switch; load lines; simple logic gates; latches and flip-flops.

2C. Circuits, Devices, and Systems

Prerequisites: ECE 2B with a grade of C- or better (may be taken concurrently); open to electrical engineering, computer engineering, and pre-computer engineering majors only. Lecture, 3 hours; laboratory, 4 hours.

Two-port network parameters; small-signal models of nonlinear devices; transistor amplifier circuits; frequency response of amplifiers; non-ideal op-amps; modulation; bandwidth; signals; Fourier analysis.

4. Design Project for Freshmen

Prerequisite: Open only to Electrical Engineering majors. Lecture: 2 hours; Laboratory: 3 hours.

4A. Foundations of Analog and Digital Circuits & Systems

Prerequisites: Mathematics 3A-B, and Mathematics 4A or 4C and Physics 1 with minimum grades of C; Engineering 3 with a minimum grade of C-.

This course introduces to a broad range of topics in Computer Engineering. Composed of lectures by different faculty members and a weekly laboratory based on projects that are executed using the Arduino environment. Aims at exposing freshmen students to the different sub-fields within Electronic and Computer Engineering.

10A. Foundations of Analog and Digital Circuits and Systems Lab

Prerequisite: ECE 10A (may be taken concurrently) with a C- or better grade. Laboratory: 4 hours.

The course will introduce the student to the power of abstraction, resistive networks, network analysis, nonlinear analysis and the digital abstraction.

10A. Foundations of Analog and Digital Circuits and Systems Lab

Prerequisite: ECE 10A (may be taken concurrently) with a C- or better grade. Lecture: 3 hours.

The goal of 10AL is to provide the student with a hands-on application of the concepts discussed in 10A. The lab will introduce the use of microcontrollers as a data acquisition system, network analysis, resistors, nonlinear analysis and digital abstraction.

10B. Foundations of Analog and Digital Circuits and Systems

Prerequisite: ECE 10A with a C- or better grade. Lecture: 3 hours.

Introduction to basic circuit analysis. KCL, KVL, nodal analysis, superposition, independent and dependent sources; diodes and I-V characteristics; basic op-amp circuits; first-order transient analysis; AC analysis and phasors. Introduction to the use of test instruments.

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Not open for credit for those who have received a C- or higher in ECE 2B.

The objective of the course is to introduce the MOSFET both as a simple digital switch and as controlled current source for analog design. The course will cover basic digital design, small-signal analysis, charge storage elements and operational amplifiers. (W)

10B. Foundations of Analog and Digital Circuits and Systems Lab
(2) STAFF
Prerequisite: ECE 10B (may be taken concurrently) with a C- or better grade. Laboratory: 4 hours
Not open for credit for those who have received a C- or higher in ECE 2B.

The goal of 10BL is to provide the student with a hands-on application of the concepts discussed in ECE 10B. The lab will utilize the microcontroller to introduce students to the understanding of datasheets for both digital and analog circuits, single-stage amplifier design and basic instrumentation.

10C. Foundations of Analog and Digital Circuits and Systems
(3) STAFF
Prerequisite: ECE 10B with a C- or better grade. Lecture: 3 hours
Not open for credit for those who have received a C- or higher in ECE 2B.

The objective of the course is to introduce the student to the basics of transient analysis. The course will energy and power dissipation in digital circuits, first-order and second-order linear time invariant circuits, sinusoidal steady state, impedance representation, feedback and resonance. (S)

10CL. Foundations of Analog and Digital Circuits and Systems Lab
(2) STAFF
Prerequisite: ECE 10C (may be taken concurrently) with a C- grade or better. Laboratory: 4 hours
Not open for credit for those who have received a C- or higher in ECE 2B.

The goal of 10CL is to provide the student with a hands-on application of the concepts discussed in ECE 10C. The lab will utilize the microcontroller to introduce students to the understanding of propagation delay in digital circuits and the resulting power dissipation, first order linear networks, second order linear networks, sinusoidal steady-state, impedance analysis and op-amp circuits.

15A. Fundamentals of Logic Design
(4) MAREK-SADOWSKA
Prerequisites: Open to electrical engineering, computer engineering, and pre-computer engineering majors only.
Not open for credit to students who have completed ECE 15. Lecture: 3 hours; discussion, 1 hour
Boolean algebra, logic of propositions, minterm and maxterm expansions, Karnaugh maps, Quine-McCluskey methods, multi-level circuits, combinatorial circuit design and simulation, multiplexers, decoders, programmable logic devices.

92. Projects in Electrical and Computer Engineering
(4) STAFF
Prerequisite: Consent of instructor; for Electrical Engineering and Computer Engineering majors only
Projects in electrical and computer engineering for advanced undergraduate students.

94AA-ZZ. Group Studies in Electrical and Computer Engineering
(1-4) STAFF
Prerequisite: Consent of instructor.
Group studies intended for small number of advanced students who share an interest in a topic not included in the regular departmental curriculum.

96. Undergraduate Research
(2-4) STAFF
Prerequisite: Consent of instructor. Must have a 3.00 GPA. May be repeated for up to 12 units.
Research opportunities for undergraduate students. students will be expected to give regular oral presentations, actively participate in a weekly seminar, and prepare at least one written report on their research.

UPPER DIVISION

120A. Integrated Circuit Design and Fabrication
(4) BOWERS
Prerequisite: ECE 132 with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours
Not open for credit for those who have taken ECE 124B.
Theory, fabrication, and characterization of solid state devices including P-N junctions, capacitors, bipolar and MOS devices. Devices are fabricated using modern VLSI processing techniques including lithography, oxidation, diffusion, and evaporation. Physics and performance of processing steps are discussed and analyzed.

120B. Integrated Circuit Design and Fabrication
(4) BOWERS
Prerequisite: ECE 2AB or either ECE 124B or ECE 120A with a minimum grade of C- or better in each of the courses. Lecture: 3 hours; Laboratory: 3 hours
Not open for credit for those who have taken ECE 124C.
Design, simulation, fabrication, and characterization of NMOS integrated circuits. Circuit design and layout is performed using commercial layout software. Circuits are fabricated using modern VLSI processing techniques. Circuit and discrete device electrical performance are analyzed.

121A. The Practice of Science
(3) HU, AWSCALOM
Prerequisite: Consent of instructor.
Same course as Physics 121A.
Provides experience in pursuing careers within science and engineering through discussions with researchers, lectures on ethics, funding, intellectual property, and commercial innovation. Students prepare a focused research proposal that is pursued in the second quarter of the course.

121B. The Practice of Science
(4) HU, AWSCALOM
Prerequisite: ECE 121A or Physics 121A; consent of instructor.
Same course as Physics 121B.
Provides experience in pursuing careers within science and engineering through discussions with researchers, lectures on ethics, funding, intellectual property, and commercial innovation. Students prepare a focused research proposal that is pursued in the second quarter of the course.

122A. VLSI Principles
(4) BANERJEE
Prerequisite: ECE 152A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours
Not open for credit for those who have taken ECE 124A or ECE 123.
Introduction to CMOS digital VLSI design: CMOS devices and manufacturing technology, transistor level design of static and dynamic logic gates and components and interconnections; circuit characterization: delay, noise margins, and power dissipation; combinational and sequential circuits; arithmetic operations and memories.

122B. VLSI Architecture and Design
(4) BREWER
Prerequisite: ECE 124A or ECE 123 or ECE 122A with a minimum grade of C-.
Lecture: 3 hours; Laboratory: 2 hours
Not open for credit for those who have taken ECE 124D.
Practical issues in VLSI circuit design, pad-pin limitations, clocking and interfacing standards, electrical packaging for high-speed and high-performance design. On-chip noise and crosstalk, clock and power distribution, architectural and circuit design constraints, interconnection limits and transmission line effects.

123. High-Performance Digital Circuit Design
(4) THEOGARAJAN
Prerequisite: ECE 2A-B-C with a minimum grade of C- in each of those courses; open to both electrical engineering and computer engineering majors only.
Not open for credit for those who have taken ECE 124A or ECE 122A.
Introduction to high-performance digital circuit design techniques. Basics of device physics including deep submicron effects; device sizing and logical effort; Circuit design: 2 hours; timing issues; memory & datapath design; Low-power design; VLSI design flows and associated EDA tools.

125. High Speed Digital Integrated Circuit Design
(4) BANERJEE
Prerequisite: ECE 124A or 137A with a minimum grade of C- in either. Lecture, 4 hours.
Advanced digital VLSI design: CMOS scaling, nanoscale issues including variability, thermal management, interconnects, reliability; non-clocked, clocked and self-timed logic gates; clocked storage elements; high-speed components, PLLs and DLLs; clock and power distribution; memory systems; signaling; and I/O design; low-power design.

130A. Signal Analysis and Processing
(4) MADHOW
Prerequisite: Mathematics 4A or 5A with a minimum grade of C and ECE 2B with a minimum grade of C; open to EE and computer engineering majors only. Lecture: 3 hours; Discussion: 2 hours

130B. Signal Analysis and Processing
(4) CHANDRAKAR
Prerequisite: ECE 130A with a grade of C- or better; open to EE and computer engineering majors only. Lecture: 3 hours; discussion, 2 hours.
Basic techniques for the analysis of linear models in electrical engineering: Gaussian elimination, vector spaces and linear equations, orthogonality, determinants, eigenvalues and eigenvectors, systems of linear differential equations, positive definite matrices, singular value decomposition.

132. Introduction to Solid-State Electronic Devices
(4) MISHRA
Prerequisite: Physics 4 or 24 with a minimum grade of C-; Mathematics 4B or 5A with a minimum grade of C; and, ECE 2A-B (may be taken concurrently) with a minimum grade of C- in each; open to EE and computer engineering majors only. Lecture: 3 hours; Discussion: 2 hours
Electrons and holes in semiconductors; doping (P and N); state occupation statistics, transport properties of electrons and holes; P-N junction diodes; I-V, C-V, and switching properties of P-N junctions; introduction of bipolar transistors, MOSFET’s and JFET’s.

134. Introduction to Fields and Waves
(4) DAGLI, YORK
Prerequisite: Physics 3 or 23 with a minimum grade of C-; Mathematics 5B or 6A with a minimum grade of C in each; and Mathematics 5C or 6B with a minimum grade of C; open to EE and computer engineering majors only. Lecture: 3 hours; Discussion: 2 hours
Introduction to applied electromagnetics and wave phenomena in high frequency electron circuits and systems. Waveson transmission-lines, elements of electromagnetic and magnetostatics; 3D applications, plane waves, examples and applications to RF, microwave, and optical systems.
135. Optical Fiber Communication
(4) DASIL
Prerequisites: ECE 132 and 134 with a minimum grade of C- in both. Lecture, 3 hours; discussion, 1 hour.
Optical fiber as a transmission medium, dispersion and nonlinear effects in fiber transmission, fiber and semiconductor optical amplifiers and lasers, optical modulators, photo detectors, optical receivers, wavelength division multiplexing components, optical filters, basic transmission system analysis and design.

137A. Circuits and Electronics I
(4) ROBDWELL
Prerequisites: ECE 2A-B-C, 130A, and 132 with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours; laboratory, 3 hours.
Analysis and design of single stage and multistage transistor circuits including biasing, gain, impedances and maximum signal levels.

137B. Circuits and Electronics II
(4) ROBDWELL
Prerequisites: ECE 2C and 137A with a minimum grade of C- in both; open to EE majors only. Lecture, 3 hours; laboratory, 4 hours.
Analysis and design of single stage and multistage transistor circuits at low and high frequencies. Transient response. Analysis and design of feedback circuits. Stability criteria.

139. Probability and Statistics
(4) ILTIS
Prerequisite: Open to Electrical Engineering, Computer Engineering and pre-Computer Engineering majors only. Lecture, 3 hours; discussion, 2 hours.
Fundamentals of probability, conditional probability, Bayes rule, random variables, functions of random variables, expectation and high-order moments, Markov chains, hypothesis testing.

141A. Introduction To Nanoelectromechanical and Microelectromechanical Systems (NEMS/MEMS)
(3) PENNATURE, TURKER
Prerequisites: ME 16 & 17, ME 152A, ME 151A (may be concurrent); or, ECE 130A and 137A with a minimum grade of C- in both.
Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluidics will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples.

141B. MEMS: Processing and Device Characterization
(4) PENNATURE, TURKER
Lectures and laboratory on semiconductor-based processing for MEMS. Description of key equipment and characterization tools used for MEMS design, fabrication, characterization and testing of MEMS Emphasis on current MEMS devices including accelerometers, comb drives, micro-resonators and capacitor-actuators. (W)

142. Introduction to Power Electronics
(4) YORK
Prerequisite: ECE 132, ECE 134, and ECE 137A with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours; laboratory, 2 hours.
An introduction to modern switched-mode power electronics and associated devices. Covers modern converter/inverter topologies for the control and conversion of electrical power with high efficiency with applications in power supplies, renewable energy systems, lighting, electric/ hybrid vehicles, and motor drivers.

144. Electromagnetic Fields and Waves
(4) YORK
Prerequisite: ECE 134 with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.
Waves in dielectric media and free space, wave propagation, reflection and refraction of electromagnetic waves, microwave integrated circuit principles, metal and dielectric waveguides, resonant cavities, antennas. Microwave and optical device examples and experience with modern microwave CAD software.

145A. Communication Electronics
(5) RODWELL
Prerequisites: ECE 137A-B with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 6 hours.

145B. Communication Electronics II
(5) STAFF
Prerequisite: ECE 145A with a minimum grade of C-. EE majors only. Lecture, 3 hours; laboratory, 6 hours.

145C. Communication Electronics III
(3) YUE
Prerequisites: ECE 145B with a minimum grade of C-. Lecture, 4 hours.

146A. Communication Systems
(3) MADHOW
Prerequisite: ECE 130A-B with a minimum grade of C-; open to EE majors only. Lecture: 3 hours; Laboratory: 6 hours.
Communication signals and systems; channel modeling and transceiver signal processing in complex baseband; analog communication techniques, including amplitude and angle modulation, superheterodyne reception, and phase locked loops; digital modulation, including bandwidth-efficient linear modulation and orthogonal modulation.

146B. DIGITAL COMMUNICATION SYSTEM DESIGN
(3) MADHOW
Prerequisite: ECE 130A-B and 146A with minimum grade of C-; open to EE majors only. Lecture: 3 hours; Laboratory: 6 hours.
Statistical modeling of signals and noise, including review of probability and random variables, and introduction to random processes; Optimal demodulation, including signal space geometry and performance estimates; communication over dispersive channels using singlecarrier and multicarrier modulation.

147A. Feedback Control Systems - Theory and Design
(5) TEEL, SMITH
Prerequisites: ECE 137A-B-C with a minimum grade of C- in each: open to EE and computer engineering majors only. Lecture, 3 hours; laboratory, 6 hours.
Feedback systems design, specifications in time and frequency domains, Analysis and synthesis of closed loop systems. Computer aided analysis and design.

147B. Digital Control Systems - Theory and Design
(5) SMITH, TEEL
Prerequisite: ECE 147A with a minimum grade of C-; open to EE and computer engineering majors only. Lecture, 3 hours; laboratory, 6 hours.
Analysis of sampled data feedback systems; state space models, state space matrices, observability, controllability, pole assignment, state feedback, observers. Design of digital control systems. (W)

147C. Control System Design Project
(5) HESPANIA
Prerequisite: ECE 147A or ME 155B or ME 173 with a minimum grade of C-. Lecture, 3 hours; laboratory, 6 hours.
Students are required to design, implement, and document a significant control systems project. The project is implemented in hardware or in high-fidelity numerical simulators. Lectures and laboratories cover special topics related to the practical implementation of control systems.

148. Applications of Signal Analysis and Processing
(4) LEE
Prerequisite: ECE 130A and 130B with a minimum grade of C- in both. Lecture: 3 hours; Discussion: 2 hours
Recommended Preparation: concurrent enrollment in ECE 130C.
A sequence of engineering applications of signal analysis and processing techniques; in communications, image processing, analog and digital filter design, signal detection and parameter estimation, holography and tomography, Fourier optics, and microwave and acoustic sensing.

150. Mobile Embedded Systems
(4) CHENG
Architecture of modern smartphones and their key hardware components including mobile application processors, communications chips, display, touchscreen, graphics, camera, battery, GPS and various sensors; the OS and software development platform of smartphones; smartphone applications; low power design techniques.

151. Distributed Systems
(4) MELLAR-JMTH
Prerequisite: Computer Science 170 with a minimum grade of C-.
Not open for credit to students who have completed Computer Science 171. Lecture, 3 hours; discussion, 1 hour.
Distributed systems architecture, distributed programming techniques, message passing, remote procedure calls, group communication and membership, naming, asynchrony, causality, consistency, fault-tolerance and recovery, resource management, scheduling, monitoring, testing and debugging.

152A. Digital Design Principles
(4) ROEPLU
Prerequisite: ECE 15A and 2A, or Computer Science 30 or 64 with a minimum grade of C- in each course; open to electrical engineering, computer engineering, and computer science majors only. Lecture: 3 hours; Laboratory: 6 hours.
Design of synchronous digital systems: timing diagrams, propagation delay, latches and flip-flops, shift registers and counters, Mealy/Moore finite state machines, Verilog, 2-phase clocking, timing analysis, CMOS implementation, S-RAM, RAM-based designs, ASM charts, state minimization.

153A. Hardware/Software Interface
(4) BREWER, KRETZ
Prerequisite: Upper division standing in Computer Engineering, Computer Science or Electrical Engineering.
Same course as Computer Science 153A. Issues in interfacing computing systems and software to practical I/O interfaces. Rapid response, real-time events and management of tasks, threads, and scheduling required for efficient design of embedded software and systems is discussed. Techniques for highly constrained systems.

153B. Sensor and Peripheral Interface Design
(4) STAFF
Prerequisite: ECE 152A with a minimum grade of C-. Lecture: 3 hours; Laboratory: 3 hours
Hardware description languages; field-programmable logic and ASIC design techniques. Mixed-signal design and I/O converter interfaces; analog and digital signal acquisition, processing and generation, communication and
network interfaces.

154A. Introduction to Computer Architecture
   (4) FARRAH
   Prerequisite: ECE 152A with a minimum grade of C-.
   Lecture: 3 hours; Discussion: 1 hour
   Not open for credit to students who have completed Computer Science 154. ECE 154A is the formerly numbered ECE 154. Students who have taken ECE 154 and have received a grade of C- or lower may take ECE 154A for a better grade.

154B. Advanced Computer Architecture
   (4) STRUKOV
   Prerequisite: ECE 154A with a grade of C- or better, Open to EE and CMPEN majors only. Lecture: 3 hours; Laboratory: 4 hours
   Not open for credit to those who have taken Computer Science 154.

155A. Introduction to Computer Networks
   (4) MOSER
   Prerequisite: Upper-division standing in Electrical Engineering, Computer Engineering and Computer Science; and CMPSC 24 with a minimum grade of C-.
   Lecture: 3 hours; Discussion 1 hour
   Not open for credit to students who have completed Computer Science 176, 176A, or ECE 155.

155B. Network Computing
   (4) MOSER
   Prerequisite: ECE 155A or CMPSC 176A with a minimum grade of C-; and CMPSC 32 with a minimum grade of C-.
   Lecture: 3 hours; Discussion 1 hour
   Not open for credit to students who have completed Computer Science 176B or ECE 194W.

156A. Digital Design with VHDL and Synthesis
   (4) WANG
   Prerequisite: ECE 152A with a minimum grade of C-.
   Lecture: 3 hours; laboratory: 3 hours
   Introduction to VHDL basic elements. VHDL simulation concepts. VHDL concurrent statements with examples and applications. VHDL subprograms, packages, libraries and design units. Writing VHDL for synthesis, Writing VHDL for finite state machines. Design case study.

156B. Computer-Aided Design of VLSI Circuits
   (4) WANG
   Prerequisite: ECE 156A with a minimum grade of C-.
   Introduction to computer-aided simulation and synthesis tools for VLSI/IC system design, flow, role of CAD tools, layout synthesis, circuit simulation, logic simulation, logic synthesis, behavior synthesis and test synthesis.

158. Digital Signal Processing
   (4) GIBSON
   Prerequisite: ECE 130A-B with a minimum grade of C- in both; open to EE majors only.
   Lecture: 3 hours; laboratory: 3 hours
   Digital signals that have taken ECE 154 and have received a grade of C- or lower may take ECE 154A for a better grade.

160. Multimedia Systems
   (4) MELLIAIR-SMITH
   Prerequisite: Upper-division standing; open to electrical engineering, computer engineering, computer science, and creative studies majors only.
   Lecture: 3 hours; Laboratory: 3 hours
   Not open for credit to students who have completed CMPSC 182.

162A. The Quantum Description of Electronic Materials
   (4) STAFF
   Prerequisite: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE and materials majors only.
   Same course as Materials 162A. Lecture: 4 hours.

162B. Fundamentals of the Solid State
   (4) COLDREN
   Prerequisite: ECE 162A with a minimum grade of C-; open to EE and materials majors only.
   Same course as Materials 162B. Lecture: 3 hours; discussion: 1 hour.

162C. Optoelectronic Materials and Devices
   (4) COLDREN
   Prerequisite: ECE 162A-B with a minimum grade of C-; open to EE and materials majors only.
   Lecture: 3 hours; discussion: 1 hour.

178. Introduction to Digital Image and Video Processing
   (4) MANJUNATH
   Prerequisite: open to EE, computer engineering, and computer science majors with upper-division standing in EE.
   Lecture: 3 hours; Discussion: 1 hour.
   Basic concepts in image and video processing. Topics include image formation and sampling, image transforms, image enhancement, and image and video compression including JPEG and MPEG coding standards.

179D. Introduction to Robotics: Dynamics and Control
   (4) BYL
   Prerequisite: ECE 130A or ME 155A (may be taken concurrently).
   Same course as ME 179D.
   Dynamic modeling and control methods for robotic systems. Lagrangean method for deriving equations of motion, introduction to the Jacobian,
evaluated through written reports, oral presentations, and demonstrations of performance.

188C. Senior Electrical Engineering Project
(3) STAFF
Prerequisite: ECE 188B with a minimum grade of C-
Lecture: 3 hours; Laboratory: 3 hours
Student groups design a significant project based on the knowledge and skills acquired in earlier coursework and integrate their technical knowledge through a practical design experience. The project is evaluated through written reports, oral presentations, and demonstrations of performance.

189A. Senior Computer Systems Project
(4) STAFF
Prerequisite: ECE 153B; senior standing in Computer Engineering, Computer Science or EE.
Lecture: 3 hours; Laboratory: 3 hours
Not open for credit to students who have completed Computer Science 189A-B.
Student groups design a significant computer-based project. Groups work independently with interaction among groups via interface specifications and informal meetings.

189B. Senior Computer Systems Project
(4) STAFF
Prerequisite: ECE 189A; senior standing in Computer Engineering, Computer Science or EE.
Lecture: 3 hours; Laboratory: 3 hours
Not open for credit to students who have completed Computer Science 189A-B.
Student groups design a significant computer-based project. Groups work independently with interaction among groups via interface specifications and informal meetings.

192. Projects in Electrical and Computer Engineering
(4) STAFF
Prerequisite: consent of instructor. Discussion, 2 hours; laboratory, 6 hours.
Projects in electrical and computer engineering for advanced undergraduate students.

193. Internship in Industry
(1-3) STAFF
Prerequisite: consent of department.
Must have a 3.0 grade-point-average. May not be used as departmental electives. May be repeated to a maximum of 12 units, Field, 1-8 hours.
Special projects for selected students. Offered in conjunction with engineering practice in selected industrial and research firms, under direct faculty supervision.

194A-ZZ. Special Topics in Electrical and Computer Engineering
(1-5) STAFF
Prerequisite: consent of instructor. Variable hours.

196. Undergraduate Research
(2-4) STAFF
Prerequisites: upper-division standing; consent of instructor.
Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated for up to 12 units. Not more than 4 units may be applied to departmental electives.
Research opportunities for undergraduate students. Students will be expected to give regular oral presentations, actively participate in a weekly seminar, and prepare at least one written report on their research.

199. Independent Studies in Electrical and Computer Engineering
(1-5) STAFF
Prerequisites: upper division standing; completion of two upper-division courses in electrical and computer engineering; consent of instructor.
Must have a minimum 3.0 grade-point average for the preceding three quarters. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined. Directed individual study, normally experimental.

GRADUATE COURSES
Graduate courses for this major can be found in the UCSB General Catalog.

Engineering Sciences Courses

LOWER DIVISION
3. Introduction to Programming for Engineers
(3) MOEHLIS, PETZOLD
Prerequisites: Open to chemical engineering, electrical engineering, and mechanical engineering majors only.
General philosophy of programming and problem solving. Students will be introduced to the programming language MATLAB. Specific areas of study will include algorithms, basic decision structures, arrays, matrices, and graphing. (F, S, M)

99. Introduction to Research
(1-3) STAFF
Prerequisite: Consent of instructor.
May be repeated for credit to a maximum of 6 units. Students are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199AA-ZZ courses combined. Directed study to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION
101. Ethics in Engineering
(1) STAFF
Prerequisite: senior standing in engineering.

103. Advanced Engineering Writing
(1) STAFF
Prerequisites: Writing 50 or 50E; upper-division standing.
Practice in the forms of communication—contractual reports, proposals, conference papers, oral presentations, business plans—that engineers and entrepreneurial engineers will encounter in professional careers. Focus is on research methods, developing a clear and persuasive writing style, and electronic document preparation.

160. Science for the Public
(1-4) STAFF
Prerequisite: consent of instructor.
Same course as Physics 160K. Open to graduate students in science and engineering disciplines and to undergraduate science and engineering majors. Provides experience in communicating science and technology to nonspecialists. The major components of the course are field work in mentoring, a biweekly seminar, presentations to precollege students and to adult nonscientists, and end-of-term research papers.

Engineering Sciences
Engineering Sciences, Office of Associate Dean for Undergraduate Studies, Harold Frank Hall, Room 1006; Telephone (805) 893-2809; Web site: engsci.ucsb.edu
Chair & Associate Dean: Glenn E. Beltz

Faculty
Glenn E. Beltz, Ph.D., Harvard, Professor
Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Professor
Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor

The Engineering Sciences program at UCSB serves as a focal point for the cross-disciplinary educational environment that prevails in each of our five degree-granting undergraduate programs (chemical engineering, computer engineering, computer science, electrical engineering, and mechanical engineering). The courses offered in this “department” are designed to cultivate well-educated, innovative engineers and scientists with excellent management and entrepreneurial skills and attitudes oriented to new technologies.

One of the missions of the Engineering Sciences program is to provide coursework commonly needed across other educational programs in the College of Engineering. For example, courses in computer programming, computation, ethics, engineering writing, engineering economics, science communication to the public, and even an aeronautics-inspired art course are offered.
177. Art and Science of Aerospace Culture (4-5) STAFF
Prerequisites: upper-division standing; consent of instructor.
Same course as Art Studio 177.
Interdisciplinary course/seminar/practice for artists, academics, engineers, and designers interested in exploring the technological, aesthetic, cultural, and political aspects of the space side of the aerospace complex. Design history, space complex aesthetics, cinema intersections, imaging/telecommunications, human spaceflight history, reduced/alternating gravity experimentation, space systems design/utilization.

199. Independent Studies in Engineering (1-5) STAFF
Prerequisite: Upper-division standing; consent of instructor.
Students must have a minimum 3.0 GPA for the preceding three quarters. May be repeated for credit to a maximum of 10 units. Directed Individual study.

GRADUATE COURSES
A graduate course listing can be found in the UCSB General Catalog.

Materials
Department of Materials
Engineering II, Room 1355;
Telephone (805) 893-4601
Web site: www.materials.ucsb.edu
Chair: Tresa M. Pollock
Vice Chair: Michael L. Chabinyc

Faculty
Guillermo C. Bazan, Ph.D., Massachusetts Institute of Technology, Professor (polymer synthesis, photophysics) *5
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Irene J. Beyerlein, Ph.D., Cornell University, Professor (computational materials science, microstructures, deformation mechanisms, composites)
John Bowers, Ph.D., Stanford, Professor (energy efficiency, optical devices and networks, silicon photonics) *1
Michael Chabinyc, Ph.D., Stanford University, Associate Professor (organic semiconductors, thin film electronics, energy conversion using photovoltaics, characterization of thin films of polymers, x-ray scattering from polymers)
Larry A. Coldren, Ph.D., Stanford University, Kavli Professor in Optoelectronics and Sensors, Director of Optoelectronics Technology Center (semiconductor integrated optics, optoelectronics, molecular beam epitaxy, microfabrication) *1
Steven P. DenBaars, Ph.D., University of Southern California, Professor (metalorganic chemical vapor deposition (MOCVD) of semiconductors, IR to blue lasers and LEDs, high power electronic materials and devices) *1
Daniel S. Gianola, Ph.D., Johns Hopkins University, Associate Professor (nanomechanical behavior and deformation mechanisms in ultra-strong materials, mechanics of disordered materials, elastic strain engineering of transport phenomena, tunable and efficient solid state energy conversion, interface engineering of nanocrystalline materials for mechanical stability and damage tolerance, quantitative in situ electron, x-ray, and light microscopy)
Craig Hawker, Ph.D., University of Cambridge, Professor, Director of Materials Research Laboratory (synthetic polymer chemistry, nanotechnology, materials science) *5
Alan J. Heeger, Ph.D., UC Berkeley, Professor, Director of Institute for Polymers and Organic Solids, 2000 Chemistry Nobel Laureate (condensed-matter physics, conducting polymers) *4
Jacob N. Israelachvili, Ph.D., University of Cambridge, Professor (adhesion, friction surface forces, colloids, biosurface interactions) *3
Carlos G. Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (materials processing, and microstructure evolution, coatings, composites, functional inorganic) *2
Robert M. McMeeking, Ph.D., Brown University, Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics, process modeling) *2
Shuji Nakamur, Ph.D., University of Tokushima, Cree Professor of Solid State Lighting and Displays (gallium nitride, blue lasers, white LEDs, solid state illumination, bulk GaN substrates)
G. Robert Odette, Ph.D., Massachusetts Institute of Technology, Professor (fundamental deformation and fracture, materials in extreme environments, structural reliability, and high-performance composites) *2
Chris Palmstrm, Ph.D., University of Leeds, Professor (atomic level control of interfacial phenomena, in-situ STM, surface and thin film analysis, metallization of semiconductors, disimilar materials epitaxial growth, molecular beam and chemical beam epitaxial growth of metallic compounds) *1
Philip A. Pincus, Ph.D., UC Berkeley, Professor (theoretical aspects of self-assembled biomolecular structures, membranes, polymers, and colloids) *4
Tresa M. Pollock, Ph.D., Massachusetts Institute of Technology, Professor (mechanical and environmental performance of materials in extreme environments, unique high temperature materials processing paths, ultrafast laser-material interactions, alloy design and 3-D materials characterization)
Cyrus R. Safinya, Ph.D., Massachusetts Institute of Technology, Professor (biophysics, supramolecular assemblies of biological molecules, non-viral gene delivery systems)
Omar A. Saleh, Ph.D., Princeton University, Assistant Professor (single-molecule biophysics, motor proteins, DNA-protein interactions)
Rachel A. Segalman, Ph.D., University of California, Santa Barbara, Professor (synthesis of macromolecules, self-assembly, electronic properties of molecular and macromolecular materials, transport processes in polymers)
Ram Seshadri, Ph.D., Indian Institute of Science, Professor (inorganic materials, preparation and magnetism of bulk solids and nanoparticles, patterned materials)
Hyungsok (Tom) Soh, Ph.D., Stanford, Associate Professor (directed evolution of biological molecules, supramolecular assemblies, integrated biosensors) *2
James S. Speck, Sc.D., Massachusetts Institute of Technology, Professor (nitride semiconductors, III-V semiconductors, ferroelectric and high-K films, microstructural evolution, extended defects, transmission electron microscopy, x-ray diffraction)
Susanne Steimer, Ph.D., University of Stuttgart, Professor (functional oxide thin films, structure-property relationships, scanning transmission electron microscopy and spectroscopy)
Galyn Stucky, Ph.D., Iowa State University, Professor (biomaterials, composites, materials synthesis, electro-optical materials catalysis) *5
Anton Van der Ven, Ph.D., Massachusetts Institute of Technology, Associate Professor (First principles prediction of thermodynamic, kinetic and and mechanical properties of alloys, ceramics and compound semiconductors, statistical mechanical methods development, electrochemical energy storage materials, high temperature structural materials corrosion)
Stephen Wilson, Ph.D., University of Tennessee, Assistant Professor (Magnetism in complex oxides, phase behaviors in correlated electron systems and quantum materials, spin-orbit coupled materials, quantum criticality, neuron and x-ray scattering, bulk single crystal growth)
Chris Van de Walle, Ph.D., Stanford University, Professor (novel electronic materials, wide-band-gap semiconductors, oxides)
Claude Weisbuch, Ph.D., Universite Paris VII, Ecole Polytechnique-Palaiseau, Professor (semiconductor physics; fundamental and applied optical studies of quantized electronic structures and photonic-controlled structures; electron spin resonance in semiconductors, optical semiconductor microcavities, photonic bandgap materials)
Francis W. Zok, Ph.D., McMaster University, Professor (mechanical and thermal properties of materials and structures)

Emeriti Faculty
Anthony K. Cheetham, Ph.D., Oxford University, Professor Emeritus (catalysis, optical materials, X-ray, neutron diffraction) *5
David R. Clarke, Ph.D., University of Cambridge, Professor Emeritus (electrical ceramics, thermal barrier coatings, piezoelectroscopy, mechanics of microelectronics) *2

Arthur C. Gossard, Ph.D., UC Berkeley, Professor Emeritus (epitaxial growth, artificially synthesized semiconductor microstructures, semiconductor devices) *1

Evelyn Hu, Ph.D., Columbia University, Professor Emeritus (high-resolution fabrication techniques for semiconductor device structures, process-related materials damage, contact/Interface studies, superconductivity) *1

Herbert Kroemer, Dr. Rer. Nat., University of Göttingen, Donald W. Whittier Professor of Electrical Engineering, 2000 Physics Nobel Laureate (device physics, molecular beam epitaxy, heterojunctions, compound semiconductors) *1

Noel C. MacDonald, Ph.D., UC Berkeley, Kavli Professor in MEMS Technology (microelectromechanical systems, applied physics, nano-fabrication, electron optics, materials, mechanics, surface analysis) *2

Frederick F. Milstein, Ph.D., UC Los Angeles, Professor Emeritus (crystal mechanics, bonding, defects, mechanical properties) *2

Pierre M. Petroff, Ph.D., UC Berkeley, Professor (semiconductor interfaces, defects physics, epitaxy of self assembled quantum structures, quantum dots and nanomagnets, spectroscopy of semiconductor nanostructures) *1

Fred Wudl, Ph.D., UC Los Angeles, Professor (optical and electro-optical properties of conjugated polymers, organic chemistry of fullerenes, and design and preparation of self-mending polymers) *1

Affiliated Faculty

David Auston, Ph.D. (Electrical and Computer Engineering)

Glenn H. Fredrickson, Ph.D. (Chemical Engineering)

Mahn Won Kim, Ph.D. (Physics)

Gary Leal, Ph.D. (Chemical Engineering)

Gene Lucas, Ph.D. (Chemical Engineering)

The Department of Materials was conceptualized and built under two basic guidelines: to educate graduate students in advanced materials and to introduce them to novel ways of doing research in a collaborative, multidisciplinary environment. Advancing materials technology today—either by creating new materials or improving the properties of existing ones—requires a synthesis of expertise from the classic materials fields of metallurgy, ceramics, and polymer science, and such fundamental disciplines as applied mechanics, chemistry, biology, and solid-state physics. Since no individual has the necessary breadth and depth of knowledge in all these areas, solving advanced materials problems demands the integrated efforts of scientists and engineers with different backgrounds and skills in a research team. The department effectively transformed the research team concept, which is the operating mode of the high technology industry, into an academic environment. The department has major research groups working on a wide range of advanced inorganic and organic materials, including advanced structural alloys, ceramics and polymers, high performance composites, thermal barrier coatings and engineered surfaces, organic, inorganic, and hybrid semiconductor and photonic material systems; catalysts and porous materials, magnetic, ferroelectric and multiferroic materials; biomaterials and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.

Materials Courses

UPPER DIVISION

100A. Structure and Properties I

Prerequisites: Chemistry 1A-B; Physics 4; and, Mathematics 4B, 6A-B. Lecture, 3 hours.


100B. Structure and Properties II

Prerequisite: Materials 100A.

Students who take Matrl 101 & 100B will only receive major credit for one of these courses. Lecture, 3 hours.


100C. Fundamentals of Structural Evolution

Prerequisite: Materials 100A and Materials 100B.


101. Introduction to the Structure and Properties of Materials

Prerequisite: upper-division standing.

Students who take MATRL 101 & 100B will only receive major credit for one of these courses. Students interested in following the BS Engineering/MS Materials program should not take this course.


135. Biophysics and Biomolecular Materials

Prerequisites: Physics 5 or 6C or 25. Same course as Physics 135.

Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems).

160. Introduction to Polymer Science

Prerequisite: Chemistry 109A-B.

Same course as Chemical Engineering 160. Introductory course covering synthesis, characterization, structure, and mechanical properties of polymers. The course is taught from a materials perspective and includes polymer thermodynamics, chain architecture, measurement and control of molecular weight as well as crystallization and glass transitions.

162A. The Quantum Description of Electronic Materials

Prerequisites: ECE 130A-B and 134 with a minimum grade of C- in all; open to EE and Materials majors only.

Same course as ECE 162A.


162B. Fundamentals of the Solid State

Prerequisites: ECE 162A with a minimum grade of C-; open to EE and materials majors only.

Same course as ECE 162B.


185. Materials in Engineering

Prerequisite: Materials 100B or 101.

Same course as ME 185. Lecture, 3 hours. Introduces the student to the main families of materials and the principles behind their development, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials

Prerequisites: ME 15 and 151C; and, Materials 100B or 101.

Same course as ME 186. Lecture, 3 hours. Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed.

188. Topics in Materials

Prerequisites: Materials for renewable energy-efficient applications: Thermoelectrics, Solid State Lighting, Solar Cells, High Temperature coatings for turbines and engines. (W)
GRADUATE COURSES
Graduate courses for this major can be found in the UCSB General Catalog.

Mechanical Engineering

Department of Mechanical Engineering, Engineering II, Room 2355; Telephone (805) 893-2430
Web site: www.me.ucsb.edu
Chair: Francesco Bullo
Vice Chair: Frederic Gibou

Faculty
Bassam Bamieh, Ph.D., Rice University, Professor (control systems design with applications to fluid flow problems)
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Glenn E. Beltz, Ph.D., Harvard, Professor (solid mechanics, materials, aeronautics, engineering education)
Ted D. Bennett, Ph.D., UC Berkeley, Associate Professor (thermal science, laser processing)
David Bothman, B.S., UC San Diego, Lecturer
Francesco Bullo, Ph.D., California Institute of Technology, Professor (motion planning and coordination, control systems, distributed and adaptive algorithms)
Otger Camps, Ph.D., Curie Institute (Paris) and University of Barcelona, Assistant Professor (physical biology, systems biology, quantitative biology, morphogenesis and self-organization of living matter)
Frederic Gibou, Ph.D., University of California, Los Angeles, Professor (computational science and engineering) *2
Stephen Laguette, M.S., University of California, Los Angeles, Lecturer (biomedical engineering design)
Carlos Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (conceptual design, synthesis and evolution in service of structural and inorganic materials, especially for high temperature applications) *3
Paolo Luzzato-Fegiz, PhD, Cornell University, Assistant Professor (fluid mechanics, wind energy and instrument development)
Eric F. Matthis, Ph.D., California Institute of Technology, Professor (heat transfer, fluid mechanics, rheology)
Robert M. McMeeking, Ph.D., Brown University, Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics) *3
Eckart Meiburg, Ph.D., University of Karlsruhe, Professor (computational fluid dynamics, fluid mechanics)
Carl D. Meinhart, Ph.D., University of Illinois at Urbana-Champaign, Professor (wall turbulence, microfluidics, flows in complex geometries)
Igor Mezić, Ph.D., California Institute of Technology, Professor (applied mechanics, non-linear dynamics, fluid mechanics, applied mathematics)
Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Professor (nonlinear dynamics, fluid mechanics, biological dynamics, applied mathematics)
Bradley E. Paden, Ph.D., UC Berkeley, Professor (control theory, kinematics, robotics)
Sumita Pennathur, Ph.D., Stanford University, Associate Professor (application of microfabrication techniques and micro/nanoscale flow phenomena)
Linda R. Petzold, Ph.D., University of Illinois at Urbana–Champaign, Professor, Director of Computational Science and Engineering Graduate Program (computational science and engineering systems biology) *2
Hyungsok Tom Soh, Ph.D., Stanford University, Professor (microelectromechanical systems, integrated biosensors, multi-functional biomaterials)
Tyler G. Susko, Lecturer Potential SOE
Kimberly L. Turner, Ph.D., Cornell University, Professor (microelectromechanical systems, dynamics, solid mechanics, measurement and characterization of microsystems motion and device parameters)
Megan Valentine, Ph.D., Harvard University, Assistant Professor (single-molecule biophysics, cell mechanics, motor proteins, biomaterials)
Henry T. Yang, Ph.D., Cornell University, Professor (aerospace structures, structural dynamics and stability, transonic flutter and aerelasticity, intelligent manufacturing systems)

Emeriti Faculty
Sanjoy Banerjee, PhD, University of Waterloo Joint Appointment: CNENG
John C. Bruch, Jr., Ph.D., Stanford University, Professor Emeritus (applied mathematics, numerical solutions and analysis)
David R. Clarke, Ph.D., University of Cambridge, Professor (electrical ceramics, thermal barrier coatings, piezospectroscopy, mechanics of microelectronics) *3
Roy S. Hickman, Ph.D., UC Berkeley, Professor Emeritus (fluid mechanics, physical gas dynamics, computer-aided design)
George Homys, Ph.D., University of Illinois, Professor Emeritus (hydrodynamic stability, thermal convection, thin film hydrodynamics, flow in microgeometries and in porous media, polymer fluid mechanics)
Keith T. Kedward, Ph.D., University of Wales, Professor (design of composite systems)
Wilbert J. Lick, Ph.D., Rensselaer Polytechnic Institute, Professor Emeritus (oceanography and limnology, applied mathematics)
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (mechanical properties of structural materials, environmental effects, structural reliability)
Noel C. MacDonald, Ph.D., UC Berkeley, Kavli Professor in MEMS Technology (microelectromechanical systems, applied physics, materials, mechanics, nanofabrication) *3
Ekkehard P. Marschall, Dr. Ing., Technische Hochschule Hannover, Professor Emeritus (thermodynamics, heat and mass transfer, desalination, energy conversion, experimental techniques)
Stephen R. McLean, Ph.D., University of Washington, Professor Emeritus (fluid mechanics, physical oceanography, sediment transport)
Frederick Milstein, Ph.D., UC Los Angeles, Professor Emeritus (mechanical properties of materials) *3
Thomas P. Mitchell, Ph.D., California Institute of Technology, Professor Emeritus (theoretical and applied mechanics)
George R. Odette, PhD, Massachusetts Institute of Technology Joint Appointment: MATRL
Theofanis G. Theofanous, Ph.D., University of Minnesota, Professor, Director of Center for Risk Studies and Safety (nuclear and chemical plant safety, multiphase flow, thermal hydraulics) *1
Marshall Tuin, M.S., Massachusetts Institute of Technology, Professor Emeritus, Ocean Engineering Laboratory Director (hydrodynamics, aerodynamics, turbulence, cavitation phenomena, drag reduction in turbulent flows)
Walter W. Yuen, Ph.D., UC Berkeley, Professor (thermal science, radiation heat transfer, heat transfer with phase change, combustion)

Affiliated Faculty
Paul J. Atzberger (Mathematics)
Katie A. Byl (Electrical and Computer Engineering)
Hector D. Ceniceros, PhD (Mathematics)
Tommy D. Dickey, PhD (Geography)
Joao P. Hespanha, PhD (Electrical and Computer Engineering)
Patricia Holden (Bren School of Environmental Science and Management)
Arturo Keller (Bren School of Environmental Science and Management)
L. Gary Leal (Chemical Engineering)
Kevin W. Plaxco, PhD (Chemistry and Biochemistry, Biomolecular Science and Engineering Program)
Libe Washburn, PhD (Geography)

The undergraduate program in mechanical engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. We offer a balanced curriculum of theory and application, involving: preparation in basic science, math, computing and writing; a comprehensive set of engineering science and laboratory courses; and a series of engineering
design courses starting in the freshman year and concluding with a three course sequence in the senior year. Our students gain hands-on expertise with state-of-the-art tools of computational design, analysis, and manufacturing that are increasingly used in industry, government, and academic institutions. In addition, the Department has a 15-unit elective program that allows students to gain depth in specific areas of interest, while maintaining appropriate breadth in the basic stem areas of the discipline. All students participate in a widely recognized design project program which includes projects sponsored by industry, UCSB researchers, as well as intercollegiate design competitions. The project program has been expanded to emphasize entrepreneurial product-oriented projects.

Mission Statement

We offer an education that prepares our students to become leaders of the engineering profession and one which empowers them to engage in a lifetime of learning and achievement.

Educational Objectives for the Undergraduate Program

It is the objective of the Mechanical Engineering Program to produce graduates who:

1. Successfully practice in either the traditional or the emerging technologies comprising mechanical engineering;
2. Are successful in a range of engineering graduate programs;
3. Have a solid background in the fundamentals of engineering allowing them to pass the Fundamentals of Engineering examination;
4. Engage in life-long learning opportunities such as professional workshops and activities in professional societies.

In order to achieve these objectives, the Department of Mechanical Engineering is engaged in a very ambitious effort to lead the discipline in new directions that will be critical to the success of 21st century technologies. While maintaining strong ties to STEM areas of the discipline, we are developing completely new cross-cutting fields of science and engineering related to topics such as: microscale engineering and microelectrical-micromechanical systems; dynamics and controls and related areas of sensors, actuators and instrumentation; advanced composite materials and smart structures; computation, simulation and information science; advanced energy and transportation systems; and environmental monitoring, modeling and remediation.

Student Outcomes

Upon graduation, students in the mechanical engineering B.S. degree program:

1. Should possess a solid foundation in, and be able to apply the principles of, mathematics, science, and engineering to solve problems and have the ability to learn new skills relevant to his/her chosen career.
2. Have the ability to conduct and analyze data from experiments in dynamics, fluid dynamics, thermal science and materials, and should have been exposed to experimental design in at least one of these areas.
3. Should have experienced the use of current software in problem solving and design.
4. Should demonstrate the ability to design useful products, systems, and processes.
5. Should be able to work effectively on teams.
6. Should have an understanding of professional and ethical responsibilities.
7. Should be able to write lab reports and design reports and give effective oral presentations.
8. Should have the broad background in the humanities and the social sciences, which provides an awareness of contemporary issues and facilitates an understanding of the global and societal impact of engineering problems and solutions.
9. Be a members of or participate in a professional society.

Undergraduate Program

Bachelor of Science—Mechanical Engineering

A minimum of 190 units is required for graduation. A complete list of requirements for the major can be found on page 54. Schedules should be planned to meet both General Education and major requirements.

Students who are not Mechanical Engineering majors may be permitted to take lower division mechanical engineering courses, subject to meeting prerequisites and grade-point average requirements, availability of space, and consent of the instructor.

The mechanical engineering elective courses allow students to acquire more in-depth knowledge in one of several areas of specialization, such as those related to: the environment; design and manufacturing; thermal and fluid sciences; structures, mechanics, and materials; and dynamics and controls. A student’s specific elective course selection is subject to the approval of the department advisor.

Courses required for the pre-major or major, inside or outside of the Department of Mechanical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

Research Opportunities

Upper-division undergraduates have opportunities to work in a research environment with faculty members who are conducting current research in the various fields of mechanical engineering. Students interested in pursuing undergraduate research projects should contact individual faculty members in the department.

Mechanical Engineering Courses

LOWER DIVISION

6. Basic Electrical and Electronic Circuits

Prerequisites: Physics 3-3L; Mathematics 3C or 4A; open to ME majors only.

Introduction to basic electrical circuits and electronics. Includes Kirchhoff’s laws, phasor analysis, circuit elements, operational amplifiers, and transistor circuits.


Prerequisites: ME majors only.

Introduction to engineering graphics, CAD, and freehand sketching. Develop CAD proficiency using advanced 3-D software. Graphical presentation of design: views, sections, dimensioning, and tolerancing.

11. Introductory Concepts in Mechanical Engineering

Prerequisites: lower-division standing.

The theme question of this course is “What do mechanical engineers do?” Survey of mechanical and environmental engineering applications. Lectures by mechanical engineering faculty and practicing engineers.

12. Manufacturing Processes

Prerequisites: ME majors only.

Processes used to convert raw material into finished objects. Overview of manufacturing processes including: casting, forging, machining, presswork, plastic and composite processing. Videos, demonstrations, and tours illustrate modern industrial practice. Selection of appropriate processes.

12S. Introduction to Machine Shop

Prerequisites: ME majors only.

Not open for credit to students who have completed Mechanical Engineering 156S.

Basic machine shop skills course. Students learn to work safely in a machine shop. Students are introduced to the use of hand tools, the lathe, the milling machine, drill press, saws, and precision measuring tools. Students apply these skills by completing a project.

14. Statics

Prerequisites: Math 3B, or AP Calculus AB with a score of 5, or AP Calculus BC with a score of 3 or better; and Physics 1.

Introduction to applied mechanics. Forces, moments, couples, and resultant vectors; vector algebra; construction of free body diagrams; equilibrium in 2- and 3- dimensions; analysis of frames, machines, trusses and beams; distributed forces; friction.

15. Strength of Materials

Prerequisites: ME 14 with a minimum grade of C-; open to mechanical engineering majors only.

Properties of structural materials, including Hooke’s law and behavior beyond the elastic limit. Concepts of stress, strain, displacement, force, force systems, and multiaxial stress states. Design applications to engineering structures, including problems of beams in tension, compression, and torsion, beams subject to flexure, pressure vessels, and buckling.


Prerequisites: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 5C or 6B; (may be
106A. Advanced Mechanical Engineering Laboratory
Prerequisite: ME 155A.

100. Professional Seminar
(1) STAFF
Prerequisite: Undergraduate standing.
May be repeated for credit up to 3 units. May not be used as a departmental elective.
A series of weekly lectures given by university staff and outside experts in all fields of mechanical and environmental engineering.

104. Mechanotransduction
(3) BAMIEH, PADEH
Prerequisites: ME 6; open to ME majors only.
Interfacing of mechanical and electrical systems and mechanotransduction. Basic introduction to sensors, actuators, and computer interfacing and control. Transducers and measurement devices, actuators, A/D and D/A conversion, conditioning and filtering. Practical skills developed in weekly laboratory exercises.

105. Mechanical Engineering Laboratory
(4) BENNETT, MATHYS, VALENTINE
Prerequisites: ME 151B, 152B, 163; and, Materials 101 or 106B.
Introduction to fundamental engineering laboratory measurement techniques and report writing skills. Experiments from thermosciences, fluid mechanics, mechanics, materials science, and environmental engineering. Introduction to modern data acquisition and analysis techniques. (S)

106A. Advanced Mechanical Engineering Laboratory
Prerequisite: ME 155A.

110. Aerodynamics and Aeronaautical Engineering
(3) BELTZ, MEINHART
Prerequisites: ME 14 and 152A.

112. Energy
(3) MATHYS
Prerequisite: Senior Undergraduate or Graduate Student status in the College of Engineering; or consent of Instructor.
Introduction to the field of Energetics. Topics may include energy sources and production, energy usage, renewable technologies, hardware, operating principles, environmental impact, energy reserves, and others.

124. Advanced Topics in Transport Phenomena/Safety
(3) STAFF
Prerequisites: Chemical Engineering 120A-C or ME 151A-B and ME 152A.

125AA-ZZ. Special Topics in Mechanical Engineering
(3) STAFF
Prerequisite: Consent of Instructor.
May be repeated for credit to a maximum of 12 units, variable hours.
Course offers students opportunity to work on established departmental design projects. PI/ NP grading, does not satisfy technical elective requirement.

128. Design of Biomedical Devices
(3) LAGUETTE
Prerequisite: Mechanical Engineering 10, 14, 15, 16, and 153; open to ME majors only.
Introductory course addresses the challenges of biomedical device design, prototyping and testing, material considerations, regulatory requirements, design control, human factors and ethics.

134. Advanced Thermal Science
(3) MATHYS, YUEN
Prerequisite: ME 151C.
This class will address advanced topics in fluid mechanics, heat transfer, and thermodynamics.

140A. Numerical Analysis in Engineering
(3) MOEHLIS, GIBOU, MEIBURG
Prerequisites: ME 17 with a minimum grade of C- or Chemical Engineering 132A; open to ME and Chemical Engineering majors only.
Numerical analysis and solution of problems described by linear and nonlinear differential equations with an emphasis on MATLAB. First and second order differential equations, systems of differential equations; linear algebraic equations, matrices and eigenvalues; boundary value problems; finite differences. (F)

140B. Theoretical Analysis in Mechanical Engineering
(4) MOEHLIS, GIBOU, MEIBURG
Prerequisites: ME 140A
Analysis of engineering problems formulated in terms of partial differential equations. Solutions of these mathematical models by means of analytical and numerical methods. Physical interpretation of the results.

141A. Introduction to Nanoelectromechanical and Microelectromechanical systems (NEMS/ MEMS)
(3) TURNER, PENNATHUR
Prerequisites: ME 16 & 17; ME 152A & ME 151A (may be concurrent); or ECE 130A & 137A with a minimum grade of C- in both.
Introduction to nanoe- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluids will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples.

141B. MEMS: Processing and Device Characterization
(3) TURNER, PENNATHUR
Prerequisites: ME 141A, ME 163 (may be concurrent); or ECE 141A.
Same course as ECE 141B.
Lectures and laboratory on semiconductor-based processing for MEMS. Description of key equipment and characterization tools used in MEMS and microsystem design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro-reactors and capacitor-actuators (W).

146. Molecular and Cellular Biomechanics
(3) VALENTINE
Course introduces fundamental concepts in molecular and cellular biomechanics. Will consider the role of physical, thermal and chemical forces, examine their influence on cell strength and elasticity, and explore the properties of enzymatically-active materials. (F)

147. Mechatronics Using Labview
(3) HARE
Prerequisite: Engineering 3; and Mechanical Engineering 6
Not open for additional credit to students who have completed ME 125CH.
Introduction to mechatronics, electromechanical systems, data acquisition, software programming and Labview. Students learn programming fundamentals, hardware interfacing and controls with simulated hardware and actual motor controllers. Students compete to control a motor system through a variety of control problems. Final projects automate working hardware in research labs.

151A. Thermosciences 1
(4) BENNETT, MEINHART
Prerequisites: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 5C.
Basic concepts in thermodynamics, system analysis, energy, thermodynamic laws, and cycles. (F)

151B. Thermosciences 2
(4) BENNETT
Prerequisites: ME 151A and 152A.
Introduction to heat transfer processes, steady and unsteady state conduction, multidimensional analysis. Introduction to convective heat transfer. (W)

151C. Thermosciences 3
(3) BENNETT
Prerequisites: ME 151B and 152B; open to ME majors only.
Convective heat transfer, external and internal flow, forced and free convection, phase change, heat exchangers. Introduction to radiative heat transfer.

152A. Fluid Mechanics
(4) KRETCHTNIKOV, MEINHART
Prerequisites: Mathematics 5C; and ME 16 with a minimum grade of C-.
Introduction to the fundamental concepts in fluid mechanics and basic fluid properties. Basic equations of fluid flow. Dimensional analysis and similitude. Hydrodynamics. (F)

152B. Fluid Mechanics (3) STAFF
Prerequisite: ME 152A; open to ME majors only. Incompressible viscous flow. Boundary-layer theory. Introductory considerations for one-dimensional compressible flow.

153. Introduction to Mechanical Engineering Design (3) BELTZ, TURNER
Prerequisites: ME 10 and 16; open to ME majors only. Design of systems using mechanics, stress analysis and finite elements. Statistical problems in manufacturing and reliability. Ethics. One paper design project plus the ASME student design project.

154. Design and Analysis of Structures (3) STAFF
Prerequisites: ME 15 and 16 with minimum grades of C-; open to ME majors only. Introductory course in structural analysis and design. The theories of matrix structural analysis and finite element analysis for the solution of analytical and design problems in structures are emphasized. Lecture material includes structural theory, compatibility method, slope deflection method, displacement method and virtual work. Topics include applications to bars, beams, trusses, frames, and solids.

155A. Control System Design (3) BAMIHI, BULLO
Prerequisite: ME 17 with a minimum grade of C-; ME 140A; and ME 163.

155B. Control System Design (3) PADEN
Prerequisite: ME 155A. Dynamic system modeling using state-space methods, controllability and observability, state-space methods for control design including pole placement, and linear quadratic regulator methods. Observers and observer-based feedback controllers. Sampled-data and digital control. Laboratory exercises using MATLAB for simulation and control design.

156A. Mechanical Engineering Design I (3) TURNER, MCMEIKING, BEGLEY
Prerequisite: ME 14, with a minimum grade of C-; and ME 15, with a minimum grade of C-; and MATRXL 101 (or MATRL 100B); or consent of instructor. Open to ME majors only. The rational selection of engineering materials, and the utilization of Ashby charts, stress, strain, strength, and fatigue failure consideration as applied to the design of machine elements. Lectures also support the development of system design concepts using assigned projects and involves the preparation of engineering reports and drawings.

156B. Mechanical Engineering Design II (3) STAFF
Prerequisites: ME 156A; open to ME majors only. Machine elements including gears, bearings, and shafts. Joint design and analysis: bolts, rivets, adhesive bonding and welding. Machine dynamics and fatigue. Design for reliability and safety. Codes and standards. Topics covered are applied in practical design projects.

157. Introduction to Multiphysics Simulation (3) MEINHART
Prerequisite: Mechanical Engineering 151A-B; and Mechanical Engineering 152A-B; and Mechanical Engineering 140A. May not be taken for additional credit by students who have completed ME 125CM. May not be taken by students who have completed ME 225CM or ME 257.

Introduces students to the concepts of multiphysics simulation. Students are introduced to PDE’s, associated analytical solutions, and the finite elements method. Multiphysics problems are solved in multiple domains, and with fluid/structure interactions. Each student conducts a project where multiphysics tools are used to explore details of multiphysical processes.

158. Computer Aided Design and Manufacturing (3) STAFF
Prerequisites: ME 10 and 156A; open to ME majors only. Emphasis on programming, operation and design of automated manufacturing tools. Students learn to program CNC tools to make parts with G&M Code and Mastercam CAM software. Students make parts in hands-on labs using CNC tools, 3D printers and laser cutters. Select topics in automated tool design and construction.

162. Introduction to Elasticity (3) MCMEIKING, BELTZ
Prerequisites: ME 15 and 140A.


163. Engineering Mechanics: Vibrations (3) MEZIC, MCMEIKING
Prerequisites: ME 16 with a minimum grade of C-; open to ME majors only. Not open for credit to students who have completed ME 163B.

Topics relating to vibration in mechanical systems; exact and approximate methods of analysis, matrix methods, generalized coordinates and Lagrange’s equations, applications to systems. Basic feedback systems and controlled dynamic behavior.

166. Advanced Strength of Materials (3) TURNER, KEDWARD
Prerequisite: ME 15. Analysis of statically determinate and indeterminate systems using integration, area moment, and energy methods. Beams on elastic foundations, curved beams, stress concentrations, fatigue, and theories of failure for ductile and brittle materials. Photoelasticity and other experimental techniques are covered, as well as methods of interpreting in-service failures.

167. Structural Analysis (3) STAFF
Prerequisites: ME 15 or 165; and ME 140A. Presents introductory matrix methods for analysis of structures. Topics include review of matrix algebra and linear equations, basic structural theorems including the principle of superposition and energy theorems, truss bar, beam and frame elements, and programming techniques to realize these concepts.

169. Nonlinear Phenomena (4) STAFF
Prerequisites: Physics 105A or ME 163; or upper-division standing in ECE.

Same course as ECE 183 and Physics 106. Not open for credit to students who have completed ME 163C.

An introduction to nonlinear phenomena. Flows and bifurcation in one and two dimensions, chaos, fractals, strange attractors. Applications to physics, engineering, chemistry, and biology.

179D. Introduction to Robotics: Dynamics and Control (4) BYL
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).

Dynamics modeling and control methods for robotic systems. An introduction to robotics, dynamic modeling for deriving equations of motion, introduction to the Jacobian, and modeling and control of forces and contact dynamics at a robotic end effector. Laboratories encourage a problem-solving approach to control.

179L. Introduction to Robotics: Design Laboratory (4) PADEN
Prerequisites: ENGR 3; and ME 6 or ECE 130C. Not open for credit to students who have completed Mechanical Engineering 118A-119A; Design, programming, and testing of mobile robots. Design problems re formulated in terms of robot performance. Students solve electromechanical problems, developing skills in brainstorming, concept selection, spatial reasoning, teamwork and communication. Robots are controlled with micro-controllers using C programming interfaced to sensors and actuators.

179P. Introduction to Robotics: Planning and Kinematics (4) BULLO
Prerequisites: Engr 3; and either ME 17 or ECE 130C (may be taken concurrently). Not open for credit to students who have completed ME 170A or ECE 181A.

Same course as ECE 179P. Motion planning and kinematics topics with an emphasis on geometric reasoning, programming and matrix computations. Motion planning: configuration spaces, sensor-based planning, decomposition and sampling methods, and advanced planning algorithms. Kinematics: reference frames, rotations and displacements, kinematic motion models.

185. Materials in Engineering (3) LEVI, ODETTE
Prerequisite: Materials 100B or 101. Same course as Materials 185. Introduces the student to the main families of materials and the principles behind their development, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials (3) LEVI
Prerequisites: ME 15 and 151C; and Materials 100B or 101. Same course as Materials 186. Introduction to the fundamentals of common manufacturing processes and their interplay with the structure and properties of materials as they are transformed into products. Emphasis on process understanding and the key physical concepts and basic mathematical relationships involved in each of the processes discussed.

189A. Capstone Mechanical Engineering Design Project (2) STAFF
Prerequisite: ME 105, ME 151C, ME 152B, ME 153, and ME 163; or consent of instructor. Open to ME majors only. Designed for majors. Concurrently offered with ME 156A. Quarters usually offered: Fall. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and ME 189A-B-C with the same design project.

Course can only be repeated as a full sequence (189A-B-C). Students work in teams under the direction of a faculty advisor (and possibly an industrial sponsor) to tackle an engineering design project. Engineering communication, such as reports and oral presentations are covered. Emphasis on practical, hands-on experience, and the integration of analytical and design skills acquired in the companion ME 156 courses.

189B. Capstone Mechanical Engineering Design Project (2) LAUETTE
Prerequisite: ME 189A Designed for majors. Concurrently offered with ME 156B. Quarters usually offered: Winter. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME
Technology Management

Technology Management Program
Phelps Hall, Room 1332
Telephone (805) 893-5133
Web site: www.tmp.ucsb.edu

Chair: Robert A. York
Vice Chair: David Seibold

Faculty
Stephen Barley, Ph.D., Massachusetts Institute of Technology, Professor
John E. Bowers, Ph.D., Stanford University, Professor
Gary S. Hansen, Ph.D., University of Michigan, Associate Professor
Paul Leonardi, Ph.D., Stanford University, Professor
Kyle Lewis, Ph.D., University of Maryland, Professor
Renee Rottner, Ph.D., UC Irvine, Assistant Professor
David Seibold, Ph.D., Michigan State University, Professor
Robert A. York, Ph.D., Cornell University, Professor

189C. Capstone Mechanical Engineering Design Project

Prerequisite: ME 189A, B
Designed for majors. Quarters usually offered: Spring. A 3-quarter sequence with grades issued for each quarter. Students may not concurrently enroll in ME 197 and ME 189A-B with the same design project. Course can only be repeated as a full sequence (189A-B-C).

Students work in teams under the direction of a faculty advisor (and possibly an industrial sponsor) to tackle an engineering design project. Engineering communication, such as reports and oral presentations, are covered. Course emphasizes practical, hands-on experience, and integrates analytical and design skills acquired in the companion ME 156 courses. (W)

197. Independent Projects in Mechanical Engineering Design

Prerequisite: ME 16; consent of instructor. Designed for students who are not able to take ME 197. May be repeated for a maximum of 12 units, with written approval by the department chair. Cannot be used as a departmental elective. May be repeated to 12 units. (1-4) STAFF

Prerequisites: consent of instructor and prior departmental approval needed.

Cannot be used as a departmental elective. May be repeated to a maximum of 2 units. Students obtain credit for a mechanical engineering related internship and/or industrial experience under faculty supervision. A 6-10 page written report is required for credit.

197. Independent Projects in Mechanical Engineering Design

Prerequisite: consent of instructor; upper-division standing; completion of two upper-division courses in Mechanical Engineering.

Students must have a minimum of 3.0 grade-point average for the preceding three quarters and are limited to 5 units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined. No more than 4 units may be used as departmental electives. May be repeated to 12 units.

Directed individual study.

GRADUATE COURSES

Graduate courses for this major can be found in the UCSB General Catalog.
126. New Venture Finance
(2) STAFF
(Offered through UC Extension)
Recommended Preparation: Economics 3A or equivalent.
Prerequisite: Upper Division standing.
Focuses on the important link between the business and talent strategy including talent value chain, recruitment/selection strategies for rewards/incentives, employee relations, leadership and team formation; conflict resolution, problem solving, and decision-making; importance of organization culture; diversity and global village. (W, S)

127. Organization Teams and Talent Management
(3) STAFF
(Offered through UC Extension)
Prerequisite: Writing 2 with a minimum grade of B and Writing 50 with a minimum grade of B or equivalent, upper division standing.
Focuses on the theory, concepts, techniques, vocabulary, and practical knowledge of project management practice. Students will learn about the process groups and knowledge areas comprising PMI’s Project Management Body of Knowledge. Provides a framework for conducting projects using project management principles.

130. Operations Management
(3) STAFF
Prerequisite: Upper Division standing and Writing 2 and Writing 50, with grades of B- or better.
Studies the flow of materials and information necessary to effectively and efficiently supply products and/or services to customers. Provides an understanding of the principles of design and management of manufacture, service, and supply chain organizations, business processes and systems.

131. Introductions to Patents and Intellectual Property
(3) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-; and upper division standing.
Provides emerging inventors, entrepreneurs, and scientists with a working knowledge of intellectual property (patents, copyrights, trademarks, and trade secrets), with the main focus being on patents. Will cover the basic functions of patents, structure of patents, and patent prosecution.

132. Business Planning for New Ventures
(4) STAFF
Prerequisite: Engineering 120 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-.
Analysis and creation of a business plan for a new business venture including demand forecasting, financial modeling, selling of the new business idea, and other issues for current business conditions.

134. Selling High Tech Products
(3) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-; and upper division standing.
Learn the art of persuasion and selling.

135. New Product Development
(4) BOWERS
Prerequisite: Upper division standing.
New product development requires technical and non-technical business persons to work across disciplines. Instruction is provided in a wide range of topics concerning customer driven product innovation. Students learn new product development processes, tools, techniques, and organizational skills.

136. Project Management
(3) STAFF
Prerequisite: Upper division standing.
Introduces the theory, concepts, techniques, vocabulary, and practical knowledge of project management practice. Students will learn about the process groups and knowledge areas comprising PMI’s Project Management Body of Knowledge. Provides a framework for conducting projects using project management principles.

144. Market Research for Business
(4) STAFF
Prerequisite: Writing 2 with a minimum grade of B, and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-; and upper division standing.

148A. New Venture Seminar
(3) STAFF
Recommended Preparation: TMP 122, TMP 149, or equivalent.
Quarters usually offered: Winter.
A two-week series of seminars about the creation of sustainable new business ventures from inception to launch. Intended for students participating in the TMP New Venture Competition. (W)

148B. New Venture Seminar
(3) STAFF
Recommended Preparation: TMP 122, TMP 149, or equivalent.
Quarters usually offered: Spring.
Continuation of twice-weekly seminar series covering the development of a validated and sustainable new business, with a focus on creating a writing business plan and oral presentation. Intended for students participating in the TMP New Venture Competition finals. (S)

149. Creating a Market-Tested Business Model
(4) STAFF
Recommended Preparation: TMP 122.
Quarters usually offered: Winter.
Course provides an experiential learning opportunity, showing how a successful business model can be created through the use of customer and market validation process. (W)

152. Decision Analysis
(3) DUNIEER
Prerequisite: Upper-division standing.
Recommended Preparation: PSTAT 5 series or PSTAT 109
Through a combination of lectures, role playing and case studies, students will develop an understanding of how decisions are made, the factors and biases that affect them, the tools that have been developed as a result, and the limitations that remain. The goal is to provide students with a solid foundation in the fundamentals of decision theory. By introducing real world applications that have a direct connection to the students, they will be inspired to apply what they have learned to their own decisions and further explore the topic well into the future.

191AA-ZZ. Special Topics in Business and Management
(2-4) STAFF
Prerequisite: Upper-division standing.
Enrollment Comments: Students must have a cumulative 3.0 for the preceding 3 quarters. May be repeated for credit provided there is no duplication of course content.
Courses provide for the study of topics of current interest in the areas of business, technology, management, entrepreneurship, and other issues related to management and creation of sustainable businesses.

GRADUATE COURSES
Graduate courses for this program can be found in the UCSB General Catalog.
CHEMICAL ENGINEERING 2016-17

**PREPARATION FOR THE MAJOR** 74

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*^ see note on next page

Technical Elective requirement ................................... 15

Prior approval of the student’s technical electives must be obtained from the undergraduate adviser.

At least 9 of the 15 units must be in the following departments in the College of Engineering: CH E, ECE, MATRL, ME

**UNIVERSITY REQUIREMENTS**

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**GENERAL EDUCATION**

**General Subject Areas**

Area A: English Reading & Comprehension – (2 courses required)

A-1: ______________________ A-2: ______________________

Areas D & E: Social Sciences, Culture and Thought (2 courses minimum)

Areas F & G: The Arts, Literature (2 courses minimum)

2 additional courses from Areas D, E, F, G, or H

**Special Subject Areas**

Depth:

Ethnicity (1 course): ______________________

European Traditions (1 course):

Writing (4 courses required):

**NON-MAJOR ELECTIVES** 32

General Education and Free Electives taken:

Courses required for the major, inside or outside of the Department of Chemical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.
## CHEMICAL ENGINEERING 2016-17

### FRESHMAN YEAR

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* If applying to the BS/MS Materials program student must take:
  - Sophomore year: Phys 4 in Winter or Spring
  - Junior year: MATRL 100A in Fall, MATRL 100B in Winter, MATRL 100C in Spring

^Students may only count one course toward the major. (MATRL 101 OR MATRL 100B)
## COMPUTER ENGINEERING 2016-17

### PREPARATION FOR THE MAJOR

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### UNIVERSITY REQUIREMENTS

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### GENERAL EDUCATION

#### General Subject Areas

**Area A:** English Reading & Comprehension – (2 courses required)

- **A-1:**
- **A-2:**

**Area D & E:** Social Sciences, Culture and Thought

- (2 courses minimum)

**Area F & G:** The Arts, Literature

- (2 courses minimum)

**2 additional courses from Areas D, E, F, G, or H**

### Special Subject Areas

**Depth:**

- ****

**Ethnicity (1 course):**

- ****

**European Traditions (1 course):**

- ****

**Writing (4 courses required):**

- ****

### NON-MAJOR ELECTIVES

<table>
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<th>Course Code</th>
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<td>CMPSC138</td>
<td>COMPUTER SCIENCE</td>
</tr>
<tr>
<td>CMPSC 153A/ECE153A</td>
<td>ELECTRICAL ENGINEERING</td>
</tr>
<tr>
<td>CMPSC 160</td>
<td>COMPUTER SCIENCE</td>
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<tr>
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</tr>
<tr>
<td>CMPSC 165A-B</td>
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</tr>
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<td>CMPSC 170</td>
<td>COMPUTER SCIENCE</td>
</tr>
<tr>
<td>CMPSC 171/ ECE 151</td>
<td>ELECTRICAL ENGINEERING</td>
</tr>
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<td>CMPSC 176A-B/ECE 155A-B</td>
<td>ELECTRICAL ENGINEERING</td>
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<td>CMPSC 176C</td>
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<td>CMPSC 178</td>
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<td>ECE 122A-B</td>
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</table>

**General Education and Free Electives taken:**

- ****

- ****

- ****

- ****

- ****

### TOTAL UNITS REQUIRED FOR GRADUATION

**191**
## FRESHMAN YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
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<tbody>
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<td>ECE 1A</td>
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<td>CMPSC 16</td>
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<tr>
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TOTAL: 17 17 17

## SOPHOMORE YEAR

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<td>5</td>
<td>CMPSC 32</td>
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<tr>
<td>ECE 10A</td>
<td>3</td>
<td>ECE 10B</td>
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<td>ECE10BL</td>
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<td>ECE 10CL</td>
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<td>ECE 15A</td>
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<td>PHYS 4</td>
<td>3</td>
<td>ECE 139 or PSTAT 120A(^2)</td>
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TOTAL: 17 18 18

## JUNIOR YEAR

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<th>units</th>
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</thead>
<tbody>
<tr>
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<td>4</td>
<td>CMPSC 130A</td>
<td>4</td>
<td>CMPEN Elective</td>
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<td>G.E. or Free Elective</td>
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<td>G.E. or Free Electives</td>
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<td>G.E. or Free Electives</td>
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</table>

TOTAL: 16 16 12

## SENIOR YEAR

<table>
<thead>
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<td>CMPEN Electives</td>
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<tr>
<td>Free Elective</td>
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<td>ENGR 101(^3)</td>
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TOTAL: 16 15 12

---

\(^1\) CMPSC 8 is recommended only for students who do not have prior programming experience, as programming experience is a prerequisite for CMPSC 16. CS 8 may be used to satisfy the Math, Science, Engineering Elective requirement.

\(^2\) PSTAT 120A is offered each quarter. ECE 139 is offered only in spring quarter, and is better suited for future upper division electives for the Computer Engineering major.

\(^3\) ENGR 101 may be taken any quarter of senior year.
## COMPUTER SCIENCE 2016-17

### PREPARATION FOR THE MAJOR 53 Units

<table>
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<tr>
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<th>Units</th>
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<tbody>
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<tr>
<td>CMPSC 24</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 32</td>
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<td>CMPSC 40</td>
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<tr>
<td>CMPSC 48</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 56</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 64</td>
<td>4</td>
</tr>
<tr>
<td>MATH 3A-B, 4A-B, 6A</td>
<td>20</td>
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<tr>
<td>PSTAT 120A</td>
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### UPPER DIVISION MAJOR 63 Units

<table>
<thead>
<tr>
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<tbody>
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<td>CMPSC 111 or 140</td>
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</tr>
<tr>
<td>CMPSC 130A-B</td>
<td>8</td>
</tr>
<tr>
<td>CMPSC 138</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 154</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 160</td>
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<tr>
<td>CMPSC 162</td>
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</tr>
<tr>
<td>CMPSC 170</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>3</td>
</tr>
<tr>
<td>PSTAT 120B</td>
<td>4</td>
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</table>

**Major Field Electives** .......................................................... 24

*(selected from the following list (at least 8 units must be CMPSC courses))*

Prior approval of the student's major field electives must be obtained from the faculty advisor.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tr>
<td>CMPSC 111</td>
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<tr>
<td>CMPSC 140</td>
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</tr>
<tr>
<td>CMPSC/ECE 153A</td>
<td>2</td>
</tr>
<tr>
<td>CMPSC 165A-B</td>
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</tr>
<tr>
<td>CMPSC 171/ECE 151</td>
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</tr>
<tr>
<td>CMPSC 174A</td>
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<tr>
<td>CMPSC 176A-B-C</td>
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</tr>
<tr>
<td>CMPSC 178</td>
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<td>CMPSC 180</td>
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<tr>
<td>CMPSC 181B/ECE 181B</td>
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<td>CMPSC 185</td>
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<td>CMPSC 189 A-B</td>
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<td>CMPSC 190 AA-ZZ</td>
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<td>CMPSC 192</td>
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<tr>
<td>MATH 119A-B</td>
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<tr>
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<tr>
<td>MATH 130A-B-C</td>
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<td>MATH 153B</td>
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<tr>
<td>MATH 156A-B</td>
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<tr>
<td>MATH 180A</td>
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<tr>
<td>ECE 130A-B-C</td>
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<td>ECE 153B</td>
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<td>ECE 156A-B</td>
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<tr>
<td>ECE 176A-B</td>
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<tr>
<td>ECE 180A</td>
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<tr>
<td>ECE 181A-B</td>
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</table>

1CMPSC 111 or CMPSC 140 can be used as an elective if not taken as a major course.

2Four units maximum from CMPSC 192 and CMPSC 196 combined; only for students with GPA of 3.0 or higher.

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>Major Field Electives taken:</td>
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### SCIENCE COURSES 20 Units

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Science Electives taken:

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<td></td>
<td></td>
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</tbody>
</table>

Courses required for the major, inside or outside of the Department of Computer Science, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

### UNIVERSITY REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Units</th>
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<tbody>
<tr>
<td>American History and Institutions – (one 4-unit course, may be counted as G.E. if selected from approved list)</td>
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</tr>
<tr>
<td>UC Entry Level Requirement: English Composition</td>
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</tr>
<tr>
<td>Must be fulfilled within three quarters of matriculation</td>
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<td>Satisfied by:</td>
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### GENERAL EDUCATION

**General Subject Areas**

<table>
<thead>
<tr>
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<tbody>
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<td>A-1</td>
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<tr>
<td>A-2</td>
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**Areas D & E: Social Sciences, Culture and Thought** (2 courses minimum)

<table>
<thead>
<tr>
<th>Courses</th>
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<tbody>
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**Areas F & G: The Arts, Literature** (2 courses minimum)

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2 additional courses from Areas D, E, F, G, or H

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**Special Subject Areas**

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<table>
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European Traditions (1 course):

<table>
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<tbody>
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Writing (4 courses required):

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### NON-MAJOR ELECTIVES 48 Units

General Education and Free Electives taken:

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### TOTAL UNITS REQUIRED FOR GRADUATION 184
## FRESHMAN YEAR

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<td>units</td>
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<td>MATH 3A</td>
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<td>MATH 4A</td>
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<td>WRIT 1, 2, or G.E. Elective</td>
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<td>PHYS 1</td>
<td>PHYS 2</td>
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<tr>
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<td>16</td>
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</table>

* CMPSC 8 is recommended only for students who do not have prior programming experience; programming experience is a prerequisite for CMPSC 16.

## SOPHOMORE YEAR

<table>
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<tr>
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<tbody>
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## JUNIOR YEAR

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<td>CMPSC 154</td>
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<td>CMPSC 138</td>
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<td>Field Elective</td>
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<td>Free Elective</td>
<td>Field or Free Elective</td>
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<tr>
<td>Science or Free Elective</td>
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<td>G.E. Elective</td>
<td>G.E. Elective</td>
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## SENIOR YEAR

<table>
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<td></td>
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<td>units</td>
<td>units</td>
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<td>Field or Free Elective</td>
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<td>ENGR 101***</td>
<td>G.E. or Free Elective</td>
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<tr>
<td>TOTAL</td>
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<td>15</td>
<td>13</td>
</tr>
</tbody>
</table>

** Or you may take CMPSC 140 in Winter Quarter to satisfy this requirement.

*** ENGR 101 may be taken any quarter of senior year.
## ELECTRICAL ENGINEERING 2016-17

### UNIVERSITY REQUIREMENTS

**American History and Institutions** – (one 4-unit course, may be counted as G.E. if selected from approved list)

**UC Entry Level Requirement: English Composition**

*Must be fulfilled within three quarters of matriculation*

Satisfied by:

### GENERAL EDUCATION

**General Subject Areas**

- **Area A:** English Reading & Comprehension – (2 courses required)
  - A-1: ____________________________
  - A-2: ____________________________

- **Areas D & E:** Social Sciences, Culture and Thought
  (2 courses minimum)
  - ____________________________

- **Areas F & G:** The Arts, Literature
  (2 courses minimum)
  - ____________________________

- 2 additional courses from Areas D, E, F, G, or H
  - ____________________________

**Special Subject Areas**

- **Depth:**
  - ____________________________

- **Ethnicity (1 course):**
  - ____________________________

- **European Traditions (1 course):**
  - ____________________________

- **Writing (4 courses required):**
  - ____________________________

### NON-MAJOR ELECTIVES

**42**

**General Education and Free Electives taken:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A, 1AL or 2A, 2AC</td>
<td>5</td>
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<tr>
<td>ECE 10A, 10AL, 10B, 10BL, 10C, 10CL</td>
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<td>ECE 15A</td>
<td>4</td>
</tr>
<tr>
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<tr>
<td>MATH 3A-B, 4A-B, 6A-B</td>
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**Departmental Electives taken:**

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<th>Course</th>
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<tbody>
<tr>
<td>ECE 130A-B</td>
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<tr>
<td>ECE 132</td>
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</tr>
<tr>
<td>ECE 134</td>
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</tr>
<tr>
<td>ECE 137A-B</td>
<td>8</td>
</tr>
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<td>ECE 152A</td>
<td>5</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>3</td>
</tr>
</tbody>
</table>

Departmental Electives selected from the following list: ____________________________

**Prior approval of the student’s departmental electives must be obtained from the student’s faculty adviser.**

**Must include at least 2 sequences, one of which must be an approved EE Senior Capstone Design/Project course sequence.**

**Approved Departmental Electives:**

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>ECE 120A-B</td>
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<tr>
<td>ECE 122A-B</td>
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<td>ECE 130C</td>
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<td>ECE 141A-B</td>
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<tr>
<td>ECE 142</td>
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<td>ECE 144</td>
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<tr>
<td>ECE 145A-B-C</td>
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<td>ECE 146A-B</td>
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**Departmental Electives taken:**

<table>
<thead>
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<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>ECE 147A-B-C</td>
<td></td>
</tr>
<tr>
<td>ECE 179D, P</td>
<td></td>
</tr>
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Courses required for the major, inside or outside of the Department of Electrical and Computer Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

**TOTAL UNITS REQUIRED FOR GRADUATION ...... 189**
# ELECTRICAL ENGINEERING 2016-17

## FRESHMAN YEAR

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<tr>
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<td>MATH 4A</td>
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## SOPHOMORE YEAR

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<td>ECE 10CL</td>
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<td>MATH 4B</td>
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<td>ECE 15A</td>
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<td>MATH 6B</td>
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<td>PHYS 4</td>
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## JUNIOR YEAR

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<tbody>
<tr>
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<td>ECE 130B</td>
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<td>ECE 137B</td>
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<td>Fall</td>
<td>ECE 132</td>
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<td>ECE 137A</td>
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<td>ECE 139 1</td>
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<td>ECE 134</td>
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<td>ECE Elective</td>
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<td>ECE 152A 2</td>
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<td>G.E. or Free Elective</td>
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## SENIOR YEAR

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<td>G.E. or Free Electives</td>
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<td>16</td>
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<td>17</td>
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</tbody>
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1. ECE 139 may also be taken in the spring quarter of the sophomore year.
2. ECE 152A may also be taken in the spring quarter of the sophomore year.
3. ENGR 101 may be taken any quarter of senior year.
## MECHANICAL ENGINEERING 2016-17

### PREPARATION FOR THE MAJOR 76

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
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<td>MATH 3A-B, 4A-B, 6A-B</td>
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<td>ME 6</td>
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<td>ME 10</td>
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<td>ME 14</td>
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<tr>
<td>ME 15</td>
<td>4</td>
</tr>
<tr>
<td>ME 16</td>
<td>4</td>
</tr>
<tr>
<td>ME 17</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 1, 2, 3, 3L, 4, 4L</td>
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### UPPER DIVISION MAJOR 70

#### Third Year

<table>
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<th>Course</th>
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<td>ME 104</td>
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<tr>
<td>ME 105</td>
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</tr>
<tr>
<td>ME 140A</td>
<td>3</td>
</tr>
<tr>
<td>ME 151A-B-C</td>
<td>11</td>
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<td>ME 152A-B</td>
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<td>ME 155A</td>
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<tr>
<td>ME 163</td>
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</table>

* see note on next page

#### Fourth Year

<table>
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<tr>
<td>ME 156A-B</td>
<td>6</td>
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<tr>
<td>ME 189A-B-C</td>
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<tr>
<td>Engineering Electives</td>
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</table>

Prior approval of the student's departmental electives must be obtained from the student's faculty adviser. Note, the list of approved electives may change from year to year and that not all courses are offered each year.

### Approved Engineering Electives:

<table>
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<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CHEM 109A</td>
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<tr>
<td>CHEM 123</td>
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</tr>
<tr>
<td>ECE 147A,C</td>
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<td>ECE 181B</td>
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<td>ENGR 101</td>
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<td>ENGR 195A,B,C</td>
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<td>ENV S 105</td>
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<td>MATRL 100A</td>
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<td>ME 106A</td>
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<td>ME 110</td>
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<td>ME 112</td>
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<td>ME 114</td>
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</tr>
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<td>ME 124</td>
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</tr>
<tr>
<td>ME 125 AA-ZZ</td>
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<tr>
<td>ME 128</td>
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<td>ME 134</td>
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<td>ME 140B</td>
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<tr>
<td>ME 141A,B</td>
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</tr>
<tr>
<td>ME 146</td>
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<tr>
<td>ME 147</td>
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</tr>
<tr>
<td>ME 155B</td>
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<td>ME 157</td>
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<td>ME 167</td>
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<td>ME 168</td>
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<td>ME 169</td>
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<td>ME 179D,L,P</td>
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<td>ME 186</td>
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<td>ME 1971</td>
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<tr>
<td>TMP 120, 122</td>
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1 Four units maximum from ME 197 and ME 199 combined.

### UNIVERSITY REQUIREMENTS

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<thead>
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<th>Requirement</th>
<th>Units</th>
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<tbody>
<tr>
<td>American History and Institutions – (one 4-unit course, may be counted as G.E. if selected from approved list)</td>
<td></td>
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<tr>
<td>UC Entry Level Requirement: English Composition</td>
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<tr>
<td>Must be fulfilled within three quarters of matriculation</td>
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Satisfied by: __________________________________________

### GENERAL EDUCATION

#### General Subject Areas

**Area A: English Reading & Comprehension – (2 courses required)**

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<tr>
<th>A-1</th>
<th>A-2</th>
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<tbody>
<tr>
<td></td>
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</table>

**Areas D & E: Social Sciences, Culture and Thought (2 courses minimum)**

Areas F & G: The Arts, Literature (2 courses minimum)

2 additional courses from Areas D, E, F, G, or H

### Special Subject Areas

Depth:

Ethnicity (1 course):

European Traditions (1 course):

Writing (4 courses required):

### NON-MAJOR ELECTIVES 44

General Education and Free Electives taken:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
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TOTAL UNITS REQUIRED FOR GRADUATION ...... 190

Courses required for the major, inside or outside of the Department of Mechanical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.
# MECHANICAL ENGINEERING 2016-17

## FRESHMAN YEAR

<table>
<thead>
<tr>
<th></th>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
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<td>CHEM 1B or 2B</td>
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## SOPHOMORE YEAR

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## JUNIOR YEAR

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<td>ME 151A</td>
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<td>ME 151B</td>
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<td>ME 151C</td>
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<td>ME 155A</td>
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## SENIOR YEAR

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<th>units</th>
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<td>ME 154 or ME 167**</td>
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<td>ME 156B</td>
<td>3</td>
<td>ME 189C</td>
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* If applying to the BS/MS Materials program, juniors must take MATRL 100A in Fall, MATRL 100B in Winter, and MATRL 100C in Spring.

** If using ME 167 to satisfy the ME 154 requirement, students may not count ME 167 as an Engineering Elective.

*Students may only count one course toward the major. (MATRL 101 OR MATRL 100B)
Additional Resources and Information

Gaucho On-Line Data (GOLD) – student record, class registration, degree audits—https://my.sa.ucsb.edu/gold
UMAIL – campus email for official notifications—http://www.umail.ucsb.edu
Schedule of Classes information – quarterly calendar and information—http://www.registrar.ucsb.edu
General Catalog for UCSB – academic requirements for all campus majors—http://my.sa.ucsb.edu/Catalog/
Summer Sessions – Summer programs and course offerings—http://www.summer.ucsb.edu
Tutoring – course-specific tutoring and academic skills development—http://www.clas.ucsb.edu
Education Abroad Program – EAP options for engineering students—email: eap@engineering.ucsb.edu
College Honors Program – program information and opportunities—email: honors@engineering.ucsb.edu

Advising Staff

College Advisors: general education requirements, academic standing, final degree clearance

Departmental Advisors: course selection, class enrollment, change of major, academic requirements

<table>
<thead>
<tr>
<th>College Advising staff</th>
<th>Phone</th>
<th>Email</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>893-8671</td>
<td><a href="mailto:cheugrads@engr.ucsb.edu">cheugrads@engr.ucsb.edu</a></td>
<td>Engr.II, Rm. 3357</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>893-8292</td>
<td><a href="mailto:ugradinfo@ece.ucsb.edu">ugradinfo@ece.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Computer Science</td>
<td>893-4321</td>
<td><a href="mailto:ugradv@cs.ucsb.edu">ugradv@cs.ucsb.edu</a></td>
<td>Frank Hall, Rm. 2104</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>893-8292</td>
<td><a href="mailto:ugradinfo@ece.ucsb.edu">ugradinfo@ece.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>893-8198</td>
<td><a href="mailto:meugrad@engr.ucsb.edu">meugrad@engr.ucsb.edu</a></td>
<td>Engr.II, Rm. 2355</td>
</tr>
<tr>
<td>Technology Management</td>
<td>893-2729</td>
<td><a href="mailto:tmp@tmp.ucsb.edu">tmp@tmp.ucsb.edu</a></td>
<td>Phelps 1333</td>
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<table>
<thead>
<tr>
<th>Departmental Advisors:</th>
<th>Phone</th>
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</table>
Policy on Academic Conduct

It is expected that all students in the College of Engineering, as well as those who take courses within the College, understand and subscribe to the ideal of academic integrity. To provide guidance on this, the College of Engineering has adopted a policy on expected academic conduct, a full copy of which appears below. As an example, it is not acceptable by default to work collaboratively on a homework assignment. In computer programming courses, a mere preliminary discussion of an assignment can lead to similarities in the final program that are detectable by sophisticated plagiarism detection software (see http://theory.stanford.edu/~aiken/moss/).

Instructors who have established that academic misconduct has occurred in their class have a variety of options at their disposal, which range from allowing the student to redo the work and/or assigning a failing grade to referring the case to the UCSB Judicial Affairs Office for either a letter of warning or a formal hearing before the Student-Faculty Committee on Student Conduct. Instructors are encouraged to discuss these remedies in further detail with the Associate Dean for Undergraduate Studies in the College of Engineering. Moreover, students who have been suspended because of academic misconduct charges are encouraged to work with the College of Engineering Undergraduate Office to develop an amended schedule that will permit the timeliest possible completion of a degree program.

College of Engineering Policy
The College of Engineering’s Academic Conduct Policy is compatible with that of the University of California, in that it is expected that students understand and subscribe to the ideal of academic integrity, and are willing to bear individual responsibility for their work. Any work (written or otherwise) submitted to fulfill an academic requirement must represent a student’s original work. Any act of academic dishonesty, such as cheating or plagiarism, will subject a person to University disciplinary action.

Cheating is defined by UCSB as the use, or attempted use, of materials, information, study aids, or services not authorized by the instructor of the course. The College of Engineering interprets this to include the unauthorized use of notes, study aids, electronic or other equipment during an examination or quiz; copying or looking at another individual’s examination or quiz; taking or passing information to another individual during an examination or quiz; taking an examination or quiz for another individual; allowing another individual to take one’s examination; stealing examinations or quizzes. Students working on take-home exams or quizzes should not consult students or sources other than those permitted by the instructor.

Plagiarism is defined by UCSB as the representation of words, ideas, or concepts of another person without appropriate attribution. The College of Engineering expands this definition to include the use of or presentation of computer code, formulae, ideas, or research results without appropriate attribution.

Collaboration on homework assignments (i.e., problem sets), especially in light of the recognized pedagogical benefit of group study, is dictated by standards that can and do vary widely from course to course and instructor to instructor. The use of old solution sets and published solution guides presents a similar situation. Because homework assignments serve two functions--helping students learn the material and helping instructors evaluate academic performance--it is usually not obvious how much collaboration or assistance from commonly-available solutions, if any, the instructor expects. It is therefore imperative that students and instructors play an active role in communicating expectations about the nature and extent of collaboration or assistance from materials that is permissible or encouraged.

Expectations of Members of the College Academic Community
In their classes, faculty are expected to (i) announce and discuss specific problems of academic dishonesty that pertain particularly to their classes (e.g., acceptable and unacceptable cooperation on projects or homework); (ii) act reasonably to prevent academic dishonesty in preparing and administering academic exercises, including examinations, laboratory activities, homework and other assignments, etc.; (iii) act to prevent cheating from continuing when it has been observed or reported to them by students, chairs, or deans; and, (iv) clearly define for students the maximum level of collaboration permitted for their work to still be considered individual work.

In their academic work, students are expected to (i) maintain personal academic integrity; (ii) treat all exams and quizzes as work to be conducted privately, unless otherwise instructed; (iii) take responsibility for knowing the limits of permissible or expected cooperation on any assignment.
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