### 2012-13 Academic Calendar

Note: Dates subject to change without notice.

<table>
<thead>
<tr>
<th></th>
<th>Fall 2012</th>
<th>Winter 2013</th>
<th>Spring 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration begins</td>
<td>May 16, 2012</td>
<td>October 27, 2012</td>
<td>February 6, 2013</td>
</tr>
<tr>
<td>Quarter begins</td>
<td>September 23, 2012</td>
<td>January 7, 2013</td>
<td>April 1, 2013</td>
</tr>
<tr>
<td>Convocation</td>
<td>September 24, 2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre–instruction Activities</td>
<td>September 24-26, 2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First day of instruction</td>
<td>September 27, 2012</td>
<td>January 7, 2013</td>
<td>April 1, 2013</td>
</tr>
<tr>
<td>Last day of instruction</td>
<td>December 7, 2012</td>
<td>March 15, 2013</td>
<td>June 7, 2013</td>
</tr>
<tr>
<td>Final examinations</td>
<td>December 8-14, 2012</td>
<td>March 16-22, 2013</td>
<td>June 8-14, 2013</td>
</tr>
<tr>
<td>Quarter ends</td>
<td>December 14, 2012</td>
<td>March 22, 2013</td>
<td>June 14, 2013</td>
</tr>
<tr>
<td>Commencement</td>
<td></td>
<td></td>
<td>June 15-16, 2013</td>
</tr>
</tbody>
</table>

### Summer Sessions 2013

Registration begins: April 8, 2013  
First day of instruction: June 24, 2013

### 2012-13 Campus Holidays

<table>
<thead>
<tr>
<th>Holiday</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor Day</td>
<td>Monday, September 3, 2012</td>
</tr>
<tr>
<td>Veterans' Day</td>
<td>Monday, November 12, 2012</td>
</tr>
<tr>
<td>Thanksgiving</td>
<td>Thursday &amp; Friday, November 22 &amp; 23, 2012</td>
</tr>
<tr>
<td>Christmas</td>
<td>Monday &amp; Tuesday, December 24 &amp; 25, 2012</td>
</tr>
<tr>
<td>New Year</td>
<td>Monday &amp; Tuesday, December 31, 2012 &amp; January 1, 2013</td>
</tr>
<tr>
<td>Martin Luther King, Jr.'s Birthday</td>
<td>Monday, January 21, 2013</td>
</tr>
<tr>
<td>Presidents' Holiday</td>
<td>Monday, February 18, 2013</td>
</tr>
<tr>
<td>Cesar Chavez Holiday</td>
<td>Friday, March 29, 2013</td>
</tr>
<tr>
<td>Memorial Day</td>
<td>Monday, May 27, 2013</td>
</tr>
<tr>
<td>Independence Day</td>
<td>Thursday, July 4, 2013</td>
</tr>
</tbody>
</table>

---

**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.
General Engineering Academic Requirements

2012-2013

College of Engineering • University of California • Santa Barbara

Volume 3, June 2012

College of Engineering
Office of Undergraduate Studies

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University of California
Santa Barbara, CA 93106-5130

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Fax (805) 893-8124
Email:coe-info@engineering.ucsb.edu

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 five Nobel Prize winners on this campus, four 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 1,350 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 in 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
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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 1,350 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-

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 College Honors Program. Students who do not enter the College of Engineering with honors at the freshman level may petition to enter the program after attaining a cumulative GPA of 3.5 or greater after two regular quarters at UCSB.

Graduating with Honors Program Designation, 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 per year, 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 Institute of Chemical Engineers
- American Society of Mechanical Engineers
- Association for Computing Machinery
- Engineering Student Council
- Engineers without Borders
- Institute of Electrical and Electronics Engineers
- Los Ingenieros (Mexican-American Engineering Society/Society of Hispanic Professional Engineers)
- National Society of Black Engineers
- Society for Advancement of Chicanos and Native Americans in Science
- Society of Women Engineers
- Student Entrepreneurship Association
- Women in Science and Engineering
- Women in Software and Hardware
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.

Students who enter UCSB as transfer students will not be able to change to or add 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, unless they can demonstrate that they will be able to complete all the degree requirements without exceeding 215 total units.

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. 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.

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 3C or 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 (CMPSC) classes, from the following: Math 4B or 5A, 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. An overall UCSB grade point average of at least 2.0;
2. Satisfactory completion (preferably at UCSB), with a grade of B better in Computer Science 16, 24, and 40;
3. Satisfactory completion (preferably at UCSB) with a grade of C or better in Math 3A and 3B; Math 3C or 4A; and Math 4B or 5A.

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 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 at least five classes, including at least two mathematics classes, from the following: Math 4B or 5A, Math 5B or 6A, Math 5C or 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 3C or 4A; Math 5A or 4B; Math 5B-C or 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 must meet with the ME Academic Advisor.

Degree Requirements

To be eligible for a bachelor of science degree from the College of Engineering, a student 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 8.

College General Education Requirements

All students must satisfy the general education requirements for the College of Engineering. These requirements are described on pages 8 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 this credit to the General Education requirements, are presented in the chart on page 7.

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 certified IB Higher Level examinations on which a student scores 5, 6, or 7. The university does not grant credit for standard level exams. The application of this credit to the General Education requirements and course equivalents for these exams are listed on page 6.

Note: International Baccalaureate 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.

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 that 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 dean of engineering to deviate from these requirements. Approval normally will be granted only in the case of medical disability, severe personal problems, or accident. 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 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, irrespective of whether they earn more than 215 units during that period. 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

Computer Engineering. A combined B.S./M.S. program in Computer Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. The M.S. degree will be earned in either the Department of Computer Science or the Department of Electrical and Computer Engineering, while the B.S. degree is earned in Computer Engineering. Additional information about this program is available from the Undergraduate Office and interested students should contact the Office early in their junior year, because the junior year class schedule will be different from other undergraduates. Transfer students should notify the Office of their interest in the program at the earliest opportunity. 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.

Computer Science. A combined B.S./M.S. program in computer science provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information is available from the computer science graduate program assistant or online at: www.cs.ucsb.edu/undergraduate/. Interested students may apply after completing at least 3 upper division computer science courses, but before the beginning of the final year in the B.S. 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.

Electrical Engineering. A combined B.S./M.S. program in Electrical Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. Interested students should contact the Office of Undergraduate Studies early in the junior year, because the junior year class schedule will be different from other undergraduates. Transfer students should notify the Office of their interest in the program at the earliest opportunity. 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.

Materials. A combined B.S. Engineering/ M.S. Materials program provides an opportunity for outstanding undergraduates in chemical, electrical, or mechanical engineering to earn both of these degrees in five years. This program enables students to develop all of the requisite knowledge in their core engineering disciplines and to complement this with a solid background in materials. This combination provides highly desirable training from an industrial employment perspective and capitalizes on the strengths of our internationally renowned materials department.

There is a five-year option for students who are pursuing a B.S. in Chemistry in the College of Letters and Science to complete an M.S. degree in Materials. Interested students should contact the Undergraduate Advisor in the Department of Chemistry & Biochemistry for additional information.

### International Baccalaureate Higher Level Exam (With Score of 5 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>C: 1 course</td>
<td>MCD20/EEMB20</td>
</tr>
<tr>
<td>Business &amp; Management</td>
<td>8</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>C: 1 course#</td>
<td>Natural Science 1B</td>
</tr>
<tr>
<td>Computer Science</td>
<td>8</td>
<td>C: 1 course#</td>
<td>Computer Science 5NM</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>Pending</td>
<td>Pending</td>
</tr>
<tr>
<td>English (A1 level)</td>
<td>8</td>
<td>Score of 5</td>
<td>Entry Level Writing</td>
</tr>
<tr>
<td>Score of 5</td>
<td>8</td>
<td>Score of 5 Writing</td>
<td>Writing 1, 1E, 1LK</td>
</tr>
<tr>
<td>Score of 6</td>
<td>8</td>
<td>Score of 6 Writing 2</td>
<td>Writing 1, 1E, 1LK, 2, 2E, 2LK</td>
</tr>
<tr>
<td>Score of 7</td>
<td>8</td>
<td>Score of 7 Writing 2, 50</td>
<td>Writing 1, 1E, 2, 2E, 50, 50E</td>
</tr>
<tr>
<td>Foreign Languages</td>
<td>8</td>
<td>B</td>
<td>Levels 1-6</td>
</tr>
<tr>
<td>Geography</td>
<td>8</td>
<td>D: 1 course</td>
<td>None</td>
</tr>
<tr>
<td>History of Africa</td>
<td>8</td>
<td>E: 1 course#</td>
<td>None</td>
</tr>
<tr>
<td>History of the Americas</td>
<td>8</td>
<td>E: 1 course</td>
<td>None</td>
</tr>
<tr>
<td>History of East/South Asia</td>
<td>8</td>
<td>E: 1 course#</td>
<td>None</td>
</tr>
<tr>
<td>History of Europe</td>
<td>8</td>
<td>E: 1 course#</td>
<td>History 4C</td>
</tr>
<tr>
<td>History of S. Asia/Middle East</td>
<td>8</td>
<td>E: 1 course#</td>
<td>None</td>
</tr>
<tr>
<td>Islamic History</td>
<td>8</td>
<td>E: 1 course#</td>
<td>None</td>
</tr>
<tr>
<td>Math</td>
<td>8</td>
<td>C: 1 course#</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>C: 1 course#</td>
<td>Natural Science 1A, 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 Anthro.</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

<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 Portfolio</td>
<td>8</td>
<td>none</td>
<td>Art Studio 18</td>
</tr>
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<td>French 1-4</td>
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<td>8</td>
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<td>French 1-5</td>
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<td>French 1-5</td>
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<td>H: 1 course</td>
<td>German 1-4</td>
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<td>8</td>
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<td>With score of 5</td>
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<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-4</td>
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<td>H: 1 course</td>
<td>Spanish 1-5</td>
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<td>Spanish 1-6</td>
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<td>D: 1 course</td>
<td>Political Science 12</td>
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<td>D: 1 course</td>
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<tr>
<td>World History</td>
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<td>no equivalent</td>
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</table>

* A maximum of 8 units EACH in art studio, English, mathematics, and physics is allowed.
# Also satisfies the quantitative relationship requirement in Area C.
+ Maximum credit for computer science exams is 4 units.
† Consult the mathematics department about optional higher placement in calculus.
* If you received a score of 5 on Mathematics-Calculus AB, see www.math.ucsb.edu/ugrad/placement.php
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; ESL 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, 144, 168A-B, 174, 188A-B-C
   - Economics 113A-B, 119
   - English 133AA-ZZ, 134AA-ZZ, 137A-B, 138C, 191
   - Environmental Studies 173
   - Feminist Studies 155A, 159B-C
   - Military Science 27
   - Political Science 12, 115, 127, 151, 152, 153, 155, 157, 158, 162, 165, 167, 168, 174, 176, 180, 185
   - Religious Studies 7, 14, 61A-B, 114B, 151A-B, 152
   - Sociology 137E, 140, 144, 155A, 157
   - 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 IGETC 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 must complete Writing 2; and Writing 50, 107T, or 109ST.

All other engineering majors are required to complete Writing 2E and Writing 50E during their first year at UCSB. Students that are unable to meet this requirement should consult with the College of Engineering Office of Undergraduate Studies.

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 8 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 9, 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 10.

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. 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.

NOTES: ENGR 101 and ENGR 103 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.

Option three is to complete an approved minor or double major, in a discipline encompassed by areas D, E, F, or G. 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.

Only courses from General Subject Areas D, E, F, G, or H may be used to meet the depth requirement.

3. Ethnicity Requirement. 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.

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: Black Studies 38A can be applied to the Writing and Ethnicity requirements in addition to the Area G 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.

### AREA A – ENGLISH READING AND COMPOSITION

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 provide an understanding of what determines or influences the behavior and beliefs of individuals and groups.

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<th>Title</th>
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<td>Introduction to Archaeology</td>
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<td>Anthropology 7</td>
<td>Introduction to Biosocial Anthropology</td>
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<td>Anthropology 25</td>
<td>Violence and the Japanese State (Same as JAPAN 25)</td>
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<td>Anthropology 103A</td>
<td>Anthropology of China</td>
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<td>Anthropology 103C</td>
<td>Anthropology of Korea</td>
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<td>Anthropology 109</td>
<td>Human Universals</td>
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<td>Anthropology 110</td>
<td>Technology and Culture</td>
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<td>Anthropology 122</td>
<td>Anthropology of World Systems</td>
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<td>Anthropology 130A-B</td>
<td>Third World Environments</td>
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<td>Anthropology 131</td>
<td>North American Indians</td>
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<td>Modern Cultures of Latin America</td>
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<td>Understanding Africa</td>
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<td>Asian American Personality and Identity</td>
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<td>Sociology of Asian America</td>
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<td>South Asian Americans</td>
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<td>Asian American Studies 107</td>
<td>Third World Social Movements</td>
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<td>Asian American Studies 111</td>
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<td>The Chicanos Community (Same as SOC 144)</td>
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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 European Traditions requirement.
**Area: Culture and Thought**

Objective: To provide a perspective on world cultures through the study of human history and thought.

- Anthropology 138TS
- Anthropology 176TS
- Art History 6A-B-C

* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.
^ This course applies toward the European Traditions requirement.

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This course applies toward the American History & Institutions requirement.

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* Religious Studies 162F
* Slavic 152A
* Slavic 152B
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* Sociology 131
* Sociology 134
& Sociology 144

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* Women, the Family and Sexuality in the Middle Ages
* Women, the Family and Sexuality in the Middle Ages
* Women and Work (Same as FEMST 153)

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* Art Survey
**12 • GENERAL EDUCATION**

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* This course applies toward the writing requirement.  
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Seventeenth-Century Art in Southern Europe

Art History 113B
Seventeenth-Century Art in Italy

Art History 113D
Architecture in Early Modern Italy

Art History 113F
Bernini and the Age of the Baroque

Art History 115B
Eighteenth-Century Art 1750-1810

Art History 115C
Eighteenth-Century British Art and Culture

Art History 115D
Eighteenth-Century in Italy: The Age of the Grand Tour

Art History 117A
Nineteenth-Century Art 1800-1848

Art History 117B
Nineteenth-Century Art 1848-1900

Art History 117C
Nineteenth-Century British Art and Culture

Art History 117D
Nineteenth-Century French Art 1800 to 1900

Art History 117F
Impressionism and Post-Impressionism

Art History 119A
Art in the Modern World

Art History 119B
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Art History 119C
Expressionism to New Objectivity, Early Twentieth-Century German Art

Art History 119D
Art in the Post-Modern World

Art History 119E
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Art History 119F
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Art History 119G
Critical Approaches to Visual Culture

Art History 121A
American Art from the Revolution to Civil War: 1700-1860

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 121E
American Things: Material Culture and Popular Art

& Art History 121F
History of Native Art and Architecture in North America

& Art History 123A
Modern Latin American Art

& Art History 125A
Chicano Art: Symbol and Meaning

* 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
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Art History 136J
Landscape of Colonialism

Art History 136M
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Art History 136O
Sustainable Architecture: History and Aesthetics

Art History 136Y
Modern Architecture in Southern California

Art History 138B
Contemporary Photography

Art History 138C
Social Documentary Photography

Art History 138D
History of Photography

Art History 140A
Portraiture

Art History 140E
Landscape Design History

Art History 141D
Birth of the Modern Museum

Art History 141G
Gender and Representation

Art History 144A
The Avant-Garde in Russia

Art History 144C
Contemporary Art in Russia and Eastern Europe (Same as SLAV 130C)

* 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 G: LITERATURE

Objective: To develop an appreciation of literature through historical study, analysis of master works, and aesthetically creative activity.

| & Asian American Studies 5 | Introduction to American Literature |
| & Asian American Studies 122 | Asian American Fiction |
| & Asian American Studies 128 | Writings by Asian American Women |
| & Black Studies 33 | Major Works of African Literatures (Same as C LIT 33) |
| & Black Studies 38A-B | Introduction to Afro-American Literature |
| & Black Studies 126 | Comparative Black Literatures |
| & Black Studies 127 | Black Women Writers |
| & Black Studies 130A | Negritude and African Literature |
| & Black Studies 130B | The Black Francophone Novel |
| & Chicano Studies 152 | Postcolonialism |
| & Chicano Studies 180 | Survey of Chicano Literature |
| & Chicano Studies 181 | The Chican novel |
| & Chicano Studies 184A | Chichana Writers |
| Chinese 110A | Classics of Ancient China |
| Chinese 112A | Major Movements in Modern Chinese Literature |
| Chinese 115A | Imagism, Haiku, and Chinese Poetry |
| Chinese 124A-B | Readings in Modern Chinese Literature |
| Chinese 132A | Classical Chinese Poetry |
| Chinese 139 | Boundaries of the Self in Late Imperial Chinese Literature |
| Chinese 142 | Tang Poetry |
| Chinese 148 | Historic Lives |
| Classics 36 | Ancient Epic |
| Classics 37 | Greek Literature in Translation |
| Classics 38 | Latin Literature in Translation |
| Classics 39 | Women in Classical Literature |
| Classics 40 | Greek Mythology |
| Classics 102 | Greek Tragedy in Translation |
| Classics 109 | Viewing the Barbarian: Representations of Foreign Peoples in Greek Literature |
| Classics 110 | From Homer to Harlequin: Masculine, Feminine, and the Romance |
| Classics 120 | Greek and Latin Lyric Poetry |
| Classics 130 | Comedy and Satire in Translation |
| Classics 175 | Ancient Theories of Literature |
| Comparative Literature 30A-B-C | Major Works of European Literature |
| Comparative Literature 31 | Major Works of Asian Literatures |
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| Comparative Literature 33 | Major Works of African Literatures (Same as BL ST 33) |
| Comparative Literature 34 | Literature of the Americas |
| Comparative Literature 100 | Introduction to Comparative Literatures |
| Comparative Literature 107 | Voyages to the Unknown |
| Comparative Literature 113 | Trauma, Memory, Historiography |
| Comparative Literature 117A-B | European Romanticism |
| Comparative Literature 122A | Representations of the Holocaust (Same as GER 116A) |
| Comparative Literature 12B | Holocauast in France (Same as FR 154E) |
| Comparative Literature 154 | Comparative Black Literatures |
| Comparative Literature 161 | Children’s Literature |
| Comparative Literature 171 | Representing Childhood |
| Comparative Literature 179B | Transpacific Literature |
| Comparative Literature 179C | Robots |
| Comparative Literature 186EE | Border Narratives |
| Comparative Literature 188 | Science Fiction in Eastern Europe |
| Comparative Literature 191 | Literature of Central Europe |
| Comparative Literature 196 | Post-Colonial Cultures (Same as FR 154G) |
| Comparative Literature 201 | Mysticism |
| Comparative Literature 202 | Mediatechnology (Same as GER 197C) |
| Comparative Literature 203 | Interdisciplinary Comparative Literature |
| Comparative Literature 204 | Comparative American Literature |
| Comparative Literature 205 | Introduction to Narrative Literature and the Culture of Information |
| Comparative Literature 206 | Introduction to Literature and the Environment |
| Comparative Literature 207 | Introduction to U.S. Minority Literature |
| Comparative Literature 208 | Topics in Literature |
| Comparative Literature 210 | English Literature from the Medieval Period to 1650 |
| Comparative Literature 211 | English and American Literature from 1650 to 1789 |
| Comparative Literature 212 | American Literature from 1789 to 1900 |
| Comparative Literature 213 | British Literature from 1789 to 1900 |
| Comparative Literature 214 | American Literature from 1900 to Present |
| Comparative Literature 215 | British Literature from 1900 to Present |
| Comparative Literature 216 | Shakespeare: Poems and Earlier Plays |
| Comparative Literature 217 | Shakespeare: Later Plays |
| Comparative Literature 218 | Literary Theory and Criticism |
| Comparative Literature 219 | Women and Literature |
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| Comparative Literature 221 | Native American Women Authors |
| Comparative Literature 222 | Medieval Literature |
| Comparative Literature 223 | Biblical Literature: The Old Testament |
| Comparative Literature 224 | Biblical Literature: The New Testament |
| Comparative Literature 225 | Studies in Medieval Literature |
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| Comparative Literature 227 | Modern Drama |
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| Comparative Literature 246 | Topics in Literature |
| Comparative Literature 247 | Studies in Literature and the Mind |
| Comparative Literature 248 | Studies in the Enlightenment |
| Comparative Literature 249 | British Romantic Writers |

* 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 European Traditions requirement.
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<td>Italian 111</td>
<td>Italian Short Fiction</td>
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<td>Italian 126A-AA-ZZ</td>
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<td>Italian 138AX</td>
<td>Cultural Representations in Italy</td>
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<td>Women in Italy</td>
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<td>Italian 144AX</td>
<td>Gender and Sexuality in Italian Culture</td>
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<td>Italian 165X</td>
<td>Early Modern Epic</td>
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<td>Japanese 115</td>
<td>Twentieth-Century Japanese Literature</td>
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<td>Korean 113</td>
<td>Korean Literature Survey</td>
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<td>Latin American &amp; Iberian Studies 102</td>
<td>Introduction to Interdisciplinary Approaches to the Cultures, Languages and Literature</td>
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<td>Medieval Studies 100B</td>
<td>Literature of Chivalry</td>
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<td>Portuguese 120A-XX</td>
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<td>Spanish 120A-B</td>
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<td>The Hispanic Novel and Cinema</td>
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<td>Spanish Golden Age Poetry</td>
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<td>Golden Age Drama</td>
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<td>Cervantes: Don Quijote</td>
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<td>The Hispanic Novel and Cinema</td>
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**Area H: Foreign Language**

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

<table>
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<tr>
<th>Course Title</th>
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<tr>
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<td>Chinese 2NH-3NH</td>
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<td>Chinese 4-5-6</td>
<td>Intermediate Modern Chinese</td>
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<td>Chinese 4NH-5NH-6NH</td>
<td>Second Year Chinese Heritage</td>
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<td>French 4-5-6</td>
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<td>French 6GS</td>
<td>Intermediate French: Global Studies - Political Sci.</td>
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<td>German 2-3</td>
<td>Elementary German</td>
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<td>German 4-5-6</td>
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<td>German 95C</td>
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<td>German 95CS</td>
<td>Advanced Yiddish</td>
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<td>Punjab (II-III-IV-VI)</td>
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<td>Greek 2</td>
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<td>Greek 3</td>
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<td>Latin 3</td>
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<td>Arabic (II-III-IV-VI)</td>
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<td>Religious Studies 118C-D-E-F</td>
<td>Hindi (II-III-IV-VI)</td>
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<td>Tibetan (II-III-IV-VI)</td>
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<td>Pashto (II-III-IV-VI)</td>
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<td>Advanced Persian (II-III)</td>
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<tr>
<td>Religious Studies 159B-C</td>
<td>Elementary Sanskrit</td>
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</table>

* 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.
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.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<td>* Anthropology 116B</td>
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<tr>
<td>* Anthropology 142B</td>
<td>Contemporary Issues in South Asia</td>
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<td>* Anthropology 143</td>
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<td>* Anthropology 148A</td>
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<td>* Anthropology 172</td>
<td>Colonialism and Culture</td>
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<td>* Art History 136A-136Z</td>
<td>Seminar in Advanced Studies in Art History</td>
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<td>&amp; Asian American Studies 100CC</td>
<td>Asian American Movement</td>
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<td>&amp; Asian American Studies 113</td>
<td>Asian American Autobiographies and Biographies</td>
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<td>&amp; Asian American Studies 121</td>
<td>Asian American Literature in Comparative Frameworks</td>
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<td>&amp; Asian American Studies 124</td>
<td>Asian American Men and Contemporary Men's Issues</td>
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<td>&amp; Black Studies 137E</td>
<td>Introduction to Video Production</td>
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<tr>
<td>&amp; Black Studies 138</td>
<td>Screenwriting</td>
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<td>&amp; Chicano Studies 139</td>
<td>Sociology of the Black Experience</td>
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<td>&amp; Chicano Studies 154F</td>
<td>Chicana/o Native American Heritage</td>
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<td>&amp; Chicano Studies 168</td>
<td>The Chicano Family</td>
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<td>&amp; Chicano Studies 168E</td>
<td>History of the Chicano Movement</td>
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<td>&amp; Chicano Studies 169</td>
<td>Racism in American History</td>
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<td>&amp; Chicano Studies 171</td>
<td>The Brown/Black Metropolis: Race, Class, &amp; Resistance in the City</td>
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<td>* Chinese 150</td>
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<td>* Chinese 166C</td>
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<td>* Chinese 166E</td>
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<td>* Communication 130</td>
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<td>* Communication 137</td>
<td>Global Communication, International Relations and the Media</td>
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<td>* Communication 150</td>
<td>Group Communication in Multiple Contexts</td>
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<td>* Communication 153</td>
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<td>* Comparative Literature 36</td>
<td>Global Humanities: The Politics and Poetics of Witnessing</td>
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<td>Mountains, Boots and Backpacks: Field Study of the High Sierra</td>
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<td>* Earth Science 104A</td>
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<td>* Earth Science 117</td>
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<td>* Earth Science 123</td>
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<td>* Earth Science 130</td>
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<td>Economic History of the United States</td>
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<td>* EEMB 127</td>
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<td>* Environmental Studies 143</td>
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<td>* Environmental Studies 146</td>
<td>Animals in Human Society: Ethical Issues of Animal Use</td>
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<td>American Immigration: Panorama of the History of America’s Racial Minorities</td>
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<td>@ History 157A-B</td>
<td>America in the Gilded Age, 1876 to 1900</td>
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<td>United States in the Twentieth Century</td>
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<td>@ History 168M</td>
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<td>@ History 178A-B</td>
<td>Native American History, 1838 to Present</td>
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<td>@ History 179B</td>
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<td>* Japanese 167A</td>
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<td>@ Linguistics 138</td>
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<td>@ Materials 10</td>
<td>Materials in Society: The Stuff of Dreams</td>
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<tr>
<td>@ Molecular, Cellular, and Developmental Biology 134H</td>
<td>Animal Virology—Honors</td>
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</table>

* 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 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.
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 10 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
   A1: Writing 2 or 2E _________ and A1: 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 9. 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 9.
   _______________________________ _______________________________

   Option 3: Complete an approved minor or double major, see page 9 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.chemengr.ucsb.edu
Chair: Michael Doherty
Vice-Chairs: Patrick Daugherty

Faculty
Bradley Chmelka, Ph.D., UC Berkeley, Professor (self-assembled materials, heterogeneous catalysis, surfactants and polymers, porous and composite solids, magnetic resonance)

Patrick S. Daugherty, Ph.D., University of Texas at Austin, Associate Professor (protein engineering and design, combinatorial molecular biology, gene targeting, viral vector engineering)

Michael F. Doherty, Ph.D., Cambridge University, Professor (process design and synthesis, separations, crystal engineering)

Francis J. Doyle III, Ph.D., California Institute of Technology, Melllichamp Professor of Process Control (process control, systems biology, nonlinear dynamics)

Glenn Fredrickson, Ph.D., Stanford University, Professor (polymer theory, block copolymers, phase transitions, statistical mechanics, glass transitions, composite media)

Michael J. Gordon, Ph.D., California Institute of Technology, Assistant Professor (surface physics, scanning probe microscopy, nanoscale materials, plasmonics, laser spectroscopy)

Matthew E. Helgeson, Ph.D., University of Delaware, Assistant Professor (colloidal thermodynamics and rheology, polymer and surfactant self-assembly, nanomaterials, microfluidics)

Jacob Israelachvili, Ph.D., University of Cambridge, Professor (surface and interfacial phenomena, adhesion, colloidal systems, surface forces, bio-adhesion, friction) 1

Edward J. Kramer, Ph.D., Carnegie Mellon University, Professor (microscopic fundamentals of fracture polymers, diffusion in polymers, and polymer surfaces, interfaces and thin films) 1

L. Gary Leal, Ph.D., Stanford University, Schlinger Distinguished Professor in Chemical Engineering (fluid mechanics, physics of complex fluids, rheology)

Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (structural materials, mechanical properties) 2

Eric McFarland, Ph.D., Massachusetts Institute of Technology, M.D., Harvard Professor (energy production, catalysis, reaction engineering, charge and energy transfer)

Samir Mitragotri, Ph.D., Massachusetts Institute of Technology, Professor (drug delivery and diagnostics, bio-membrane transport, membrane biophysics, biomedical ultrasound)

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)

Baron G. Peters, Ph.D., UC Berkeley, Assistant Professor (molecular simulation, chemical kinetics, catalytic reaction mechanisms, nucleation, electron transfer)

Susannah Scott, Ph.D., Iowa State University, Professor (heterogeneous catalysis, surface organometallic chemistry; analysis of electronic structure and stoichiometric reactivity to determine catalytic function) 3

M. Scott Shell, Ph.D. Princeton, Assistant Professor (molecular simulation, statistical mechanics, complex materials, protein biophysics)

Todd M. Squires, Ph.D., Harvard, Associate Professor (fluid mechanics, microrheology, microrheology, complex fluids)

Theofanis G. Theofanous, Ph.D., University of Minnesota, Professor, Center for Risk Studies and Safety Director (transport phenomena in multiphase systems, risk analysis) 2

Owen T. Hanna, Ph.D., Purdue University, Professor Emeritus (transport processes, multiphase systems, transport safety) 2

Duncan A. Mellichamp, Ph.D., Purdue University, Professor Emeritus (process dynamics and control, digital computer control)

Orville C. Sandall, Ph.D., UC Berkeley, Professor Emeritus (transport of mass, energy, and momentum; separation processes)

Dale E. Seborg, Ph.D., Princeton University, Professor Emeritus (transport processes in systems, process control, monitoring and fault detection, system identification)

Affiliated Faculty

Song-I Han, Ph.D. (Chemistry)

G. Robert Odette, Ph.D. (Materials, Mechanical Engineering)

Philip Alan Pincus, Ph.D. (Materials)

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.

At the undergraduate level, emphasis is placed on a thorough background in the fundamental principles of science and engineering, strongly reinforced by laboratory courses in which students become familiar with the application of theory. At the graduate level, students take advanced courses and are required to demonstrate competence in conducting basic and applied research.

The B.S. degree provides excellent preparation for both challenging industrial jobs and graduate degree programs.

Interdisciplinary B.S./M.S degree programs are also available which result in M.S. degrees in other fields. Students who complete a major in chemical engineering may be eligible to pursue a California teaching credential. Interested students should consult the credential advisor in the Graduate School of Education as soon as possible.

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. Each undergraduate also is assigned a faculty advisor, to assist in selection of elective courses, plan academic programs, and provide advice on professional career objectives. Undergraduates in other majors who plan to change to a major in the Department of Chemical Engineering should consult the department academic advisor for the requirements.

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 science and technology that addresses the needs of industry, the scientific community, and society.

Educational Objectives for the Undergraduate Program

• We expect our graduates to become innovative, competent, contributing engineers in the process industries.
20 • CHEMICAL ENGINEERING

• We expect our graduates to demonstrate their flexibility and adaptability in the workplace, so that they remain effective engineers, take on new responsibilities, and assume leadership roles.
• We expect at least an average of 15% of our graduates to continue their education by obtaining advanced degrees.

Program Outcomes
Upon graduation, graduates of the Chemical Engineering program at UCSB are expected to have:
1. Fundamentals – the fundamental knowledge of mathematics, computing, science, and engineering needed to practice chemical engineering and the ability to apply this knowledge to identify, formulate, and solve chemical engineering problem;
2. Laboratory – the ability to design and conduct experiments and to analyze and interpret data;
3. Design – the ability to design a system, component, or process to meet desired specifications; ability to use modern engineering tools necessary for engineering practice;
4. Advanced Training – beyond the basic fundamentals in at least one area of professional and ethical responsibility; a recognition of the need for and the ability to engage in lifelong learning;
5. Teamwork/Communication – the ability to function productively in multidisciplinary teams working towards common goals; the ability to communicate effectively through written reports and oral presentations;
6. Engineering & Society – the broad education necessary to understand the impact of engineering solutions in a global/societal context; a knowledge of contemporary issues; an understanding of professional and ethical responsibility; a recognition of the need for and the ability to engage in lifelong learning.

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 42. 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 worksheet must be submitted to the department by fall quarter of the senior year. Transfer students who have completed most of the lower-division coursework 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.

Chemical Engineering Courses

LOWER DIVISION

1A. Engineering and the Scientific Method
(1) STAFF
Prerequisite: Chemistry 1A-B-C or 2A-B-C; Mathematics 3A-B and Mathematics 3C or Mathematics 4A; and Engineering 3; chemical engineering majors only.

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

55. Chem-E-Car Activity
(1) STAFF
Prerequisite: Chem 1C and 1CL.

99. Introduction to Research
(1-3) STAFF
Prerequisite: consent of instructor and undergraduate advisor.

UPPER DIVISION

102. Biomaterials and Biosurfaces
(3) ISRAELACHVIL
Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.
Not open for credit to students who have completed Chemical Engineering 121.
Fundamentals of natural and artificial biomaterials and biosurfaces with emphasis on molecular level structure and function and the interactions of biomaterials and surfaces with the body. Design issues of grafts and biopolymers. Basic biological and biochemical systems reviewed for nonbiologists.

110A. Chemical Engineering Thermodynamics
(3) SHELL
Prerequisite: Chemical Engineering 10; Mathematics 5A or Mathematics 4B; Engineering majors only.
Use of the laws of thermodynamics to analyze processes encountered in engineering practice, including cycles and flows. Equations-of-state for describing properties of fluids and mixtures. Applications, including engines, turbines, refrigeration and power plant cycles, phase equilibria, and chemical-reaction equilibria.

110B. Chemical Engineering Thermodynamics
(3) STAFF
Prerequisite: Chemical Engineering 110A; Mathematics 5A or 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
Prerequisite: 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, MITROGOTRI
Prerequisite: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or 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) PETERS
Prerequisite: Chemical Engineering 120A; Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.
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 120B; Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.
Introductory course in the mathematical analysis of conductive, convective and radiative heat transfer with applications to the design of mass transfer equipment.

121. Colloids and Biosurfaces
(3) ISRAELACHVIL
Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology. Not open for credit to students who have completed Chemical Engineering 102.
Basic forces and interactions between atoms, molecules, small particles and extended surfaces. Special features and interactions associated with soft biological molecules, biomaterials and surfaces: lipids, proteins, fibrous molecules (DNA), biological membranes, hydrophobic and hydrophilic interactions, bio-specific and non-equilibrium interactions.

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) MITROGOTRI
Applications of engineering to biological and medical systems. Introduction to drug delivery,

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 42. 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 worksheet must be submitted to the department by fall quarter of the senior year. Transfer students who have completed most of the lower-division coursework 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.

Chemical Engineering Courses

LOWER DIVISION

1A. Engineering and the Scientific Method
(1) STAFF
Prerequisite: Chemistry 1A-B-C or 2A-B-C; Mathematics 3A-B and Mathematics 3C or Mathematics 4A; and Engineering 3; chemical engineering majors only.

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

55. Chem-E-Car Activity
(1) STAFF
Prerequisite: Chem 1C and 1CL.

99. Introduction to Research
(1-3) STAFF
Prerequisite: consent of instructor and undergraduate advisor.

UPPER DIVISION

102. Biomaterials and Biosurfaces
(3) ISRAELACHVIL
Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.
Not open for credit to students who have completed Chemical Engineering 121.
Fundamentals of natural and artificial biomaterials and biosurfaces with emphasis on molecular level structure and function and the interactions of biomaterials and surfaces with the body. Design issues of grafts and biopolymers. Basic biological and biochemical systems reviewed for nonbiologists.

110A. Chemical Engineering Thermodynamics
(3) SHELL
Prerequisite: Chemical Engineering 10; Mathematics 5A or Mathematics 4B; Engineering majors only.
Use of the laws of thermodynamics to analyze processes encountered in engineering practice, including cycles and flows. Equations-of-state for describing properties of fluids and mixtures. Applications, including engines, turbines, refrigeration and power plant cycles, phase equilibria, and chemical-reaction equilibria.

110B. Chemical Engineering Thermodynamics
(3) STAFF
Prerequisite: Chemical Engineering 110A; Mathematics 5A or 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
Prerequisite: 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, MITROGOTRI
Prerequisite: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or 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) PETERS
Prerequisite: Chemical Engineering 120A; Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.
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 120B; Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.
Introductory course in the mathematical analysis of conductive, convective and radiative heat transfer with applications to the design of mass transfer equipment.

121. Colloids and Biosurfaces
(3) ISRAELACHVIL
Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology. Not open for credit to students who have completed Chemical Engineering 102.
Basic forces and interactions between atoms, molecules, small particles and extended surfaces. Special features and interactions associated with soft biological molecules, biomaterials and surfaces: lipids, proteins, fibrous molecules (DNA), biological membranes, hydrophobic and hydrophilic interactions, bio-specific and non-equilibrium interactions.

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) MITROGOTRI
Applications of engineering to biological and medical systems. Introduction to drug delivery,
128. Separation Processes
(3) SCOTT
Prerequisites: 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
Prerequisites: Mathematics 5A or Mathematics 4B; Mathematics 5B or Mathematics 6A.
Practical application of fluid mechanics and heat transfer, 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
(3) FREDRICKSON, GORDON
Prerequisites: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.

132C. Statistical Methods in Chemical Engineering
(3) PETERS
Prerequisites: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or 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.

136. Introduction to Multiphase Flows
(3) THEOFANOUS
Prerequisites: Chemical Engineering 120A-B-C, or Mechanical Engineering 151C and 152A.
Same course as ME 136.
Development from basic concepts and techniques of fluid mechanics and heat transfer, to local behavior in multiphase flows. Key multiphase phenomena, related physics. Extension of local conservation principles to usable formulations in multiphase flows. Modelling approaches. Practical examples.

138. Risk Assessment and Management
(3) THEOFANOUS
Prerequisites: Chemical Engineering 120A-B-C, or Mechanical Engineering 151B and 152A.
Same course as ME 138.

140A. Chemical Reaction Engineering
(3) MCFARLAND, SCOTT
Prerequisites: Chemical Engineering 110A and 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) CHMIELKA, MCFARLAND
Prerequisites: Chemical Engineering 110A, 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 Conversors
(3) MCFARLAND
Prerequisite: Chemical Engineering 110A and 140A.
Equivalent upper-division coursework in thermodynamics and kinetics from outside department will be considered.
Framework for understanding the energy supply issues facing society with a focus on the science, engineering, and economic principles of the major alternatives. Emphasis will be on the physical and chemical fundamentals of energy conversion technologies.

152A. Process Dynamics and Control
(4) DOYLE
Prerequisites: Chemical Engineering 120A-C and 140A.
Development of theoretical and empirical models for chemical and physical processes, dynamic behavior of processes, transfer function and block diagram representation, process instrumentation, control system design and analysis, stability analysis, computer simulation of controlled processes.

152B. Advanced Process Control
(3) DOYLE
Prerequisite: Chemical Engineering 152A.
The theory, design, and experimental application of advanced process control strategies including feedforward control, cascade control, enhanced single-loop strategies, and model predictive control. Analysis of multi-loop control systems. Introduction to on-line optimization.

154. Engineering Approaches to Systems Biology
(3) DOYLE
Prerequisite: Chemical Engineering 170 and Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.
Applications of engineering tools and methods to solve problems in systems biology. Emphasis is placed on integrative approaches that address multi-scale and multi-rate phenomena in biological regulation. Modeling, optimization, and sensitivity analysis tools are applied to biological systems. Some computer programming is required.

160. Introduction to Polymer Science
(3) KRAMER
Prerequisite: Chemistry 109A-B.
Same course as Materials 160.
Introduction to polymer 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.

170. Molecular and Cellular Biology for Engineers
(3) SHELL
Prerequisite: Chemical Engineering 120A-B-C, 140A and Chemistry 109C. Not open to credit to students who have completed Ch E 172.
Introduction to molecular and cellular biology from an engineering perspective. Topics include protein structure and function, transcription, translation, post-translational processing, cellular organization, molecular transport and trafficking, and cellular models.

171. Introduction to Biochemical Engineering
(3) DAUGHERTY
Prerequisite: Chemical Engineering 170.
Introduction to biochemical engineering covering cell growth kinetics, bioreactor design, enzyme processes, biotechnologies for modification of cellular information, and molecular and cellular engineering.

179. Biotechnology Laboratory
(4) DAUGHERTY
Prerequisite: Chemical Engineering 170 or MCDB 1A or Chemistry 142A-B or Consent of Instructor.
Must have an overall grade point average of 3.3 or above.
This course will provide an introduction to theoretical principles and practical methods used in modern biotechnology, genetic engineering and synthetic biology. Topics will include protein and cellular engineering using recombinant DNA technologies, mutagenesis, library construction, and biosynthetic display technologies.

180A Chemical Engineering Laboratory
(3) STAFF
Prerequisites: Chemical Engineering 110A and 120A-B.
Experiments in thermodynamics, fluid mechanics, heat transfer, mass transfer, and chemical processing. Analysis of results, and preparation of reports.

180B Chemical Engineering Laboratory
(3) STAFF
Prerequisites: Chemical Engineering 120C, 128, 140A, and 152A.
Experiments in mass transfer, reactor kinetics, process control, and chemical and biochemical processing. Analysis of results, and preparation of reports.

184A. Design of Chemical Processes
(3) DOHERTY
Prerequisites: Chemical Engineering 110A-B, 120A-B-C, 128, 132B, 140A, and 152A.

184B. Design of Chemical Processes
(3) DOHERTY
Prerequisites: Chemical Engineering 184A.
The solution to comprehensive plant design problems. Use of computer process simulators. Optimization of plant design, investment, and operations.

194. Group Studies for Advanced Students
(1-4) STAFF
Prerequisite: consent of instructor. Limited to majors in the College of Engineering. Check with department for quarters offered. Group studies intended for small number of advanced students who share an interest in a topic not included in the regular departmental curriculum.

196. Undergraduate Research
(2-4) STAFF
Prerequisite: Upper-division standing, completion of 2 upper-division courses in Chemical Engineering; consent of the 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 3 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.

198. Independent Studies in Chemical Engineering
(1-5) STAFF
Prerequisites: consent of instructor; upper-division standing; completion of two upper-division courses in chemical engineering. Must have a minimum 3.0 grade-point-average for the preceding three quarters. May be repeated up to twelve units. Students are limited to five units per quarter and 30 units total in all 98/99/198/199/199DC/199RA courses combined. Directed individual studies.

Graduate Courses
Graduate courses for this major can be found in the UCSB General Catalog.
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: Frederic T. Chong 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)

Kaustav 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)

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)

Tevfik Bultan, Ph.D., University of Maryland, College Park, Professor (specification and automated analysis of concurrent systems, computer-aided verification, model checking)

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

Frederic T. Chong, Ph.D., Massachusetts Institute of Technology, Professor (computer architecture, novel computing technologies, quantum computing, embedded systems, and architectural support for system security and reliability)

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)

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

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

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

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

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

Tim Sherwood, Ph.D., UC San Diego, Associate 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)

Luke Theogarajan, Ph.D., Massachusetts Institute of Technology, Assistant 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 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)

Patrick Yue, Ph.D., Stanford University, Professor (high-speed CMOS IC design, cell-based RF CAD methodology and integrated biomedical sensors)

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. The Computer Engineering degree program is conducted jointly with faculty from the Department of Computer Science and the Department of Electrical and Computer Engineering.

Educational Objectives

The Computer Engineering Program seeks to produce graduates who:

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 design-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 envi-
6) Completed a well-rounded and balanced course program and senior project must be
approved by a departmental faculty advisor students for making professional con-
tributions 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 44. Schedules should be planned to meet both General Education and major require-
ments.

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/ CMPSC 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 let-
ter 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 re-
quired 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 per-
mit 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 advi-
sor. 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 sys-
tems; 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 179, 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 Elec-
trical and Computer Engineering courses
have prerequisites which must be com-
pleted 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. Stu-
dents 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
Engineering Courses

See listings for Computer Science starting
on page 25 and Electrical and Computer
Engineering starting on page 30.
and software for computational science and engineering, numerical linear algebra)

**Teofilo Gonzalez**, Ph.D., University of Minnesota, Professor (approximation algorithms; parallel computing; multicasting; scheduling theory; placement and routing; computational algorithms; 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, Associate Professor (human computer interaction; augmented reality; visual reality; visualization; computer graphics; 3D displays and interaction; wearable and ubiquitous 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)

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

**Tim Sherwood**, Ph.D., University of California, San Diego, Associate Professor (network science, data-intensive computing, cloud computing, dynamic spectrum networks, anonymity and privacy, distributed systems)

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

**Subhash Suri**, Ph.D., Johns Hopkins University, Professor (computer architecture, secure processors, embedded systems, program analysis and characterization)

**Ambuj Singh**, Ph.D., University of Texas at Austin, Professor (network science, computer networks, bioinformatics, graph querying and mining, databases)

**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)

**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)

**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 economics 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)

**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)

**Roger C. Wood**, Ph.D., University of California, Los Angeles, Professor Emeritus (computer system modeling, design and analysis, computer architecture)

*1 Joint appointment with College of Creative Studies
*2 Joint appointment with Mechanical Engineering
*3 Joint appointment with Biomedical Science & Engineering
*4 Joint appointment with Geography
*5 Joint appointment with Physics
*6 Joint appointment with Electrical & Computer Engineering

**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)

**Mission Statement**

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 computing 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, as well as advisors in the department. A faculty advisor is also available to help with academic program planning.

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.

**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)
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 issues.
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. UCSC 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 46. 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 unless they can demonstrate that they will be able to complete all of the degree requirements for the proposed program without exceeding 215 units.

Students may petition to enter the Computer Science major when the following requirements are met:
1. An overall UCSB grade point average of at least 2.0.
2. Satisfactory completion (preferably at UCSC), with a grade of B or better of CMPSC 16, 24, and 40.
3. Satisfactory completion (preferably at UCSC) with a grade of C or better of MATH 3A, 3B, 4A, and 4B.

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 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 unless they can demonstrate that they will be able to complete all of the degree requirements for the proposed program without exceeding 215 units.

Students may petition to enter the Computer Science major when the following requirements are met:
1. An overall UCSB grade point average of at least 2.0.
2. Satisfactory completion (preferably at UCSC), with a grade of B or better of CMPSC 16, 24, and 40.
3. Satisfactory completion (preferably at UCSC) with a grade of C or better of MATH 3A, 3B, 4A, and 4B.

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 free elective.

Bachelors of Arts—Computer Science
The College of Letters and Science offers a bachelor of arts degree in computer science, with emphases in computational biology, computational economics, and computational geography. For information about this major, refer to the College of Letters and Science section of the UCSB General Catalog.

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 22.

Computer Science Courses

LOWER DIVISION
1. Seminar on the Field of Computer Science
   (1) FRANKLIN
   Overview of 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 10, Computer Science 16, or Engineering 3.
   Legal repeat for CMPSC SAA-ZZ.
   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, KRINZ
   Prerequisite: Math 3A (may be taken concurrently)
   Recommended Preparation: Students with no experience with computer programming are encouraged to take Computer Science 5 or 6 before Computer Science 16.
   Legal repeat of CMPSC 10.
   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 tool.

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.
   Computer Science 32 is a legal repeat for Computer Science 60.
   Advanced topics in object-oriented computing. Topics include encapsulation, data hiding,
40. Foundations of Computer Science
(4) VAN DAM, SU
Prerequisites: Computer Science 16 with a grade of C or better; and Mathematics 3C.
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, interface design, 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
Prerequisites: Computer Science 24 with a grade of C or better.
Recommended Preparation: Students are encouraged to complete Computer Science 32 prior to enrolling in Computer Science 56.
Pe 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 4A.
Not open for credit to students who have completed ECE 15 or ECE 15B or Computer Science 30.
Repeat Comment: Course counts as a legal repeat of CMPC 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-ZZ. 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 99/199/199 courses combined.
Independent studies in computer science for advanced students.

UPPER DIVISION

111. Introduction to Computational Science
(4) PETZOLD
Prerequisites: Mathematics 6A; and, 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 and Computer Science 32 with a grade of C or better; 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) EDECSOL
Prerequisite: Computer Science 40 with a grade of C or better; open to computer science and computer engineering majors only.
Not open for credit to students who have completed Computer Science 136.
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) GILBERT
Prerequisites: Mathematics 5B; Computer Science 130A.
Not open for credit to students who have completed Computer Science 136.
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 numerical algorithms and applications with different performance trade-offs.

153A. Hardware/Software Interface
(4) KRUNTZ, BREWER
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 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.

154. Computer Architecture
(4) SHERWOOD, CHONG
Prerequisite: ECE 152A.
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
Prerequisites: Computer Science 64; 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, storage management, control flow, exception handling; encapsulation and modularization mechanism; reusability through genericity and inheritance; type systems; programming paradigms (imperative, 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 130B.
Not open to students who have completed Computer Science 190N.
Review of the fundamentals of molecular biology and genetics; pairwise sequence alignment: dynamic programming, database searching; multiple sequence alignment: microarray data analysis; protein structure alignment: phylogeny construction; distance and character based methods; other current topics.

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 170.
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 Forms.

174B. Design and Implementation Techniques of Database Systems
(4) BUI, YAN
Prerequisite: Computer Science 130B.
Recommended Preparation: Students are strongly encouraged to complete Computer Science 56 prior to enrolling in Computer Science 174B.
Queries and processing, optimizer, cost models, execution plans, rewriting rules, access methods, spatial indexing, transactions, ACID properties, concurrency control, restartability, two-phase locking, timestamping, logging, checkpointing, transaction abort and commit, crash recovery, distributed databases.

176A. Introduction to Computer Communication Networks
(4) ALMEROOTH, BELDING
Prerequisites: PSTAT 120A or ECE 139; open to computer science, computer engineering, and electrical 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, WING
Prerequisite: Computer Science 176A.
Not open for credit to students who have completed ECE 155B or 149W.
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) BELDING, 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) EDCHIOLI
Prerequisites: Computer Science 24 and Computer Science 40 with a grade of C or better; and PSTAT 120A 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 130B 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.

182. Multimedia Computing
(4) ALMEROOTH, ZHENG
Not open for credit to students who have completed ECE 160.
Introduction to multimedia and applications. Topics include streaming media, conferencing, webcasting, digital libraries, multimedia system architectures, standards (including JPEG and MPEG), and multimedia storage and retrieval. A key emphasis is on using the Internet for delivery of multimedia data.

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.

186. Theory of Computation
(4) IBARRA
Prerequisite: Computer Science 138; open to computer science majors only.
Not open for credit to students who have completed Mathematics 150A.
Turing machines; computability and unsolvability; computational complexity; intractability and NP-completeness.

189A. Senior Computer Systems Project
(4) BULTAN
Prerequisite: senior standing in Computer Engineering, Electrical Engineering, or Computer Science; 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: CMPS 172 or CMPS 189A; Senior standing in computer engineering, computer science, or electrical engineering, consent of instructor.
Not open for credit to students who have completed ECE 198A or ECE 198B.
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.

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. Intelligent and interactive systems; N. General

192. Projects in Computer Science
(4) STAFF
Prerequisite: consent of instructor.
Students must have a minimum 3.0 GPA. May be repeated to a maximum of 5 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
(2-4) STAFF
Prerequisites: upper-division standing, consent of the instructor.
May have a minimum 3.0 grade-point average for the preceding three quarters. 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.
Independent study in computer science for advanced students.

GRADUATE COURSES
Graduate courses for this 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: Jerry Gibson
Vice Chairs: Joao Hespanha
B.S. Manjunath

Faculty

Rod C. Alferness, Ph.D., University of Michigan, Professor and Dean (integrated optoelectronics, optical switching technology and switched optical networks)

Kaustav 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, photonics 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)

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)

Katie A. Byl, Ph.D., Massachusetts Institute of Technology, Assistant 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)

Nadir Dagli, Ph.D., Massachusetts Institute of Technology, Professor (design, fabrication, and modeling of photonic integrated circuits, ultrafast electrooptic modulators, solid state microwave and 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 semiconductor devices, indium phosphide and gallium nitride, photonic devices)

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)

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

Herbert Kroemer, 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)

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, Assistant 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)

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

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

Umesh 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)

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

Christopher J. Palmstrom, Ph.D., Leeds University, Professor (atomic level control of interfacial phenomena, in-situ STM, surface and thin film analysis, metallization of semiconductors, dissimilar materials epitaxial growth, molecular beam and chemical beam epitaxial growth of metallic compounds)

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; telecommunications)

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)

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

John J. Shynk, Ph.D., Stanford University, Professor (adaptive filtering, array processing, wireless communications, blind equalization, neural networks)

Dmitri B. Strukov, Ph.D., Stony Brook University, Assistant 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)

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

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)

Patrick Yue, Ph.D., Stanford University, Professor (high-speed CMOS IC design, cell-based RF CAD methodology and integrated biomedical sensors)
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 device 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

Petr 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)

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

George L. Matthaei, 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)

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) *1

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

Venkatesh Narayanamurti, 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) *1

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)

Roger C. Wood, Ph.D., UC Los Angeles, Professor Emeritus (computer system modeling, design, and analysis, computer architecture, and instructional use of computers) *2

*1 Joint appointment with Materials Engineering
*2 Joint appointment with Computer Science

Affiliated Faculty

David Aueschalom, Ph.D. (Physics)

Elizabeth Belding, Ph.D. (Computer Science)

Francesco Bullo, Ph.D. (Mechanical Engr.)

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)

E h i t r i c a l  a n d C o m p u t e r E n g i n e e r i n g is a broad field encompassing many diverse areas such as computers and digital syste m s, 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 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:

• 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 strong 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.

• 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 educa-
tional 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. Experienced 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 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.

**Undergraduate Program**

**Bachelor of Science—Electrical Engineering**

A minimum of 194 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 department academic advisor can suggest a recommended study plan for electrical engineering freshmen and sophomores. Each student is assigned a departmental faculty advisor who must be consulted in planning the junior and senior year programs.

The required 32 units (8 courses) of departmental electives are taken primarily in the senior year, and they permit students to develop depth in specialty areas of their choice. A student’s elective curriculum 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.
3. successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B-C and Mathematics 5A and 5B which require a grade of C or better to apply 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 22.

**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**

1. Ten Puzzling Problems In Computer Engineering
   (1) PARKHILL
   Prerequisite: open to pre-computer engineering only. Seminar, 1 hour.
   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
   (5) YORK
   Prerequisites: Mathematics 3A-B, and Mathematics 3C or 4A with a minimum grade of C; and, Mathematics 5A 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 only. Lecture, 3 hours; laboratory, 4 hours.

   Introduction to basic circuit analysis. KCL, KVL, nodal analysis, superposition, independent and dependent sources, diode 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
   (5) YORK
   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
   (5) YORK
   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 and 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
   (4) STAFF
   Prerequisites: Mathematics 3A-B and Mathematics 3C or 4A and Physics 1 with minimum grades of C; Engineering 3 with a minimum grade of C-. Lecture, 3 hours; laboratory, 3 hours.

   This first course on design gives an intuitive introduction to engineering design. Learn how to take an idea of a system and convert it to a working model. Use hardware and software for building a system.

15A. Fundamentals of Logic Design
   (4) MAREK-SADOWSKA
   Prerequisites: ECE 2A with a minimum grade of C-; 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, combinational circuit design and simulation, multiplexers, decoders, programmable logic devices.

94AA-2Z. 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.

**UPPER DIVISION**

121A. The Practice of Science
   (3) HU, AWSCHALOM
   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, AWSCHALOM
   Prerequisite: ECE 121A or Physics 121A; consent of instructor.

   Same course as Physics 121B.

   Provides experience in pursuing careers within
123. High-Performance Digital Circuit Design

Prerequisites: 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.

Introduction to high-performance digital circuit design techniques. Basics of device physics including deep submicron effects; device sizing and design techniques; low-power design; VLSI design flows and associated EDA tools.

124A. VLSI Principles

Prerequisites: ECE 132 (may be taken concurrently) and ECE 152A with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 3 hours.

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.

124B. Integrated Circuit Design and Fabrication

Prerequisites: ECE 132 with a minimum grade of C-. Lecture, 4 hours; laboratory, 3 hours.

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.

124C. Integrated Circuit Design and Fabrication

Prerequisites: ECE 124B and ECE 137A with a minimum grade of C- in all. Lecture, 4 hours; laboratory, 3 hours.

Design, simulation, fabrication, and characterization of NMOS integrated circuits. Circuit design and layout is performed using commercial layout software and VLSI design techniques. Circuit and discrete device electrical performance are analyzed.

124D. VLSI Architecture and Design

Prerequisites: ECE 124A with a minimum grade of C-. Lecture, 3 hours; laboratory, 2 hours.

Practical issues in VLSI circuit design, pad/pin limitations, clocking and interlocking standards, electrical packaging for high-speed and high-performance devices. On-chip noise and crosstalk, clock and power distribution, architectural and circuit design constraints, interconnection limits and transmission line effects.

125. High Speed Digital Integrated Circuit Design

Prerequisites: 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

Prerequisites: Mathematics 5A and ECE 2B with a minimum grade of C- in both; open to EE and computer engineering majors only. Lecture, 3 hours; discussion, 2 hours.


130B. Signal Analysis and Processing (4)

Prerequisites: ECE 130A with a grade of C- or better; open to EE and computer engineering majors only. Lecture, 3 hours; laboratory, 2 hours.

Analysis of discrete time linear systems in the time and frequency domains. Z transforms, Discrete Fourier transforms. Sampling and aliasing.

130C. Signal Analysis and Processing (4)

Prerequisites: ECE 130A-B with a minimum grade of C- in both. Lecture, 3 hours; discussion, 2 hours.

Basic techniques for the analysis of linear models in electrical engineering, including 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

Prerequisites: Physics 4 or 24 with a minimum grade of C; Mathematics 5A-B with a minimum grade of C; and ECE 2A-B (may be taken concurrently) with a minimum grade of C- in both; 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

Prerequisites: Physics 3 or 23 with a minimum grade of C; and Mathematics 5A-B with a minimum grade of C; and Mathematics 5C 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 electronic circuits and systems. Waves on transmission-lines, elements of electrostatics and magnetostatics and applications, plane waves, examples and applications to RF, microwave, and optical systems.

135. Optical Fiber Communication

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 characteristics of multimode and single-mode 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

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

Prerequisites: ECE 2C and 137A with a minimum grade of C- in both; open to EE majors only. Lecture, 3 hours; laboratory, 3 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

Prerequisites: 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)

Prerequisites: ME 16 & 17, ME 152A, ME 151A (may be concurrent); or, ECE 130A and 137A with a minimum grade of C- in both.

Same course as ME 141A. Lecture, 3 hours.

Introduction to nano- 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

Prerequisites: ME 141A, ME 163 (may be concurrent); or ECE 141A.

Same course as ME 141B. Lecture, 2 hours; laboratory, 6 hours.

Lectures and laboratory on semiconductor-based processing for MEMS. Description of key equipment and characterization tools used for MEMS and design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro-reactors and capacitor-actuators.

141C. Introduction to Microfluidics and BioMEMS

Prerequisites: ECE 141A or ECE 141A; open to ME and EE majors only.

Same course as ME 141C. Lecture, 3 hours.

Introduces physical phenomena associated with micro/nanoscale fluid mechanics, microfluids, and bioMEMS. Analytical methods and numerical simulation tools are used for analysis of microfluids.

144. Electromagnetic Fields and Waves

Prerequisites: ECE 134 with a minimum grade of C- Lecture, 3 hours; laboratory, 3 hours.

Waves on transmission lines, Maxwell’s equations, skin effect, propagation and reflection of electromagnetic waves, fluid wave interactions, circuit principles, metal and dielectric waveguides, resonant cavities, antennas. Microwave and optical device examples and experience with modern microwave and CAD software.

145A. Communication Electronics

Prerequisites: ECE 137A-B with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 6 hours.

RF/Microwave circuits. Transistor, transmission-line, and passive element characteristics. Transmission-line theory and impedance matching. Amplifier design for maximum gain, Amplifier stability, Gain compression and power limits. Introduction to noise figure, and to intermodulation distortion.

145B. Communication Electronics II

Prerequisites: ECE 145A with a minimum grade of C-; EE majors only. Lecture, 3 hours; laboratory, 6 hours.


145C. Communication Electronics III

Prerequisites: ECE 137B with a minimum grade of C-; Lecture, 4 hours.

Modern wireless communication standards. Cellular phone. Wireless LAN. Introduction to multi-
access techniques. Advanced modulation schemes. Interference and distortion. Modern transceiver architecture. Direct conversion vs. low IF vs. superheterodyne. Sub-sampling receiver. Direct polar modulator. Frequency synthesis using PLL.

146A. Analog Communication Theory and Techniques
(4) ILTS
Prerequisites: ECE 130A-B with a minimum grade of C- in both; open to EE majors only. Lecture, 3 hours; laboratory, 6 hours.

Modulation theory, AM, FM, PM, and analog pulse modulation and demodulation techniques. System noise and performance calculations.

146B. Digital Communication Theory and Techniques
(4) SHYNK
Prerequisites: ECE 130A-B, 140 and 146A with minimum grades of C-; open to EE majors only. Lecture, 3 hours; laboratory, 6 hours.


Link design: power-bandwidth tradeoffs, link budget analysis.

147A. Feedback Control Systems - Theory and Design
(5) TEE, SMITH
Prerequisites: ECE 130A-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, TEE
Prerequisites: 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 description of linear systems; observability, controllability, pole assignment, state feedback, observers. Design of digital control systems. (W)

147C. Control System Design Project
(5) HESPANA
Prerequisites: 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
Prerequisites: ECE 130A-B with a minimum grade of C- in both. Lecture, 3 hours; discussion, 2 hours.

A sequence of engineering applications of signal analysis and processing techniques; in telecommunications, image processing, analog and digital filter design, signal detection and parameter estimation, holography and tomography, Fourier optics, and microwave and acoustic sensing.

149. Active and Passive Network Synthesis
(4) ILTS
Prerequisite: Upper-division standing; open to EE majors only.

Designed for juniors to take right after ECE 130A/B. Combines the areas of electronics and network theory in the subject of passive and active network design. Topics include passive synthesis, optimization techniques, approximations to ideal filters, feedback networks, sensitivity and the modern design techniques, and applications of active filters.

150. Mobile Embedded Systems
(4) CHENG
Prerequisite: Proficiency in JAVA programming.

Architectures 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) MILLER-SMITH
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
(5) RODOPLU
Prerequisites: ECE 15 or 15A or Computer Science 30 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.

152B. Digital Design Methodologies
(5) CHENG
Prerequisites: ECE 152A with a minimum grade of C-; open to EE, computer engineering, and computer science majors only. Lecture, 3 hours; discussion, 6 hours.

Design methodologies of digital systems, the register and processor levels. Design of functional subsystems, microprocessor architecture, hardwired and microprogrammed control units, memory systems, and bussing systems. System organization including communication, input/output systems, and multiple CPU systems.

153A. Hardware/Software Interface
(4) BREWER, KRINZ
Prerequisite: Upper division standing in Computer Engineering, Computer Science or Electrical Engineering.

Same course as Computer Science 153A.

Issues in interfacing computer 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) BUTNER
Prerequisites: ECE 152B and 153A with a minimum grade of C- in both. Lecture, 3 hours; laboratory, 3 hours.

Hardware description languages; field-programmable logic and ASIC design techniques. Mixed-signal techniques: A/D and D/A converter interfaces; video and audio signal acquisition, processing and generation, communication and network interfaces.

154A. Introduction to Computer Architecture
(4) PARHAM
Prerequisite: ECE 152A with a minimum grade of C-; open to electrical engineering and computer engineering majors only.

Not open for credit to students who have completed Computer Science 154.

Instruction-set architecture (ISA) and computer performance; Machine instructions, assembly, addressing modes; Memory map, arrays, pointers; Procedure calls; Number formats; Simple ALUs; Data path, control, microprogram; Buses, I/O programming, interrupts; Pipelined data paths and control schemes.

154B. Advanced Computer Architecture
(4) STRUKOV
Prerequisite: ECE 154A with a minimum grade of C-; open to electrical engineering and computer engineering majors only.

Not open for credit to students who have completed Computer Science 154.

ISA variations; Pipeline data and control hazards; Fast ALU design; Instruction level parallelism; multithreading; VLIW; Vector and array processing, multi/many-core chips; Cache and virtual memory; Disk arrays; Shared- and distributed-memory systems, supercomputers, Reconfigurable and application-specific circuits.

155A. Introduction to Computer Networks
(4) BORER
Prerequisite: ECE 154 with a minimum grade of C-; and, Computer Science 12 or 60 with a minimum grade of C-.

Not open for credit to students who have completed Computer Science 176 or 176A, or ECE 155. Lecture, 3 hours; discussion, 1 hour.

Topics in this course include network architectures, protocols, wired and wireless networks, transmission media, multiplexing, switching, framing, error detection and correction, flow control, routing, congestion control, TCP/IP, DNS, email, World Wide Web, network security, socket programming in C/C++.

155B. Network Computing
(4) MOSER
Prerequisites: ECE 155A with a minimum grade of C-; and, Computer Science 5JA or 10 or 11A with a minimum grade of C-.

Not open for credit to students who have completed Computer Science 176B or ECE 194W. Lecture, 3 hours; discussion, 1 hour.

Topics in this course include client/server computing, threads, Java applets, Java sockets, Java RMI, Java servlets, Java Server Pages, Java Database Connectivity, Enterprise Java Beans, Hypertext Markup Language, extensible Markup Language, Web Services, programming networking applications in Java.

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-.

Lecture, 3 hours; laboratory, 3 hours.

Introduction to computer-aided simulation and synthesis tools for VLSI. VLSI 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) MITRA
Prerequisites: ECE 130A-B with a minimum grade of C- in both; open to EE majors only.

Lecture, 3 hours; laboratory, 3 hours.

Discrete signals and systems, convolution, z-transforms, discrete Fourier transforms, digital filters.

160. Multimedia Systems
(4) MILLER-SMITH
Prerequisites: upper-division standing; open to
162A. The Quantum Description of Electronic Materials
(4) BOWERS
Prerequisites: 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
Prerequisites: 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
Prerequisites: ECE 162A-B with a minimum grade of C-: open to electrical engineering and materials majors only. Lecture, 3 hours; discussion, 1 hour.


178. Introduction to Digital Image and Video Processing
(4) MANJUNATH
Prerequisites: open to EE, computer engineering, and computer science majors with upper-division standing. 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) BYTCH
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).

Same course as ME 179D.

Dynamic modeling and control methods for robotic systems. LaGrangian method 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.

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 Mechanical Engineering 170A or ECE 181A.

Same course as ME 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.

181B. Introduction to Computer Vision
(4) MANJUNATH
Prerequisites: Upper-division standing.

Same course as Computer Science 181B.

Overview of computer vision problems and techniques for analyzing the content of 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.

183. Nonlinear Phenomena
(4) TEEL
Prerequisites: Physics 105A or ME 163 or upper-division standing in EE.

Same course as Physics 106 and ME 169. Not open for credit to students who have completed ECE 163C. Lecture, 3 hours; discussion, 1 hour.

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

188A. Senior Electrical Engineering Project
(4) STAFF
Prerequisites: Consent of instructor; completion of at least four required upper division Electrical Engineering courses with a 3.0 GPA or higher.

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.

188B. Senior Electrical Engineering Project
(4) STAFF
Prerequisites: ECE 188A with a minimum grade of C-.

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) BUTNER
Prerequisites: ECE 152B; senior standing in Computer Engineering, Computer Science or EE. 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) BUTNER
Prerequisites: ECE 189A; senior standing in Computer Engineering, Computer Science or EE. 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
Prerequisites: consent of instructor. Discussion, 2 hours; laboratory, 6 hours.

Projects in electrical and computer engineering for advanced undergraduate students.

193. Internship in Industry
(1-4) 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
(1-4) 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.

196. Undergraduate Research
(2-4) STAFF
Prerequisites: upper-division standing; consent of instructor.

Graduate courses for this major can be found in the UCSB General Catalog.
Engineering Sciences

Engineering Sciences, Office of Associate Dean for Undergraduate Studies, Harold Frank Hall, Room 1006; Telephone (805) 893-2809
Web site: http://engrsci.ucsb.edu
Chair & Associate Dean: Glenn E. Beltz
Director of Technology Management Program: Robert A. York

Faculty
Glenn E. Beltz, Ph.D., Harvard, Professor
John E. Bowers*, Ph.D., Stanford University, Professor
Gary S. Hansen*, Ph.D., University of Michigan, Associate Professor
Jeffrey M. Moehlis, Ph.D., University of California, Berkeley, Associate Professor
Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor
David Seibold*, Ph.D., Michigan State University, Professor
Robert A. York*, Ph.D., Cornell University, Professor

* Technology Management Program faculty

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.

Engineering Sciences Courses

LOWER DIVISION

3. Introduction to Programming for Engineers
(3) STAFF
Prerequisites: Open to chemical engineering, electrical engineering, and mechanical engineering majors only.
- General philosophy of programming for engineering majors. Students will be introduced to a modern programming language or software package. Specific areas of study will include algorithms, basic decision structures, arrays, matrices, and graphing. Engineering applications will be emphasized. (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
(3) STAFF
Prerequisite: senior standing in engineering.
- The nature of moral value, normative judgment, and moral reasoning. Theories of moral value. The engineer’s role in society. Ethics in professional practice, Safety, risk, responsibility. Morality and career choice. Code of ethics. Case studies will facilitate the comprehension of the concepts introduced. (W,S,M)

102AA- ZZ. Special Topics in Engineering, Business, and Society
(1) STAFF
Prerequisites: Upper-division standing.
- May be repeated for credit if there is no duplication of course content.
- A series of weekly lectures given by university staff and outside experts in all fields of new technology management.

103. Advanced Engineering Writing
(4) 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.

111. Opportunities and Perspectives in Technology, Business, and Society
(1) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent with a minimum grade of B.
- Writing 50 or equivalent in the prerequisites is intended to include: ENGL 10, WRIT 50, WRIT 105, WRIT 107 & WRIT 109.

This course replaces the ENGR 102A-B-C series. Lecture series where entrepreneurial, technological, business, and governmental leaders share their lessons of experience and discuss current business issues. For anyone interested in entrepreneurship, management, technology development, and commercialization and the impact that innovation has on society.

120. Business Strategy & Leadership Skills
(4) HANSEN
Prerequisite: Writing 2 with a minimum grade of B; and, Writing 50 or equivalent with a minimum grade of B; and upper division standing.
- Introduction to critical business principles and practices required by leaders for business success and societal benefit. Students will be exposed to key management theories, models and tools in strategy, finance, accounting, commercialization, marketing, and sales.

122. Entrepreneurship
(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-
- Learn how to start any type of venture; for profit, non-profit, service, sole-proprietorship, with a focus on high-tech ventures. Analysis of new business opportunities, development of customer-centric value propositions, financing, marketing, selling, and protection of intellectual property.

124. Entrepreneurial Marketing
(2) STAFF
Prerequisite: Writing 2 with a minimum grade of B; and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, and upper division standing.
- Introduction to basic marketing concepts and how these concepts can be applied to any organization, particularly technology firms. Additionally, they will be introduced to how management of the marketing function within an organization is critical to the organization’s success. (F, W, S)

126. New Venture Finance
(2) STAFF
Prerequisite: Economics 1 or Economics 3A with a minimum grade of B-
- Presents the tools necessary for the strategic analysis and understanding of financial information particular to new ventures. Provides insight into how financial information can be used to design optimal financial strategies, prepare valuation models for new ventures, and assist in strategic planning for the venture.

130. Managing Operations
(3) STAFF
Prerequisite: Upper Division standing
- Provides students with tools to manage projects and operations to ensure projects are completed on time, within budget, and with high quality, by exploring specific techniques for accomplishing these goals. Prepares students to manage people, budgets, scheduling, and quality of projects.

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: 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-
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. Theory and applications of the basic tenets of persuasion and how such scientifically supported techniques can be deployed to positively impact the sales process.

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.

140. The Business of Healthcare: How Innovation and Entrepreneurship will Alter the Future Delivery of Medical Goods and Services
(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.

Review of hospitals, physician offices, insurance companies, and medical suppliers that make up the health care universe, history and evolution of the business models by which they deliver goods and services and how they profit from the existing healthcare system.

141. The Early Stage of Life Science Company: The Challenges faced by Entrepreneurs in Creating and Growing New Businesses Based on Human Biology
(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.

Using the biotechnology industry as a prototype, the course explores what makes life science-based businesses different from other enterprises, and the special risks (and opportunities) faced by these businesses both in the earliest stages and in maintaining long-term growth.

145. Entrepreneurial Opportunities in IT and Telecom
(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 a high-level view of key analysis and management skills needed in today’s competitive Telecom and IT business environments via readings, guest lectures, class discussions, case studies and a long term project team.

146. Critical Issues in Early Stage IT and Telecom Companies
(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.

Enables motivated business, technology-oriented student to gain a clearer understanding of management issues such as leadership, culture, planning and control, and growth management in today’s competitive Telecom and IT business environments.

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 non-specialists. The major components of the course are field work in mentoring, bi-weekly seminar, presentations to precollege students and to adult nonscientists, and end-of-term research papers. The course is offered in the 160K section.

177. Art and Science of Aerospace Culture
(4) 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.

190AA-ZZ. Special Topics in Engineering
(4) STAFF
Prerequisite: Upper-division standing.

May be repeated for credit if there is no duplication of course content.

Courses provide for the study of topics of current interest in the areas of entrepreneurship, business engineering management, and other related areas. A. Business strategies, B. Entrepreneurship, C. Product development, D. General.

191AA-ZZ. Professional Seminar in New Technology Management
(2) STAFF
Prerequisite: Upper-division standing.

May be repeated for credit if there is no duplication of course content.

Courses provide for the study of topics of current interest in the areas of entrepreneurship, business engineering management, and other issues related to the successful practice of engineering.

199. Independent Studies in Engineering
(1-6) 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) 969-4362
Web site: www.materials.ucsb.edu

Chair: Tresa M. Pollock
Vice Chair: Francis W. Zok

Faculty
Guillermo C. Bazan, Ph.D., Massachusetts Institute of Technology, Professor (polymer synthesis, photophysics) *5
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
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
Edward J. Kramer, Ph.D., Carnegie Mellon University, Professor (fracture and diffusion in polymers; polymer surfaces, interfaces, and thin films) *3
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
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 Nakamura, 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)
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 has effectively transferred 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 biomedical surfaces, 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

(3) SESHADRI, SPALDIN
Prerequisites: Chemistry 1A-B; Physics 4; and, Mathematics 5A-B-C. Lecture, 3 hours.

100B. Structure and Properties II

(3) STEMMER, ZOK
Prerequisite: Materials 100A.
Not open for credit to students who have completed Materials 101. Lecture, 3 hours.

100C. Fundamentals of Structural Evolution

(3) LEVI, ODETTE, ZOK
Prerequisites: Materials 100A or ECE 132; and, Materials 100B or Chemical Engineering 185 or ME 180. Lecture, 3 hours.

101. Introduction to the Structure and Properties of Materials

(3) STAFF
Prerequisite: upper-division standing.
Not open for credit to students who have completed Materials 102B.
and failure. Stiffening, strengthening, and toughening mechanisms.

135. Biophysics and Biomolecular Materials
(3) SAFINIA
Prerequisites: Physics 5 or 6C or 25.
Same course as Physics 135.
Structure and function of cellular molecules (lipids, nucleic acids, proteins, 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
(3) KRAMER
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
(4) STAFF
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.
Electrons as particles and waves, Schrödinger’s equation and illustrative solutions. Tunneling, Atomic structure, the Exclusion Principle and the periodic table. Bonds. Free electrons in metals. Periodic potentials and energy bands. (F)

162B. Fundamentals of the Solid State
(4) COLDREN, PETROFF
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
(3) LEVI, ODETTE
Prerequisites: 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
(3) LEVI
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
(2) VANDEWALLE
Topics in 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: Kimberly Turner
Vice Chair: Jeffrey M. Moehlis

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 (thermodynamic 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 Campas, 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)
Gary S. Hansen, Ph.D., University of Michigan, Associate Professor (technology management program)
Keith T. Kedward, Ph.D., University of Wales, Professor (design of composite systems)
Mustafa Khammass, Ph.D., Rice University, Professor (robust analysis and synthesis of control systems and controls in biological systems)
Rouslan Krechetnikov, Ph.D., Moscow Institute of Physics & Technology, Assistant Professor (fluid mechanics, complex fluid interfaces, analytical mechanics, dynamical systems, stability theory, applied mathematics)
Stephen Lagatte, 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)
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (mechanical properties of structural materials, environmental effects, structural reliability)

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)
Eckart Meiburg, Ph.D., University of Karlsruhe, Professor (computational fluid dynamics, fluid mechanics)
Carl D. Meinhardt, Ph.D., University of Illinois at Urbana-Champaign, Professor (wall turbulence, microfluidics, flows in complex geometries)
Igor Mezic, 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, Associate Professor (nonlinear dynamics, fluid mechanics, biological dynamics, applied mathematics)
G. Robert Odette, Ph.D., Massachusetts Institute of Technology, Professor (deformation and fracture, high performance materials for use in severe environments)
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)
Linh T. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor, Director of Computational Science and Engineering Graduate Emphasis (computational science and engineering; systems biology)
Hyongsok Tom Soh, Ph.D., Stanford University, Associate Professor (microelectromechanical systems, integrated biosensors, multi-functional biomaterials)
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)
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 aeroelasticity, intelligent manufacturing systems)
Emeriti Faculty
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, piezoelectroscopy, mechanics of microelectronics)
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 including those in mechanical, environmental and materials engineering;
3. Have a solid background in the fundamentals of engineering allowing them to pass the Fundamentals of Engineering Examination;
4. Are active 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.

**Program 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. Should be members of the American Society of Mechanical Engineers.

**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 50. 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
(4) STAFF
Prerequisites: Physics 3-3L; Mathematics 3C or 4A; open to ME majors only.
Not open for credit to students who have completed ECE 2A or 2B, or ECE 6A or 6B.
Introduction to basic electrical circuits and electronics. Includes Kirchhoff's laws, phasor analysis, circuit elements, operational amplifiers, and transistor circuits.

(4) STAFF
Prerequisite: ME majors only.
Introduction to engineering graphics, CAD, and freehand sketching. Development of computer-aided design proficiency using advanced 3-D software. Graphical presentation of design: views, sections, dimensioning, and tolerancing.

11. Introductory Concepts in Mechanical Engineering
(1) BOTHMAN, FIELDS, BELTZ
Prerequisite: 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
(1) BOTHMAN
Prerequisite: 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
(1) STAFF
Prerequisite: ME majors only.
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
(4) BELTZ, SHUGAR, TURNER
Prerequisite: Physics 1 and Mathematics 3B; open to ME majors only.
Introduction to applied mechanics. Forces, moments, couples, and resultants; vector algebra; construction of free body diagrams; equilibrium in 2- and 3-dimensional analysis of frames, machines, trusses and beams; restrained forces; friction.

15. Strength of Materials
(4) BELTZ, KEDWARD
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 bars in tension, compression, and torsion, beams subject to flexure, pressure vessels, and buckling.

(4) TURNER, MEZEG, BAMIHE
Prerequisites: Physics 2: ME 14 with a minimum grade of C-; and, Mathematics 5C or 6B; (may be taken concurrently); open to ME majors only.
Not open for credit to students who have completed ME 163A.

17. Mathematics of Engineering
(3) MOELHLIS, GIBIOU
Prerequisite: Engineering 3; Mathematics 5B or 6A (may be taken concurrently); open to ME majors only.
Introduction to basic numerical and analytical methods, with implementation using MATLAB.
Topics include root finding, linear algebraic equations, introduction to matrix algebra, determinants, inverses and eigenvalues, curve fitting and interpolation, and numerical differentiation and integration. (S, M)

95. Introduction to Mechanical Engineering
(1-4) STAFF
Prerequisite: consent of instructor.
May be repeated for credit to a maximum of 6 units.
Participation in projects in the laboratory or machine shop. Projects may be student- or faculty-originated depending upon student interest and consent of faculty member.

97. Mechanical Engineering Design Projects
(1-4) STAFF
Prerequisite: consent of instructor.
May be repeated for maximum of 12 units, variable hours.
Course offers students opportunity to work on established departmental design projects. P/ NP grading, does not satisfy technical elective requirement.

99. Introduction to Research
(1-3) STAFF
Prerequisite: consent of instructor.
May be repeated for maximum of 6 units, variable hours.
Directed study to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION

100. Professional Seminar
(1) STAFF
Prerequisite: undergraduate standing.
May be repeated for 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. Mechatronics
(3) BAMIHE, PADOE
Prerequisite: ME 6; open to ME majors only.
Interfacing of mechanical and electrical systems and mechatronics. Basic introduction to sensors, actuators, and computer interfacing and control. Transducers and measurement devices, actuators, A/D and D/A conversion, signal conditioning and filtering. Practical skills developed in weekly lab exercises.

105. Mechanical Engineering Laboratory
(4) BENNETT, MATTHYS, VALENTINE
Prerequisite: ME 151B, 152B, 163; and, Materials 101 or 100B.
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
(3) KHAMMASH, BAMIHE
Prerequisite: ME 155A.
An advanced lab course with experiments in dynamical systems and feedback control design.

Students design, troubleshoot, and perform detailed, multi-session experiments.

106B. Mechanics, Materials and Structures Laboratory
(3) ZOK
Prerequisites: ME 15; ME 154; ME 156A; and Materials 100B or 101.
Experiments on mechanical behavior of materials and structures. Assessment of analytical and finite element methods for mechanical design, with applications to optimization of lightweight structures.

106C. Advanced Thermo/Fluids Laboratory
(3) BENNETT
Prerequisite: ME 105 and 151A-B, ME 151C (may be concurrent) and ME 152A-B
Perform thermal fluid experiments that emphasize elements of thermodynamics, heat transfer, and fluid mechanics. This laboratory course stresses critical thinking skills required to construct and perform experiments independently, and to investigate physical phenomena experimentally.

110. Aerodynamics and Aeronautical Engineering
(3) BELTZ, MEINHART
Prerequisites: ME 14 and 152A
Concepts from aerodynamics, including lift and drag analysis for airfoils as well as aircraft sizing/ scaling issues. Structural mechanics concepts are applied to practical aircraft design. Intended for students considering a career in aeronautical engineering.

112. Energy
(3) MATTHYS, MARSCHALL
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, national and global energy budgets, historical perspectives, economics, societal considerations, and others.

119. Introduction to Coastal Engineering
(3) STAFF
Prerequisite: ME 152A.
Quantitative description of waves and tides: refraction, shoaling. Nearshore circulation. Sediment characteristics and transport; equilibrium beach profile; shoreline protection.

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

125AA-2Z. Special Topics in Mechanical Engineering
(1) STAFF
Prerequisite: Consent of instructor.
May be repeated for credit to a maximum of 12 units provided letter designations are different. Students are advised to consult their faculty advisor before making their course selection.

Individual courses each concentrating on one area in the following subjects: applied mechanics, cad/cam, controls, design, environmental engineering, fluid mechanics, materials science, mechanics of solids and structures, ocean and coastal engineering, optoics, theoretical mechanics, thermal sciences, and recent developments in mechanical engineering.

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
   (B) MATTHIES, YUEN
   Prerequisite: ME 151C.
   This class will address advanced topics in fluid mechanics, heat transfer, and thermodynamics. Topics of interest may include combustion, phase change, experimental methods, microfluidic processing, manufacturing, engines, HVAC, non-Newtonian fluids, etc.

136. Introduction to Multiphase Flows
   (B) THEOFANOUS
   Prerequisite: Chemical Engineering 120A-B-C; or, ME 151C and 152A.
   Same course as Chemical Engineering 136.
   Development from basic concepts and techniques of fluid mechanics and heat transfer, to local behavior in multiphase flows. Key multiphase phenomena, related physics. Extension of local conservation principles to usable formulations in multiphase flows. Modelling approaches. Practical examples.

140A. Numerical Analysis in Engineering
   (3) MOELISI, GILOB, MIERBURG
   Prerequisite: ME 17 with a minimum grade of C-; Chemical Engineering 152A; open to ME and Chemical Engineering majors only.
   Numerical analysis and analytical solutions 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
   (3) MOELISI, GILOB, MIERBURG
   Prerequisite: ME 140A; open to ME and Chemical Engineering majors only.
   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
   Prerequisite: ME 16 & 17; ME 152A & ME 151A (may be concurrent); or ECE 130A & 137A with a minimum grade of C- in both.
   Same course as ECE 141A.
   Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects in the nanoscale include 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
   (4) TURNER, PENNATHUR
   Prerequisite: 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 techniques used for MEMS and design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro- and capacitor-actuators.

141C. Introduction to Microfluidics and BioMEMS
   (3) MEINHART
   Prerequisite: ME 141A or ECE 141A; open to ME and EE majors only.
   Same course as ECE 141C.
   Introduces physical phenomena associated with microscale/nanoscale fluid mechanics, microfluidics, and bioMEMS. Mathematical methods and numerical simulation tools are used for analysis of microfluids.

146. Molecular and Cellulr Biomechanics
   (3) VALENTE
   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.

151A. Thermosciences
   (4) BENNETT
   Prerequisite: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 5C or 6B.
   Basic concepts in thermodynamics, system analysis, energy, thermodynamic laws, and cycles. (F)

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

151C. Thermosciences
   (3) BENNETT
   Prerequisite: 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) MEINHART, PENNATHUR
   Prerequisite: Mathematics 5C or 6B; 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 similarity. Hydrodynamics. (F)

152B. Fluid Mechanics
   (3) MEINHART, PENNATHUR
   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, KEDWARD
   Prerequisites: ME 10 and 16; open to ME majors only.

154. Design and Analysis of Structures
   (3) MCMEEEKING, KEDWARD, SHUGAR
   Prerequisite: ME 15 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) BAMER, BULLO, KHAMMASH
   Prerequisite: ME 14 with a minimum grade of C-; ME 140A (may be taken concurrently); and ME 163.
   The discipline of control and its application. Dynamics and feedback. The mathematical models: transfer functions and state space descriptions. Simple control design (PID). Assessment of a control problem, specification, fundamental limitations, codesign of system and control.

155B. Control System Design
   (3) PADEN
   Prerequisite: ME 155A.
   Dynamic system modeling using state-space methods, controllability and observability, state-space methods for system 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, LUCAS
   Prerequisites: ME 151C, 152B, and 153; and MATLAB 101 or 100B; 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) KEDWARD
   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.

158. Computer Aided Design and Manufacturing
   (3) BOTHMAN
   Prerequisites: ME 10 and 156A; open to ME majors only.
   Engineering applications using advanced 3-D CAD software for plastic part designs and tooling. Topics include overview of the design for injection molded plastic parts, material selections and electronic tooling design via CAD and CNC system software. Emphasis is put into final design projects that are designed to be functional, manufacturable, and esthetically pleasing.

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

   (3) MEIZIC, MCMEEEKING
   Prerequisite: ME 16 with a minimum grade of C-; open to ME majors only.
   Not open for credit to students who have completed ME 163B.

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) YANG
   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 plane frame elements, and programming techniques to realize these concepts.

169. Nonlinear Phenomena
   (4) MEIZIC, KHAMMASH
   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.

173. Control Systems Synthesis
(3) BAUMEN
Prerequisite: ME 155A.
Not open for credit to students who have completed ECE 147A.
Pole-placement, observer design, observer-based compensation, frequency and time-domain techniques, internal model principle, linear quadratic regulators, modeling uncertainty in signals and systems, robust stability and performance, synthesis for robustness.

179D. Introduction to Robotics: Dynamics and Control
(4) BYU
Prerequisites: ECE 130A or ME 155A (may be taken concurrently).
Dynamic modeling and control methods for robotic systems. LaGrangian method 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) PADEH
Prerequisites: ENGR 3, and ME 6 or ECE 2A. Not open for credit to student who have completed Mechanical Engineering 170C or ECE 181C.
Design, programming, and testing of mobile robots. Design problems re-formulated in terms of robot performance. Students solve electromagnetic 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 motors.

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.
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 and more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials
(3) LEVI, ODETTE
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.

ME 189A. Capstone Mechanical Engineering Design Project
(2) LAGUETTE
Prerequisite: ME 153; and ME 156A (may be taken concurrently).
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. Course emphasizes practical, hands-on experience, and integrates analytical and design skills acquired in the companion ME 156 courses.

ME 189B. Capstone Mechanical Engineering Design Project
(2) LAGUETTE
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 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.

ME 189C. Capstone Mechanical Engineering Design Project
(2) LAGUETTE
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-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. Course emphasizes practical, hands-on experience, and integrates analytical and design skills acquired in the companion ME 156 courses.

193. Internship in Industry
(1-4) STAFF
Prerequisite: 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
(1-4) STAFF
Prerequisites: ME 16; consent of instructor.
May be repeated for a maximum of 12 units, variable hours. No more than 4 units may be used as departmental electives.
Special projects in design engineering. Course offers motivated students opportunity to synthesize academic skills by designing and building new machines.

199. Independent Studies in Mechanical Engineering
(1-3) STAFF
Prerequisites: 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.
## CHEMICAL ENGINEERING 2012-13

### PREPARATION FOR THE MAJOR  
**Units:** 80

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### UPPER DIVISION MAJOR  
**Units:** 78

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<td>CHE 184A-B</td>
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<td>MATRL 101 or MATRL 100B *</td>
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* see note on next page

Technical Elective requirement .......................................................... 12

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

Approved Technical Elective Requirement classes:

- CHE 102 CHEM 126 MCDB 111
- CHE 121 CHEM 142A-B-C MCDB 126A-B-C
- CHE 124 CHEM 145 MCDB 133
- CHE 125 CHEM 147 MCDB 138
- CHE 136 CHEM 150 ME 110
- CHE 138 ECE 130A-B-C ME 112
- CHE 141 ECE 183 ME 114
- CHE 152B ENGR 101 ME 119
- CHE 154 ENGR 103 ME 128
- CHE 160 ENV S 105 ME 134
- CHE 171 MATH 122A-B ME 169
- CHE 196 MATRL 100A,C ME 185
- CHE 198 MATRL 160 PHYS 123A-B
- CHEM 115A-B-C MATRL 185 PHYS 127AL
- CHEM 123 MCDB 101A-B PHYS 127BL

*Three units maximum from CH E 196 and CH E 198 combined; only for students with GPA of 3.0 or higher.

Technical electives taken:

**UNIVERSITY REQUIREMENTS**

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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>
</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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</table>

**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  
**Units:** 36

General Education and Free Electives taken:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Description</th>
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</tr>
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</table>

**TOTAL UNITS REQUIRED FOR GRADUATION ...... 194**

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 2012-13

### FRESHMAN YEAR

<table>
<thead>
<tr>
<th></th>
<th>FALL units</th>
<th>WINTER units</th>
<th>SPRING units</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
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<td>CHEM 1B or 2B</td>
<td>CHEM 1C or 2C</td>
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<tr>
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<td>CHEM 1A or 2A</td>
<td>CHEM 1BL or 2BC</td>
<td>CHEM 1CL or 2CC</td>
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<tr>
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<td>CHEM 1AL or 2AC</td>
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<td>MATH 4A</td>
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<td>WRIT 2E or 50E</td>
<td>WRIT 50E or G.E. Elective</td>
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<td>or ENGR 3</td>
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### SOPHOMORE YEAR

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<th>SPRING units</th>
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<td></td>
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<td>CH E 110A</td>
<td>CH E 110B</td>
<td>15</td>
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<tr>
<td></td>
<td>CHEM 109A</td>
<td>CHEM 6AL</td>
<td>CHEM 6BL</td>
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<td>MATH 4B</td>
<td>CHEM 109B</td>
<td>CHEM 109C</td>
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### JUNIOR YEAR

<table>
<thead>
<tr>
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<th>SPRING units</th>
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</tr>
</thead>
<tbody>
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<td>CH E 120B</td>
<td>CH E 120C</td>
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<td></td>
<td>CH E 120A</td>
<td>CH E 132C</td>
<td>CH E 140A</td>
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<td></td>
<td>CH E 128</td>
<td>CHEM 113B</td>
<td>CH E 180A</td>
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<td>CH E 132A</td>
<td>MATRL 101 or MATRL 100B*</td>
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<td>G.E. Elective</td>
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### SENIOR YEAR

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<th>SPRING units</th>
<th>TOTAL</th>
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<tr>
<td></td>
<td>CH E 132B</td>
<td>CH E 180B</td>
<td>CH E 184B</td>
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<td></td>
<td>CH E 140B</td>
<td>CH E 184A</td>
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<td>CH E 152A</td>
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<td>CH E 170</td>
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<td>Technical or Free Electives</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.
### COMPUTER ENGINEERING 2012-13

#### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
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</thead>
<tbody>
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<tr>
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<td>4</td>
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<tr>
<td>CMPSC 24</td>
<td>4</td>
</tr>
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<td>CMPSC 32</td>
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<td>CMPSC 40</td>
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<tr>
<td>ECE 2A-B-C</td>
<td>15</td>
</tr>
<tr>
<td>ECE 15A</td>
<td>4</td>
</tr>
<tr>
<td>MATH 3A-B, 4A-B</td>
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<tr>
<td>PHYS 1, 2, 3, 3L, 4L</td>
<td>16</td>
</tr>
</tbody>
</table>

**TOTAL** 73

### 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

**44**

**TOTAL UNITS REQUIRED FOR GRADUATION** ...... 189

---

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

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
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</thead>
<tbody>
<tr>
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<td>ECE 15A or Math, Science, or Engr. Elective</td>
<td>CMPSC 16</td>
</tr>
<tr>
<td>CHEM 1AL or 2AC</td>
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<td>4</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>MATH 3B</td>
<td>ECE 1</td>
</tr>
<tr>
<td>G.E. Elective or CMPSC 8(^1)</td>
<td>PHYS 1</td>
<td>ECE 152A</td>
</tr>
<tr>
<td>WRIT 1E or 2E</td>
<td>WRIT 2E or 50E</td>
<td>ECE 139 or PSTAT 120A(^2)</td>
</tr>
<tr>
<td>TOTAL</td>
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<td>16</td>
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</tbody>
</table>

\(^1\) CMPSC 8 is recommended only for students who do not have prior programming experience, as programming experience is a prerequisite for CMPSC 16.

\(^2\) 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.
### COMPUTER SCIENCE 2012-13

#### PREPARATION FOR THE MAJOR  
<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>CMPSC 16</td>
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</tr>
<tr>
<td>CMPSC 24</td>
<td>4</td>
</tr>
<tr>
<td>CMPSC 32</td>
<td>4</td>
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<td>CMPSC 40</td>
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<tr>
<td>CMPSC 48</td>
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</tr>
<tr>
<td>CMPSC 56</td>
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<tr>
<td>CMPSC 64</td>
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<td>MATH 3A-B, 4A-B, 6A</td>
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<tr>
<td>PSTAT 120A</td>
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</table>

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

#### 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  
**General Education and Free Electives taken:**

#### TOTAL UNITS REQUIRED FOR GRADUATION  
**184**

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.
# FRESHMAN YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
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<td>CMPSC 24</td>
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<td>MATH 3A</td>
<td>MATH 3B</td>
<td>MATH 4A</td>
</tr>
<tr>
<td>WRIT 1, 2, or G.E. Elective</td>
<td>PHYS 1</td>
<td>PHYS 2</td>
</tr>
<tr>
<td>G.E. Elective</td>
<td>WRIT 1, 2, or G.E. Elective</td>
<td>Science or Free Elective</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

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

** or you may take CMPSC 140 in winter quarter to satisfy this requirement.

# SOPHOMORE YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
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<tbody>
<tr>
<td>CMPSC 32</td>
<td>CMPSC 48</td>
<td>CMPSC 64</td>
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<tr>
<td>CMPSC 40</td>
<td>CMPSC 56</td>
<td>PSTAT 120A</td>
</tr>
<tr>
<td>MATH 4B</td>
<td>MATH 6A</td>
<td>G.E. Elective</td>
</tr>
<tr>
<td>PHYS 3</td>
<td>WRIT 50</td>
<td>Science or Free Elective</td>
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<td>PHYS 3L</td>
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# JUNIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
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<td>CMPSC 130A</td>
<td>CMPSC 130B</td>
<td>CMPSC 154</td>
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<td>CMPSC 138</td>
<td>ECE 152A</td>
<td>PSTAT 120B</td>
</tr>
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<td>Free Elective</td>
<td>Field or Free Elective</td>
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<td>G.E. Elective</td>
<td>G.E. Elective</td>
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# SENIOR YEAR

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<th>SPRING</th>
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<td>ENGR 101</td>
<td>G.E. or Free Elective</td>
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| **TOTAL**         | **12**     | **15**      | **13**
# ELECTRICAL ENGINEERING 2012-13

## PREPARATION FOR THE MAJOR 84

<table>
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<td>CMPSC 24</td>
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<td>ECE 2A-B-C</td>
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<td>ECE 15A</td>
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## 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

### Upper Division Major 68

<table>
<thead>
<tr>
<th>Course</th>
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<td>ECE 134</td>
<td>4</td>
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<td>ECE 137A-B</td>
<td>8</td>
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<td>ECE 152A</td>
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<tr>
<td>ENGR 101</td>
<td>3</td>
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</table>

Departmental electives selected from the following list: 32

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

### Approved Departmental Electives:

- ECE 123
- ECE 124-A-B-C-D
- ECE 125
- ECE 130C
- ECE 135
- ECE 141A-B-C
- ECE 144
- ECE 145A-B-C
- ECE 146A-B
- ECE 147A-B-C
- ECE 148

**Departmental Electives taken:**

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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.

### Non-Major Electives 42

General Education and Free Electives taken:

<table>
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**TOTAL UNITS REQUIRED FOR GRADUATION ...... 194**
## FRESHMAN YEAR

<table>
<thead>
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<th>FALL</th>
<th>Units</th>
<th>WINTER</th>
<th>Units</th>
<th>SPRING</th>
<th>Units</th>
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## SOPHOMORE YEAR

<table>
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<th>WINTER</th>
<th>Units</th>
<th>SPRING</th>
<th>Units</th>
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<td>ECE 15A</td>
<td>4</td>
<td>ECE 2C</td>
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</tr>
<tr>
<td>PHYS 3</td>
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<td>MATH 6A</td>
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<td>MATH 6B</td>
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## JUNIOR YEAR

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<th>Units</th>
<th>SPRING</th>
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<td>ECE 137B</td>
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<td>ECE 132</td>
<td>4</td>
<td>ECE 137A</td>
<td>4</td>
<td>ECE 139</td>
<td>4</td>
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<tr>
<td>ECE 134</td>
<td>4</td>
<td>ECE Elective</td>
<td>4</td>
<td>ECE 152A</td>
<td>5</td>
</tr>
<tr>
<td>G.E. or Free Elective</td>
<td>4</td>
<td>G.E. or Free Elective</td>
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<td>G.E. or Free Elective</td>
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<tr>
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## SENIOR YEAR

<table>
<thead>
<tr>
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<th>Units</th>
<th>WINTER</th>
<th>Units</th>
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<td>ECE Electives</td>
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<td>G.E. or Free Electives</td>
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<td>ENGR 101</td>
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<td>G.E. or Free Electives</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>16</strong></td>
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<td><strong>17</strong></td>
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</table>

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.
# Mechanical Engineering 2012-13

## Preparation for the Major

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHEM 1A, 1AL, 1B, 1BL or 2A, 2AC, 2B, 2BC</td>
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<tr>
<td>ENGR 3</td>
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<tr>
<td>MATH 3A-B, 4A-B, 6A-B</td>
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</tr>
<tr>
<td>ME 6</td>
<td>4</td>
</tr>
<tr>
<td>ME 10</td>
<td>4</td>
</tr>
<tr>
<td>ME 14</td>
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</tr>
<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, 3L, 4, 4L</td>
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## Upper Division Major

### Third Year

<table>
<thead>
<tr>
<th>Course</th>
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<tr>
<td>MATRL 101 or MATRL 100B*</td>
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<tr>
<td>ME 104</td>
<td>3</td>
</tr>
<tr>
<td>ME 105</td>
<td>4</td>
</tr>
<tr>
<td>ME 140A</td>
<td>3</td>
</tr>
<tr>
<td>ME 151A-B-C</td>
<td>11</td>
</tr>
<tr>
<td>ME 152A-B</td>
<td>7</td>
</tr>
<tr>
<td>ME 153</td>
<td>3</td>
</tr>
<tr>
<td>ME 155A</td>
<td>3</td>
</tr>
<tr>
<td>ME 163</td>
<td>3</td>
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* see note on next page

### Fourth Year

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>ME 154</td>
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<tr>
<td>ME 156A-B</td>
<td>6</td>
</tr>
<tr>
<td>ME 189A-B-C</td>
<td>6</td>
</tr>
</tbody>
</table>

## Engineering Electives

Prior approval of the student's departmental electives must be obtained from the student's faculty advisor. 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>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CHEM 109A</td>
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</tr>
<tr>
<td>CHEM 123</td>
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</tr>
<tr>
<td>ECE 147A,C</td>
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</tr>
<tr>
<td>ECE 181A,C</td>
<td></td>
</tr>
<tr>
<td>ENGR 101</td>
<td></td>
</tr>
<tr>
<td>ENGR 103, 120, 122</td>
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</tr>
<tr>
<td>(max 1 course)</td>
<td></td>
</tr>
<tr>
<td>ENV S 105</td>
<td></td>
</tr>
<tr>
<td>MATRL 100A</td>
<td></td>
</tr>
<tr>
<td>MATRL 100C</td>
<td></td>
</tr>
<tr>
<td>MATRL 186</td>
<td></td>
</tr>
<tr>
<td>MATRL 188</td>
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</tr>
<tr>
<td>ME 106A-B-C</td>
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</table>

* Four units maximum from ME 197 and ME 199 combined.

## 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>
<td></td>
</tr>
<tr>
<td>UC Entry Level Requirement: English Composition</td>
<td></td>
</tr>
<tr>
<td>Must be fulfilled within three quarters of matriculation</td>
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</table>

## General Education

### General Subject Areas

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

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

<table>
<thead>
<tr>
<th>Areas F &amp; G: The Arts, Literature – (2 courses minimum)</th>
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</thead>
</table>

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

## Special Subject Areas

#### Depth:

<table>
<thead>
<tr>
<th>Ethnicity (1 course):</th>
<th>European Traditions (1 course):</th>
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</thead>
</table>

#### Writing (4 courses required):

<table>
<thead>
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<th>Writing (4 courses required):</th>
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</thead>
</table>

## Non-Major Electives

General Education and Free Electives taken:

<table>
<thead>
<tr>
<th>General Education and Free Electives taken:</th>
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## Total Units Required for Graduation

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.
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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</thead>
<tbody>
<tr>
<td>CHEM 1A or 2A</td>
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<td>CHEM 1B or 2B</td>
<td>3</td>
<td>MATH 4A</td>
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</tr>
<tr>
<td>CHEM 1AL or 2AC</td>
<td>2</td>
<td>CHEM 1BL or 2BC</td>
<td>2</td>
<td>ME 10</td>
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<tr>
<td>ENGR 3 or G.E. Elective</td>
<td>3/4</td>
<td>MATH 3B</td>
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<td>PHYS 2</td>
<td>4</td>
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<tr>
<td>MATH 3A</td>
<td>4</td>
<td>PHYS 1</td>
<td>4</td>
<td>WRIT 50E, ENGR 3, or 3/4</td>
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<td>WRIT 1E or 2E</td>
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<td>WRIT 2E or 50E</td>
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<td>G.E. Elective</td>
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<tr>
<td><strong>TOTAL</strong></td>
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SOPHOMORE YEAR

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<tr>
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<tbody>
<tr>
<td>MATH 4B</td>
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<td>MATH 6A</td>
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<tr>
<td>ME 14</td>
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<td>ME 6</td>
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<td>ME 16</td>
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<td>ME 15</td>
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<td>PHYS 3L</td>
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<td>PHYS 4</td>
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<td>G.E. Elective</td>
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<td>G.E. Elective</td>
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<td>PHYS 4L</td>
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JUNIOR YEAR

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<tbody>
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<td>ME 140A</td>
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<td>ME 153</td>
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<td>ME 151A</td>
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<td>ME 151B</td>
<td>4</td>
<td>ME 151C</td>
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<tr>
<td>ME 152A</td>
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<td>ME 152B</td>
<td>3</td>
<td>ME 155A</td>
<td>3</td>
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<tr>
<td>G.E. or Free Elective</td>
<td>4</td>
<td>ME 163</td>
<td>3</td>
<td>G.E. or Free Elective</td>
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<td></td>
<td></td>
<td>G.E. or Free Elective</td>
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<tr>
<td><strong>TOTAL</strong></td>
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SENIOR 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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</thead>
<tbody>
<tr>
<td>ME 154</td>
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<td>ME 156B</td>
<td>3</td>
<td>ME 189C</td>
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<tr>
<td>ME 156A</td>
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<td>ME 189B</td>
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</tr>
<tr>
<td>ME 189A</td>
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<td>Departmental Electives</td>
<td>6</td>
<td>G.E. or Free Electives</td>
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</tr>
<tr>
<td>Departmental Electives</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>15</strong></td>
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</table>

* if applying to the BS/MS Materials program, juniors must take MATRL 100A in fall, MATRL 100B in winter, and MATRL 100C in spring.
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>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>Laura Crownover</td>
<td>893-8671</td>
<td><a href="mailto:laura@engr.ucsb.edu">laura@engr.ucsb.edu</a></td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>Val De Veyra</td>
<td>893-8292</td>
<td><a href="mailto:ugradinfo@ece.ucsb.edu">ugradinfo@ece.ucsb.edu</a></td>
</tr>
<tr>
<td>Computer Science</td>
<td>Benji Dunson</td>
<td>893-4321</td>
<td><a href="mailto:ugradv@cs.ucsb.edu">ugradv@cs.ucsb.edu</a></td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>Val De Veyra</td>
<td>893-8292</td>
<td><a href="mailto:ugradinfo@ece.ucsb.edu">ugradinfo@ece.ucsb.edu</a></td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>Suzi See</td>
<td>893-8198</td>
<td><a href="mailto:meugrad@engr.ucsb.edu">meugrad@engr.ucsb.edu</a></td>
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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.