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 inside and outside the classroom, to enhance your education. We have a talented and wise faculty and staff, equipped with extensive knowledge and diverse experience, to help you make decisions about courses and other activities as you pursue your degree. We look forward to having you in our classes, laboratories, and offices as you discover where your interests lead you.

Glenn Beltz
Associate Dean for Undergraduate Studies
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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 engineering systems; and exposure to current engineering practice and cutting edge engineering research and technology. A spirit of entrepreneurship in education, scholarly activity and participation in engineering practice infuses UCSB’s College of Engineering.

College of Engineering Honors Program

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

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

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

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

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

Dean’s Honors

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

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

Tau Beta Pi

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

Education Abroad Program (EAP)

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

Student Organizations

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

• American Institute of Chemical Engineers
• American Society of Mechanical Engineers
• Association for Computing Machinery
• Engineering Student Council
• Engineers without Borders
• Entrepreneurship Association
• 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 Chicano and Native Americans in Science
• Society of Women Engineers
• 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. It is incumbent upon students to continue to make progress in a backup major while pursuing a new major in the College of Engineering, and to periodically consult academic advisors in both the desired major as well as the backup major regarding the viability of pursuing the change of major.

Students who enter UCSB as transfer students will not be able to change to or add an engineering major, if not initially accepted into one. Students who began as freshmen who plan to enter an 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.

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 or 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 once both of the following requirements are met:
1. An overall UCSB grade point average of at least 3.0.
2. Satisfactory completion at UCSB, with a grade point average of 3.0 or better, of at least five classes, including at least two mathematics classes, from the following: Math 4B 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 are required to meet with the ME Academic Advisor.

Degree Requirements

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

General University Requirements

All undergraduate students must satisfy university academic residency, UC Entry Level Writing Requirement, American history and institutions, unit, and scholarship requirements. These requirements are described fully on page 8.

College General Education Requirements

All students must satisfy the general education requirements for the College of Engineering. These requirements are described on page 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 these credits 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 Examinations 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 what is prescribed by the prevailing academic Senate regulation regarding Minimum Cumulative Progress. At least three-fourths of the minimum number of academic units passed must include courses prescribed for the major.

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

Students must obtain the approval of the dean of engineering to deviate from these requirements. Approval normally will be granted only in cases of medical disability, severe personal problems, or accidents. Students enrolled in dual-degree programs must submit their proposed programs of study to the Associate Dean for Undergraduate Studies in the College of Engineering for approval. The individual programs must contain comparable standards of minimal academic progress.

215–Unit and Quarter Enrollment Limitations

The college expects students to graduate 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 Studies 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 possible 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.

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 the 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 departments.

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>MCD 20/EEMB 20</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>D: 2 courses</td>
<td>Econ 1,2</td>
</tr>
<tr>
<td>English (A1 level)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score of 5</td>
<td>8</td>
<td>Entry Level Writing</td>
<td>Writing 1, 1E, 1LK</td>
</tr>
<tr>
<td>Score of 6</td>
<td>8</td>
<td>Writing 2</td>
<td>Writing 1, 1E, 1LK, 2, 2E, 2LK</td>
</tr>
<tr>
<td>Score of 7</td>
<td>8</td>
<td>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 World Cultures Requirement
^ course also satisfies the European Traditions Requirement
# course also satisfies the Quantitative Relationships Requirement
## College Board Advanced Placement Credit

<table>
<thead>
<tr>
<th>Advanced Placement Exam</th>
<th>Units Awarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Art History</strong></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>
<tr>
<td>*Art Studio 3D Design Portfolio</td>
<td>8</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>*Art Studio Drawing Portfolio</td>
<td>8</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>8</td>
<td>C: 1 course</td>
<td>EEMB 20, MCDB 20, Natural Science 1C</td>
</tr>
<tr>
<td>Chemistry</td>
<td>8</td>
<td>C: 1 course</td>
<td>Natural Science 1B</td>
</tr>
<tr>
<td>Chinese Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td></td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td></td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td></td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td></td>
</tr>
<tr>
<td>Comparative Government and Politics</td>
<td>4</td>
<td>D: 1 course</td>
<td></td>
</tr>
<tr>
<td>+Computer Science A</td>
<td>2</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Economics – Macroeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td></td>
</tr>
<tr>
<td>Economics – Microeconomics</td>
<td>4</td>
<td>D: 1 course</td>
<td></td>
</tr>
<tr>
<td>*English – Composition and Literature or Language and Composition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>Entry Level Writing</td>
<td>Writing 1, 1E, 1LK</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>Writing 2</td>
<td>Writing 1, 1E, 1LK, 2E, 2LK</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>Writing 2, 50</td>
<td>Writing 1, 1E, 1LK, 2E, 2LK, 50, 50E, 50LK</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>4</td>
<td>C: 1 course</td>
<td>Environmental Studies 2</td>
</tr>
<tr>
<td>European History</td>
<td>8</td>
<td>E: 1 course</td>
<td>no equivalent</td>
</tr>
<tr>
<td>French Language</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-5</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-6</td>
</tr>
<tr>
<td>French Literature</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-5</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-3</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-4</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-5</td>
</tr>
<tr>
<td>German Language</td>
<td>8</td>
<td>H: 1 course</td>
<td>Italian 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Italian 1-5</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Italian 1-6</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>Latin: Vergil</td>
<td>4</td>
<td>H: 1 course</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>Latin: Literature</td>
<td>4</td>
<td>H: 1 course</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>*Mathematics – Calculus AB (or AB subscore of BC exam)</td>
<td>8</td>
<td>C: 2 courses</td>
<td>Mathematics 3A, 3B, 15, 34A, or equivalent</td>
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<tr>
<td>Mathematics – Calculus BC</td>
<td>8</td>
<td>C: 1 course</td>
<td>Mathematics 3A, 3B, 15, 34A, 34B, or equivalent</td>
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<tr>
<td>Music – Theory</td>
<td>8</td>
<td>F: 1 course</td>
<td>Music 11</td>
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<td>*Physics – B</td>
<td>8</td>
<td>C: 1 course</td>
<td>Physics 10, Natural Science 1A</td>
</tr>
<tr>
<td>*Physics – C (Mechanics)</td>
<td>4</td>
<td>C: 1 course</td>
<td>Physics 6A and 6AL</td>
</tr>
<tr>
<td>*Physics – C (Electricity &amp; Magnetism)</td>
<td>4</td>
<td>C: 1 course</td>
<td>Physics 6B and 6BL</td>
</tr>
<tr>
<td>Psychology</td>
<td>4</td>
<td>D: 1 course</td>
<td>Psychology 1</td>
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<td>Spanish Language</td>
<td>8</td>
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<td>Spanish 1-3</td>
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<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
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<td>Spanish Literature</td>
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<td>H: 1 course</td>
<td>Spanish 1-5</td>
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<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>With score of 4 or 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>Statistics</td>
<td>4</td>
<td>C: 1 course</td>
<td>Communication 87, EEMB 30, Geography 17</td>
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<tr>
<td>U.S. Government and Politics</td>
<td>4</td>
<td>D: 1 course</td>
<td>Political Science 12</td>
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<td>U.S. History</td>
<td>8</td>
<td>D: 1 course</td>
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</tr>
<tr>
<td>World History</td>
<td>8</td>
<td>none</td>
<td>no equivalent</td>
</tr>
</tbody>
</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.
*B 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

**Note:** Information on this chart is subject to change. For updates go to: [http://my.sa.ucsb.edu/catalog/current/UndergraduateEducation/APCreditandChart.aspx](http://my.sa.ucsb.edu/catalog/current/UndergraduateEducation/APCreditandChart.aspx).
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 IGETC (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. Objective: To study and practice with writing, reading, and critical analysis within specific disciplines. Students will demonstrate abilities by producing written work totaling at least 1,800 words that is independent of or in addition to written examinations. Assessment of written work must be a significant consideration in total assessment of student performance in the course. At least four designated General Education courses that meet the following criteria: (1) the courses require one to three papers totaling at least 1,800 words, exclusive of elements such as footnotes, equations, tables of contents, or references; (2) the required papers are independent of or in addition to written examinations; and (3) the paper(s) is a significant consideration in the assessment of student performance in the course. Courses marked with an asterisk (*) on the lists in this document apply to this requirement. The writing requirement may be met only with designated UCSB courses.

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.

Starting Fall 2012, students have the option of fulfilling the depth requirement by completing an approved minor or double major, in a discipline encompassed by areas D, E, F, or G, listed below.

Approved Minors

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

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

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

Other Regulations:
- No more than two courses from the same department may apply to the General Education areas D, E, F, G, and H. (Except if a student completes one of the specific course sequences, such as History 4A-B-C, listed above for the depth requirement.)
- A course listed in more than one general subject area can be applied to only one of these areas. (Example: Art History 6A cannot be applied to both areas E and F.) However, a course can be applied towards a single general subject area and any special subject areas which that course fulfills. (Example: Asian American Studies 4 can be applied to the Writing and Ethnicity requirements in addition to the Area F requirement.)
- Some courses taken to satisfy the General Education requirements may also be applied simultaneously to the American History and Institutions requirement. Such courses must be on the list of approved General Education courses and on the list of approved American History and Institutions courses.
- Courses taken to fulfill a General Education requirement may be taken on a P/NP basis, if the course is offered with that grading option (refer to GOLD for the grading option for a particular course).

GENERAL EDUCATION COURSES

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

AREA A – ENGLISH READING AND COMPOSITION

Objective: To learn to analyze purposes, audiences, and contexts for writing through study of and practice with writing.
2 courses required
Writing 2 or 2E and Writing 50, 50E, 107T or 109ST are required, and must be taken for letter grades.

AREAS D AND E – SOCIAL SCIENCES, CULTURE & THOUGHT

2 course minimum

Area D: Social Sciences
Objective: To apply perspectives, theories, and methods of social science research to understand what motivates, influences, and/or determines the behaviors of individuals, groups, and societies. Area D courses are based upon systematic studies of human behavior which may include observation, experimentation, deductive reasoning, and quantitatative analysis.
<table>
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<tr>
<th>Course Code</th>
<th>Course Name</th>
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<tr>
<td>Anthropology 2</td>
<td>Introductory Cultural Anthropology</td>
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<td>* Anthropology 3</td>
<td>Introductory Archaeology</td>
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<td>Anthropology ISS</td>
<td>Introduction to Archaeological Theory</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 103B</td>
<td>Anthropology of Japan</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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<tr>
<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 130-A/B</td>
<td>Third World Environments</td>
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<tr>
<td>@ &amp; Anthropology 131</td>
<td>North American Indians</td>
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<tr>
<td>Anthropology 134</td>
<td>Modern Cultures of Latin America</td>
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<tr>
<td>* Anthropology 135</td>
<td>Modern Mexican Culture</td>
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<td>Anthropology 136</td>
<td>Peoples and Cultures of the Pacific</td>
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<td>Anthropology 137</td>
<td>The Ancient Maya</td>
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<td>* Anthropology 141</td>
<td>Agriculture and Society in Mexico: Past and Present</td>
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<td>Anthropology 142</td>
<td>Peoples and Cultures of India</td>
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<td>* Anthropology 176</td>
<td>Representations of Sexuality in Modern Japan</td>
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<tr>
<td>&amp; Anthropology 191</td>
<td>Indigenous Movements in Asia</td>
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<tr>
<td>@ &amp; Asian American Studies 1</td>
<td>Introduction to Asian American History, 1850-Present</td>
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<tr>
<td>@ &amp; Asian American Studies 2</td>
<td>American Migration since 1965</td>
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<tr>
<td>@ &amp; Asian American Studies 3</td>
<td>Asian American Personality and Identity</td>
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<td>&amp; Asian American Studies 6</td>
<td>Sociology of Asian America</td>
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<td>@ &amp; Asian American Studies 7</td>
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<td>&amp; Asian American Studies 107</td>
<td>Third World Social Movements</td>
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<td>&amp; Asian American Studies 109</td>
<td>Asian American Women and Work</td>
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<td>Asian American Communities and Contemporary Issues</td>
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<td>&amp; Asian American Studies 119</td>
<td>Asian Americans and Race Relations</td>
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<td>* &amp; Asian American Studies 136</td>
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<td>&amp; Asian American Studies 137</td>
<td>Multicultural Asian Americans</td>
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<td>&amp; Asian American Studies 165</td>
<td>Ethnographies of Asian Americans</td>
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<td>@ &amp; Black Studies 1, 1H</td>
<td>Introduction to Afro-American Studies</td>
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<td>@ &amp; Black Studies 56</td>
<td>Critical Introduction to Race and Racism</td>
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<tr>
<td>@ &amp; Black Studies 6</td>
<td>The Civil Rights Movement</td>
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<td>@ &amp; Black Studies 15</td>
<td>The Psychology of Blacks</td>
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<td>Black Studies 100</td>
<td>Africa and United States Policy</td>
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<td>@ &amp; Black Studies 102</td>
<td>Black Radicals and the Radical Tradition</td>
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<td>@ &amp; Black Studies 103</td>
<td>The Politics of Black Liberation -The Sixties</td>
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<td>@ &amp; Black Studies 122</td>
<td>The Education of Black Children</td>
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<td>* &amp; Black Studies 124</td>
<td>Housing, Inheritance and Race</td>
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<td>* &amp; Black Studies 125</td>
<td>Queer Black Studies</td>
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<td>* &amp; Black Studies 129</td>
<td>The Urban Dilemma</td>
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<tr>
<td>* &amp; Black Studies 131</td>
<td>Race and Public Policy</td>
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<td>* &amp; Black Studies 160</td>
<td>Analyses of Race and Social Policy in the U.S.</td>
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<tr>
<td>@ &amp; Black Studies 169AR-BR-CR</td>
<td>Afro-American History (Same as HIST 169AR-BR-CR)</td>
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<tr>
<td>* Black Studies 171</td>
<td>Africa in Film and Art</td>
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<tr>
<td>* Black Studies 174</td>
<td>From Plantations to Prisons</td>
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<tr>
<td>@ &amp; Chicano Studies 1A-B-C</td>
<td>Introduction to Chicano/a Studies</td>
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<td>Chicano Studies 114</td>
<td>Cultural and Critical Theory</td>
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<tr>
<td>&amp; Chicano Studies 137</td>
<td>Chicano/a Oral Traditions</td>
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<tr>
<td>&amp; Chicano Studies 140</td>
<td>The Mexican Cultural Heritage of the Chicano</td>
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<td>* Chicano Studies 144</td>
<td>The Chicano Community (Same as SOC 144)</td>
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<td>&amp; Chicano Studies 151</td>
<td>De-Colonizing Feminism</td>
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<td>&amp; Chicano Studies 155W</td>
<td>La Chicana: Mexican Women in the U.S.</td>
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<td>Chicano Studies 168A-B</td>
<td>History of the Chicano (Same as HIST 168A-B)</td>
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<tr>
<td>* Chicano Studies 172</td>
<td>Law and Civil Rights</td>
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<tr>
<td>&amp; Chicano Studies 173</td>
<td>Immigrant Labor Organizing</td>
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<tr>
<td>@ &amp; Chicano Studies 174</td>
<td>Chicano/a Politics (Same as POL S 174)</td>
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<tr>
<td>@ &amp; Chicano Studies 175</td>
<td>Comparative Social Movements</td>
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<td>Chicano Studies 176</td>
<td>Political Life</td>
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<tr>
<td>&amp; Chicano Studies 178A</td>
<td>Global Migration, Transnationalism in Chicano/a Contexts</td>
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<tr>
<td>* Chicano Studies 179</td>
<td>Democracy and Diversity</td>
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<td>* Chicano Studies 187</td>
<td>Language, Power, and Learning</td>
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<td>&amp; Chicano Studies 189B</td>
<td>The Global Underground</td>
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<td>Chicano Studies 189C</td>
<td>Cultures of Globalization</td>
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<td>* Communication 1</td>
<td>Introduction to Communication</td>
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<td>East Asian Cultural Studies 40</td>
<td>Gender and Sexuality in Modern Asia</td>
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<td>Anthropology of Japan 103B</td>
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<tr>
<td>Anthropology of Contemporary Korea 103A</td>
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<td>Studies 140</td>
<td>Indigenious Movements in Asian America</td>
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<tr>
<td>East Asian Cultural Studies 186</td>
<td>The Invention of Tradition in Contemporary Asia</td>
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<td>East Asia</td>
<td>Vietnamese History (Same as HIST 189A)</td>
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<td>&amp; Education 187</td>
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<td>Environmental Studies 1</td>
<td>Introduction to Environmental Studies</td>
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<tr>
<td>Environmental Studies 130-A-B</td>
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</tr>
<tr>
<td>Environmental Studies 132</td>
<td>Human Behavior and Global Environment</td>
</tr>
<tr>
<td>* Feminist Studies 30 or 30H</td>
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<td>* Feminist Studies 153</td>
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<td>* History 117C</td>
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* This course applies toward the writing requirement.  
& This course applies toward the ethnicity requirement.  
@ This course applies toward the American History & Institutions requirement.  
^ This course applies toward the European Traditions requirement.
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<td>Politics and Religion in the City: Jerusalem</td>
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<td>* Religious Studies 136</td>
<td>Religion and the American Experience</td>
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<td>* Religious Studies 141A-B</td>
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<td>@ Religious Studies 151A-B</td>
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**Objective:** To learn to situate and investigate questions about world cultures through the study of human history and thought and to learn about the roles that citizens play in the construction and negotiation of human history and cultures.

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<td>Art History 109G</td>
<td>Leonardo Da Vinci: Art, Science, and Technology in Early Modern Italy</td>
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<td>Art and Empire in the Americas: Aztec, Inca, Spanish</td>
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^ This course applies toward the European Traditions requirement.
**Politics and Government**

**History 2A-B-C**
World History

**History 2A-B-C**
World History (Honors)

**History 4A-B-C**
Western Civilization

**History 4A-B-C**
Western Civilization (Honors)

**History 8**
Introduction to History of Latin America

**History 33D**
The Holocaust: Interdisciplinary Perspectives

**History 46**
Survey of Middle Eastern History

**History 49A-B**
Survey of African History

**History 80**
East Asian Civilization (Same as EACS 80)

**History 87**
Japanese History through Art and Literature

**History 106A**
The Origins of Western Science, Antiquity to 1500 (Same as ENV S 108A)

**History 106B**
The Scientific Revolution, 1500 to 1800

**History 106C**
History of Modern Science

**History 107B**
History of Biological Sciences: Circa 1600 to 1800

**History 107C**
The Darwinian Revolution and Modern Biology

**History 107E**
History of Animal Use in Science (Same as ENV S 107E)

**History 114B-C-D**
History of Christianity

**History 133A**
Nineteenth Century Germany

**History 133B-C**
Twentieth Century Germany

**History 133D**
The Holocaust in German History

**History 182A-B**
Korean History and Civilization (Same as KOR 182A-B)

**History 185A-B**
Modern China

**History 187A-B-C**
Modern Japan

**History 188T**
Modernity and the Masses of Taisho Japan

(Same as JAPAN 164)

**History 189E**
History of the Pacific

**Italian 20X**
Introduction to Italian Culture

**Italian 138A-CX-D-DX-EX-FX**
Cultural Representations in Italy

**Italian 138AX**
Cultural Representations in Italy

**Italian 144AX**
Gender and Sexuality in Italian Culture

**Italian 189A**
Italian Mediterranean

**Japanese 164**
Modernity and the Masses of Taisho Japan

(Same as HIST 188T)

**Korean 182A-B**
Korean History and Civilization (Same as HIST 182A-B)

**Latin American & Iberian Studies 101**
Interdisciplinary Approaches to History and Societies of Latin America

**Linguistics 30**
The Story of English

**Linguistics 50**
Language and Power

**Linguistics 80**
Endangered Languages

**Middle East Studies 45**
Introduction to Islamic & Near East Studies

**Molecular, Cellular & Developmental Biology 27**
Neuroscience (Same as C LIT 27 & FR 40X)

**Philosophy 1**
Short Introduction to Philosophy

**Philosophy 3**
Critical Thinking

**Philosophy 4**
Introduction to Ethics

**Philosophy 20A-B-C**
History of Philosophy

**Philosophy 100A**
Ethics

**Philosophy 100B**
Theory of Knowledge

**Philosophy 100C**
Philosophy of Language

**Philosophy 100D**
Philosophy of Mind

**Philosophy 100E**
Metaphysics

**Philosophy 112**
Philosophy of Religion

**Physics 43**
Origins: A Dialogue Between Scientists and Philosophers (Same as RG ST 43)

**Political Science 187**
Classical Political Theory

**Political Science 188**
Modern Political Theory

**Political Science 189**
Recent and Contemporary Political Theory

**Portuguese 125A**
Culture and Civilization of Portugal

**Portuguese 125B**
Culture and Civilization of Brazil

**Religious Studies 1**
Introduction to the Study of Religion

**Religious Studies 2**
Introduction to Asian Religious Traditions

(Same as EACS 3)

**Religious Studies 3**
Introduction to Buddhism

**Religious Studies 5**
Introduction to Judaism, Christianity, and Islam

**Religious Studies 6**
Islam and Modernity

**Religious Studies 12**
Religious Approaches to Death

**Religious Studies 19**
The Gods and Goddesses of India

**Religious Studies 20**
Indic Civilization

**Religious Studies 21**
Zen

**Religious Studies 25**
Global Catholicism

**Religious Studies 31**
Religions of Tibet

**Religious Studies 34**
Saints and Miracles in the Catholic Tradition

**Religious Studies 43**
Origins: A Dialogue Between Scientists and Humanists (Same as PHYS 43)

**Religious Studies 71**
Introduction to Asian Religious Traditions

**Religious Studies 80A-B-C**
Religion and Western Civilization

**Religious Studies 116A**
The New Testament and Early Christianity

**Religious Studies 116B**
Asian American Religions (Same as AS AM 161)

**Religious Studies 123**
Roman Catholicism Today

**Religious Studies 126**
Judaism

**Religious Studies 130**
Creation Myths

**Religious Studies 136**
Catholic Practices & Global Cultures

**Religious Studies 138B**
Christian Spirituality

**Religious Studies 150**
Sikhism

**Religious Studies 162C**
American Spirituality

**Religious Studies 162E**
Indian Civilization

**Religious Studies 164A**
Buddhist Traditions in South Asia

**Religious Studies 164B**
Buddhist Traditions in East Asia

**Religious Studies 183**
Quest for Narrative in Late Imperial China

**Slavic 33**
Russian Culture

**Slavic 130D**
Russian Art

**Spanish 153**
Basque Studies

**Spanish 177**
Spanish-American Thought

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**Area F: Arts**

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

**Art History 1**
Introduction to Art

**Art History 5A**
Introduction to Architecture and the Environment

**Art History 6A**
Art Survey I: Ancient Art-Medieval Art

**Art History 6B**
Art Survey II: Renaissance Art-Baroque Art

**Art History 6C**
Art Survey III: Modern-Contemporary Art

**Art History 6DS**
Survey: History of Art in China

**Art History 6E**
Survey: Art of Japan and Korea

**Art History 6F**
Survey: Arts in Africa, Oceania, and Native North America

**Art History 6G**
Pre-Columbian Art

**Art History 6H**
Islamic Art and Architecture

**Art History 101B**
Classical Greek Art (480 to 320 BCE)

**Art History 101A**
Roman Architecture

**Art History 103A**
Roman Art: From the Republic to Empire (509 BC to AD 337)

**Art History 103B**
Greek Architecture

**Art History 103C**
Medieval Architecture: From Constantine to Charlemagne

**Art History 105C**
The Origins of Romanesque Architecture

**Art History 105E**
Late Romanesque and Gothic Architecture

**Art History 105G**
Art and Society in Late Medieval Tuscany

**Art History 105L**
Painting in Fifteenth-Century Netherlands

**Art History 107A**
Painting in Sixteenth-Century Netherlands

**Art History 107B**
Italian Renaissance Art 1400-1500

**Art History 109A**
Italian Renaissance Art 1500-1600

**Art History 109B**
Art as Technique, Labor, and Idea in Renaissance Italy

**Art History 109C**
Art and the Formation of Social Subjects in Early Modern Italy

**Art History 109D**
Michelangelo

**Art History 109E**
Leonardo da Vinci: Art, Science and Technology in Early Modern Italy

**Art History 109F**
Art and Moral Values

**Art History 109G**
Dutch Art in the Age of Rembrandt

**Art History 111B**
Dutch Art in the Age of Vermeer

**Art History 111C**
Gender and Power in Sixteenth- and Seventeenth-Century European Art

**Art History 111E**
Rethinking Rembrandt

**Art History 113A**
Seventeenth-Century Art in Southern Europe

**Art History 113B**
Seventeenth-Century Art in Italy
**Area G: Literature**

**Objective:** To learn to analyze texts using methods appropriate to literary study and to situate analysis within contexts where texts circulate.

- **& Asian American Studies 5** Introduction to Asian American Literature
- **& Asian American Studies 122** Asian American Fiction
- **& Asian American Studies 128** Writing 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 Chicano Novel
- **& Chicano Studies 184A** Chicana 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
- **Comparative Literature 32** Major Works of Middle Eastern Literatures
- **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 122B** Holocaust in France (Same as FR 154E)
- **Comparative Literature 126** Comparative Black Literatures
- **Comparative Literature 128A** Children’s Literature
- **Comparative Literature 128B** Representing Childhood
- **Comparative Literature 133** Transpacific Literature
- **Comparative Literature 146** Robots
- **Comparative Literature 153** Border Narratives
- **Comparative Literature 154** Science Fiction in Eastern Europe
- **Comparative Literature 161** Literature of Central Europe
- **Comparative Literature 171** Post-Colonial Cultures (Same as FR 154G)
- **Comparative Literature 179B** Mysticism
- **Comparative Literature 186AD** Mediantechnology (Same as GER 179C)
- **Comparative Literature 186EE** Adultery in the Novel
- **Comparative Literature 187** Interdisciplinary Comparative Literature
- **Comparative Literature 188** Strauss and Hofmannsthal
- **Comparative Literature 189** Narrative Studies
- **Comparative Literature 191** Narrative in the First Person
- **English 15** Fantasy and the Fantastic (Same as FR 153D)
- **English 21** Introduction to Shakespeare
- **English 25** Introduction to Narrative
- **English 35** Introduction to Literature and the Culture of Information
- **& English 38A-B** Introduction to African American Literature
- **& English 50** Introduction to U.S. Minority Literature
- **& English 65AA-ZZ** Topics in Literature
- **& English 101** English Literature from the Medieval Period to 1650
- **& English 102** English Literature from 1650 to 1780
- **& English 103A** American Literature from 1789 to 1900
- **& English 103B** British Literature from 1789 to 1900
- **& English 104A** American Literature from 1900 to Present
- **& English 104B** British Literature from 1900 to Present
- **& English 105A** Shakespeare: Poems and Earlier Plays
- **& English 105B** Shakespeare: Later Plays
- **& English 113AA-ZZ** Literary Theory and Criticism
- **& English 113A-ZZ** Women and Literature
- **& English 114BW** Black Women Authors
- **& English 114BW** Native American Women Authors
- **& English 115** Biblical Literature: The Old Testament
- **& English 116B** Studies in Medieval Literature
- **& English 119** Medieval Literature in Translation
- **& English 119X** Modern Drama
- **& English 120** The Art of Narrative
- **& English 121** Cultural Representations
- **& English 122B** Cultural Representations
- **& English 122NE** Cultural Representations of Nature and the Environment (Same as ENV S 122NE)
- **& English 124** Readings in the Modern Short Story
- **& English 126A-B** Survey of British Fiction
- **& English 128AA-ZZ** Literary Genres
- **& English 131AA-ZZ** Studies in American Literature
- **& English 133AA-ZZ** Studies in American Regional Literature
- **& English 134AA-ZZ** Literature of Cultural and Ethnic Communities in the United States
- **& English 137A-B** Poetry in America
- **& English 138C** Prose Narrative in America Since 1917
- **& English 140** Contemporary American Literature

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^ This course applies toward the European Traditions requirement.
Literature Courses Taught in the Original Language

* English 150 Anglo-Irish Literature
* English 152A Chaucer: Canterbury Tales
* English 156 Literature of Chivalry
* English 157 English Renaissance Drama
* English 162 Milton
* English 165A-ZZ Topics in Literature
* English 170CM,JM,LM,MT Studies in Literature and the Mind
* English 172 Studies in the Enlightenment
* English 179 British Romantic Writers
* English 180 The Victorian Era
* English 181,181MT Studies in the Nineteenth Century
* English 184 Modern European Literature
* English 185 Modernism in English
* English 187A-ZZ Studies in Modern Literature
* English 189 Contemporary Literature
* English 190A-ZZ World Literature in English
* English 191 Afro-American Fiction and Criticism, 1920s to Present
* English 192 Science Fiction
* English 193 Detective Fiction
* Environmental Studies 122LE Cultural Representations: Literature and the Environment
* Environmental Studies 122NE Cultural Representations of Nature and the Environment (Same as ENGL 122NE)
* Feminist Studies 40 or 401 Women, Representation, and Cultural Production
* Feminist Studies 171CN Citizenesses! Women and Politics in Modern France (Same as FR 155D)
* French 101A-B-C Literary and Cultural Analysis
* French 147A French and Francophone Poetry
* French 147B French and Francophone Theater
* French 148C Women in the Middle Ages
* French 148E The Age of Louis XIV
* French 149B The Politics of Paradise
* French 149D Reading Paris (1830-1890)
* French 149E Post-War Avant-Gardes
* French 153A Medieval Literature in Translation
* French 153B French Theater in Translation
* French 153C Autobiography
* French 153D Fantasy & the Fantastic (Same as C LIT 191)
* French 153E The Power of Negative Thinking: Sartre, Adorno, and Marcuse
* French 153F Existentialist Literature in Translation
* French 154A Voyages to the Unknown
* French 154D Torture
* French 154E Holocaust in France (Same as C LIT 122B)
* French 154F Time Off in Paris
* French 154G Post-Colonial Cultures (Same as C LIT 171)
* French 155A Women in the Middle Ages
* French 155B Women on Trial
* French 155C Citoyennes! Women and Politics in Modern France (Same as FEMST 171CN)
* French 155D Modern Images of the Middle Ages
* French 156C German Childhood and Youth
* French 156D Survey of German Literature
* French 156E Representations of the Holocaust (Same as C LIT 122A)
* German 138 Psy Ft: German Science Fiction
* German 143 The Superhuman
* German 151C Literature of Central Europe
* German 164E-F-G German Writers in German Language
* German 164I Modern Autobiography and Memoir
* German 166 Grimm
* German 179B Mysticism
* German 179C Mediatechnology (Same as C LIT 179C)
* German 182 Vampirism in German Literature and Beyond
* German 187 Satan in German Literature and Beyond
* Greek 100 Introduction To Greek Prose
* Greek 101 Introduction To Greek Poetry
* Hebrew 114A-B-C Readings in Modern Hebrew Prose and Poetry
* Italian 101 Modern Italy
* Italian 102 Medieval and Renaissance Italy
* Italian 111 Italian Short Fiction
* Italian 114X Dante’s “Divine Comedy”
**Area H: Foreign Language**

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

<table>
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<tr>
<th>Course</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Chinese 2-3</td>
<td>Elementary Modern Chinese</td>
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<td>Chinese 4-5-6</td>
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<td>Chinese 4NH-5NH-6NH</td>
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<td>French 6GS</td>
<td>Intermediate French: Global Studies-Political Sci.</td>
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<td>Intermediate Yiddish</td>
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<td>German 95C</td>
<td>Advanced Yiddish</td>
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<td>Global Studies 60B-C-D-E-F</td>
<td>Punjabi (II-III-IV-VI)</td>
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<td>Greek 3</td>
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<td>Greek 12-13</td>
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<td>Hebrew 2-3</td>
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<td>Hebrew 4-5-6</td>
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<td>Religious Studies 11B-C-D-E-F</td>
<td>Hindi (II-III-IV-VI)</td>
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<td>Syriac (II-III)</td>
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### 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.

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<td>Myth, Ritual, and Symbol</td>
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<td>* Anthropology 116B</td>
<td>Anthropological Approaches to Religion</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>
<td>Introduction to Contemporary Social Theory</td>
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<tr>
<td>&amp; Anthropology 148A</td>
<td>Comparative Ethnicity</td>
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<td>* Anthropology 172</td>
<td>Colonialism and Culture</td>
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<td>* Art History 186AA-ZZ</td>
<td>Seminar in Advanced Studies in Art History</td>
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<td>&amp; Asian American Studies 100CC</td>
<td>Filipino Americans</td>
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<td>&amp; Asian American Studies 113</td>
<td>The Asian American Movement</td>
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<td>&amp; Asian American Studies 121</td>
<td>Asian American Autobiographies and Biographies</td>
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<tr>
<td>&amp; Asian American Studies 124</td>
<td>Asian American Literature in Comparative Frameworks</td>
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<td>* Asian American Studies 134</td>
<td>Asian American Men and Contemporary</td>
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<tr>
<td>&amp; Asian American Studies 148</td>
<td>Asian American Studies 149</td>
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<td>&amp; Black Studies 137E</td>
<td>Sociology of the Black Experience</td>
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<td>&amp; Chicano Studies 139</td>
<td>Cinco/a Native American Heritage</td>
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<td>&amp; Chicano Studies 154F</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 168F</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>Chicano Theater</td>
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<td>Immigration and the US Border</td>
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<td>Special Topics in Modern Chinese Poetry</td>
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<td>* Chinese 150</td>
<td>The Language of Vernacular Chinese Literature</td>
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<td>* Chinese 166A</td>
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<td>* Chinese 166B</td>
<td>Taoist Traditions in China</td>
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<td>* Chinese 166C</td>
<td>Confucian Tradition: The Classical Period</td>
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<td>* Chinese 166E</td>
<td>The Flowering of Chinese Buddhism</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>* Comparative Literature 124</td>
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<td>* Comparative Literature 170</td>
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<td>* Counseling, Clinical &amp; School Psychology 101</td>
<td>Global Humanities: The Politics and Poetics of Witnessing</td>
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<td>* Earth Science 6</td>
<td>Old Comedy/New Comedy</td>
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<td>* Earth Science 10</td>
<td>Literary Translation: Theory and Practice</td>
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<td>* Earth Science 104A</td>
<td>Introduction to Applied Psychology</td>
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<td>* Earth Science 104B</td>
<td>Mountains, Boots and Backpacks: Field Study of the High Sierra</td>
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<td>* Earth Science 117</td>
<td>Antarctica: The Last Place on Earth</td>
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<td>* Earth Science 123</td>
<td>Field Studies in Geological Methods</td>
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<td>* Earth Science 130</td>
<td>Field Methods</td>
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<td>* East Asian Cultural Studies 178</td>
<td>Earth Surface Processes and Landforms</td>
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<td>@ Economics 113A-B</td>
<td>The Solar System</td>
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<td>@ Economics 117A</td>
<td>Global Warming - Science and Society</td>
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<td>@ Economics 119A</td>
<td>The Body Religious in Chinese Culture</td>
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<td>Economic History of the United States</td>
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<td>@ Ecology, Evolution, and Marine Biology 124</td>
<td>Law and Economics</td>
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<td>@ EEAB 134</td>
<td>United States Business History</td>
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<td>@ EEAB 135</td>
<td>Introduction to the University Experience</td>
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<td>@ EEAB 138</td>
<td>Biochemical Ecology</td>
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<td>@ EEAB 142BL</td>
<td>Biology of Seaweeds and Phytoplankton</td>
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<tr>
<td>@ EEAB 142CL</td>
<td>Evolutionary Ecology</td>
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<td>@ EEAB 147</td>
<td>Ethology and Behavioral Ecology</td>
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<tr>
<td>@ EEAB 149</td>
<td>Chemical and Physical Methods of Aquatic Environments</td>
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<td>@ EEAB 179</td>
<td>Methods of Aquatic Biology</td>
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<td>@ English 36</td>
<td>Biology of Coral Reefs</td>
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<td>@ Engineering 101</td>
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<td>@ Engineering 103</td>
<td>Modeling Environmental and Ecological Change</td>
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<td>@ Environmental Studies 20</td>
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<td>@ Environmental Studies 146</td>
<td>Shoreline Issues</td>
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<td>@ Environmental Studies 161</td>
<td>Disease and the Environment</td>
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<td>@ Environmental Studies 173</td>
<td>Endangered Species Management</td>
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<td>&amp; Environmental Studies 189</td>
<td>Animals in Human Society: Ethical Issues of Animal Use</td>
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<td>&amp; Environmental Studies 190</td>
<td>Environmental Journalism: A Survey American Environmental History</td>
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<td>&amp; Feminist Studies 80 or 80H</td>
<td>Religion and Ecology in the Americas</td>
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<tr>
<td>&amp; Feminist Studies 142</td>
<td>Introduction to LGBTQ Studies</td>
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<td>&amp; Feminist Studies 150, 150H</td>
<td>Black Women Filmmakers</td>
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<tr>
<td>&amp; Feminist Studies 154A</td>
<td>Sex, Love, and Romance</td>
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<td>&amp; Feminist Studies 155A</td>
<td>Sociology of the Family</td>
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<td>&amp; Feminist Studies 157A</td>
<td>Women in American Society</td>
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<td>&amp; Feminist Studies 162</td>
<td>Critical LGBTQ Studies</td>
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<td>Film Studies 101A-B-C</td>
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<td>Film Studies 146</td>
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<td>Film Studies 191</td>
<td>Film Criticism</td>
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<td>@ Geography 8</td>
<td>Living with Global Warming</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 Men's Issues requirement.  
@ This course applies toward the American Studies requirement.  
^ This course applies toward the European Traditions requirement.
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<td>Native American History, 1838 to Present</td>
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<td>History 164PR</td>
<td>Prosiminar of the History of America's Racial Minorities</td>
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<td>History 165</td>
<td>America in the Gilded Age, 1876 to 1900</td>
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<td>History 166A-B</td>
<td>The American South</td>
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<td>History 167</td>
<td>The American West</td>
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<td>Materials in Society: The Stuff of Dreams</td>
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<td>* Molecular, Cellular, and Developmental Biology 134H</td>
<td>Animal Virology – Honors</td>
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<td>* Molecular, Cellular, and Developmental Biology 138</td>
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<td>* Music 12</td>
<td>Mariculture for the 21st Century</td>
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<td>Biomedical Ethics</td>
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CHECKLIST OF GENERAL UNIVERSITY AND GENERAL EDUCATION REQUIREMENTS

GENERAL UNIVERSITY REQUIREMENTS

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

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

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

One course ________ or Advanced Placement ___________ or International waiver ___________

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

GENERAL EDUCATION REQUIREMENTS

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

General Subject Areas

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

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

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

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

Special Subject Areas

In the process of fulfilling the G.E. General Subject Area requirements, students must fulfill the following Special Subject Area requirements, as outlined on page 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, 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, Mellichamp 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, Associate 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, Associate Professor (molecular simulation, chemical kinetics, catalytic reaction mechanisms, nucleation, electron transfer)
Sussannah 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, Associate Professor (molecular simulation, statistical mechanics, complex materials, protein biophysics)
Todd M. Squires, Ph.D., Harvard, Associate Professor (fluid mechanics, microfluidics, microrheology, complex fluids)
*1 Joint appointment with Materials Engineering
*2 Joint appointment with Mechanical Engineering
*3 Joint appointment with Chemistry and Biochemistry

Emeriti Faculty
Sanjoy Banerjee, Ph.D., University of Waterloo, Professor Emeritus (transport processes, multiphase systems, process safety) *2
Owen T. Hanna, Ph.D., Purdue University, Professor Emeritus (theoretical methods)
Duncan A. Mellichamp, Ph.D., Purdue University, Professor Emeritus (process dynamics and control, digital computer control)
Robert G. Rinker, Ph.D., California Institute of Technology, Professor Emeritus (chemical kinetics, reaction engineering, catalysis)
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 (process dynamics and control, monitoring and fault detection, system identification)
Theofanis G. Theofanous, Ph.D., University of Minnesota, Professor, Center for Risk Studies and Safety Director (transport phenomena in multiphase systems, risk analysis) *2

Affiliated Faculty
Song-I Han, Ph.D. (Chemistry)
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 needs, 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.
• We expect our graduates to demonstrate their flexibility and adaptability in the workplace, so that they remain effective.
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 problems;
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, while recognizing, assessing and mitigating potential hazards; the ability to use modern engineering tools necessary for engineering practice;
4. Advanced Training – knowledge beyond the basic fundamentals in chemical engineering and/or related technical fields as preparation for a continuing process of lifelong learning; 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 educational necessity 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 courses listed above and are entering the junior year of the chemical engineering program may take Chemical Engineering 10 concurrently with Chemical Engineering 120A in the fall quarter.

Chemical Engineering Courses

LOWER DIVISION

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

10. Introduction to Chemical Engineering
    (3) DAUGHERTY, GORDON
    Prerequisites: Chemistry 1A-B-C or 2A-B-C; Mathematics 3A-B and Mathematics 3C or Mathematics 4A; and Engineering 3; chemical engineering majors only. Elementary principles of chemical engineering. The major topics discussed include material and energy balances, stoichiometry, and thermodynamics.

55. Chem-E-Car Activity
    (1) STAFF
    Prerequisite: Chem 1C and 1CL.
    Students apply chemistry and engineering knowledge to design a model-scale, chemically powered car with chemically actuated brakes. The cars represent UCSB at American Institute of Chemical Engineering meetings. Grading is based on participation, design creativity, and car performance.

99. Introduction to Research
    (1-3) STAFF
    Prerequisites: consent of instructor and undergraduate advisor.
    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 98/99/198/199/199DC/199RA courses combined.
    Directed study, normally experimental, to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION

102. Biomaterials and Biosurfaces
    (3) ISRAELACHVILI
    Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.
    Not open for credit to students who have completed Chemical Engineering 121.
    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 equilibria. Liquid-vapor separations calculations are emphasized. Introduction to equations of state for mixtures.

119. Current Events in Chemical Engineering
    (1) STAFF
    Prerequisites: Chemical Engineering 110A-B.
    Assigned readings in technical journals on current events of interest to chemical engineers. Student groups present oral reports on reading assignments pertaining to new technologies, discoveries, industry challenges, society/government issues, professional and ethical responsibilities.

120A. Transport Processes
    (4) STAFF
    Prerequisites: 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) STAFF
    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) STAFF
    Prerequisite: Chemical Engineering 120B; Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B; and Physics 4.
    Introductory course in the fundamentals of mass transfer with applications to the design of mass transfer equipment.

121. Colloids and Biosurfaces
    (3) ISRAELACHVILI
    Recommended Preparation: Basic physical chemistry, chemistry, physics, thermodynamics and biology.
    Not open for credit to students who have completed Chemical Engineering 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
    Prerequisites: Chemical Engineering 120A-B-C or Mechanical Engineering 151A-B; and Chemical Engineering 152A.
    Same course as ME 124.
    Hazard identification and assessments, runaway reactions, emergency relief, Plant accidents and safety issues. Dispersion and consequences of releases.
125. Principles of Bioengineering

(i) MITRAOPOULOS

Applications of engineering to biological and medical systems. Introduction to drug delivery, tissue engineering, and modern biomedical devices. Design and applications of these systems are discussed.

128. Separation Processes

(ii) 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

(iv) FREDRICKSON, GORDON

Prerequisites: Mathematics 5A or Mathematics 4B; Mathematics 5B or Mathematics 6A.


132B. Computational Methods in Chemical Engineering

(iii) FREDRICKSON, GORDON

Prerequisites: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.


132C. Statistical Methods in Chemical Engineering

(i) 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 and application of empirical chemical engineering models using regression techniques, design of experiments, process monitoring based on statistical quality control techniques.

136. Introduction to Multiphase Flows

(v) TEOFANOUS

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

(vi) TEOFANOUS

Prerequisites: Chemical Engineering 120A-B-C; or Mechanical Engineering 151B and 152A.

Same course as ME 138.


140A. Chemical Reaction Engineering

(iii) 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

(iii) CHMELKA, 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 Conversion

(iii) MCFARLAND

Prerequisites: Chemical Engineering 110A and 140A.

Equivalent upper-division coursework in thermodynamics and kinetics from outside of 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

(iv) DOYLE

Prerequisites: Chemical Engineering 120A-B-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

(iv) DOYLE

Prerequisites: 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 multivariable control systems. Introduction to on-line optimization.

154. Engineering Approaches to Systems Biology

(iv) DOYLE

Prerequisites: Chemical Engineering 170 and Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.

Applications of engineering tools and methods to 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 and techniques.

160. Introduction to Polymer Science

(iii) KRAMER

Prerequisites: 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

(iv) SHELL

Prerequisites: Chemical Engineering 120A-B-C, 140A and Chemistry 109C.

Not open for credit to students who have completed CHE 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

(iii) DAUGHERTY

Prerequisites: 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

(iv) DAUGHERTY

Prerequisites: Chemical Engineering 170 or MCB 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

(iii) 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

(iii) 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

(iii) DONHY

Prerequisites: Chemical Engineering 110A-B, 120A-B-C, 128, 132B, 140A-B, and 152A.


184B. Design of Chemical Processes

(iii) DONHY

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

Prerequisites: 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

Prerequisites: 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.
Computer Engineering

Computer Engineering Major, Trailer 380, Room 101; Telephone (805) 893-8615 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)

Tim Sherwood, Ph.D., UC San Diego, Professor (computer architecture, dynamic optimization, network and security processors, embedded systems, program analysis and characterization, and hardware support of software systems)

Dmitri B. Strukov, Ph.D., Stony Brook University, Assistant Professor (hybrid circuits, nanoelectronics, resistance switching devices, memristors, digital memories, programmable circuits, bio-inspired computing)

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 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)

Ben Zhao, Ph.D., University of California, Berkeley, Associate Professor (computer/overlay/mobile networking, large-scale distributed systems, operating systems, network simulation and modeling)

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

The Computer Engineering major’s objective is to educate broadly based engineers with an understanding of digital electronics, computer architecture, system software and integrated circuit design. These topics bridge traditional electrical engineering and computer science curricula. The Computer Engineering degree program is conducted jointly with faculty from the Department of Computer Science and the Department of Electrical and Computer Engineering. Computer engineers emerging from this program will be able to design and build integrated digital hardware and software systems in a wide range of applications areas. Computer engineers will seldom work alone and thus teamwork and project management skills are also emphasized. The undergraduate major in Computer Engineering prepares students for a wide range of positions in business, government and private industrial research, development and manufacturing organizations. Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Faculty advisors are also available to help with academic program planning. Students who hope to change to this major should consult the department advisor.


Mission Statement

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

Educational Objectives

The Computer Engineering Program seeks to produce graduates who:

1) Make positive contributions to society by applying their broad knowledge of computer engineering theories, techniques, and tools.

2) Create processes and products, involving both hardware and software components, that solve societal and organizational problems effectively, reliably, and economically.

3) Are committed to the advancement of science, technical innovation, lifelong learning, professionalism, and mentoring of future generations of engineers.

4) Understand the ethical, social, business, technical, and human contexts of the world in which their engineering contributions will be utilized.

Program Outcomes

Upon completion of this program, students will have:

1) Acquired strong basic knowledge and skills in those fundamental areas of mathematics, science, and engineering necessary to facilitate specialized professional training at an advanced level. Developed a recognition of the need for and the ability to engage in lifelong learning.

2) Experienced in-depth training in state-of-the-art specialty areas in computer engineering.

3) Benefited from hands-on, practical laboratory experiences where appropriate throughout the program. The laboratory experiences will be closely integrated with coursework and will make use of up-to-date instrumentation and computing facilities. Students will have completed both hardware-oriented and software-oriented assignments.

4) Experienced 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 environments. To this end, students must develop communication skills, both written and oral, through teamwork and
Completed a well-rounded and balanced aided design (CAD); computer systems include those with emphasis in: computer-considered acceptable. Sample programs sor. A variety of elective programs will be course program and senior project must be taken primarily in the senior year; they per-
mit students to develop depth in specialty sequences. Each sequence be chosen are:
- Computer Systems Design: ECE/CMPSC 153A, ECE 153B
- Computer Networks: ECE 155A/CMPSC 176A, ECE 155B/CMPSC 176B
- Distributed Systems: ECE 151/CMPSC 171 and one or both of the Computer Networks courses
- Programming Languages: CMPSC 160, 162
- Real-Time Computing & Control: ECE 147A-B, 157
- Multimedia: ECE 178, ECE/CMPSC 181B, ECE 160/CMPSC 182
- VLSI: ECE 124A, 124D
- Signal Processing: ECE 130A-B

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

Computer Engineering Courses
See listings for Computer Science starting on page 25 and Electrical and Computer Engineering starting on page 30.
John R. Gilbert, Ph.D., Stanford University, Professor (combinatorial scientific computing, high-performance graph algorithms, tools and software for computational science and engineering, numerical linear algebra)

Teofil Gonzalez, Ph.D., University of Minnesota, Professor (approximation algorithms; parallel computing; multicasting; scheduling theory; placement and routing; computational geometry; analysis of algorithms)

Ben Hardekopf, Ph.D., University of Texas at Austin, Assistant Professor (programming languages: design, analysis and implementation)

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

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))

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

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

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

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

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 economies for resource allocation and scheduling)

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

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

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

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

Emeriti Faculty

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

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)

Affiliated Faculty

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

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

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

Martin Raubal, Ph.D. (Geography)

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

Mission Statement

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

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

One of the most important aspects of the Computer Science program at UCSB is the wealth of “hands-on” opportunities for students. UCSB has excellent computer facilities. Campus Instructional Computing makes accounts available to all students. Computer Science majors and premajors use the workstations in the Computer Science Instructional Lab and Engineering Computing Infrastructure 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.
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. UCSB students in majors other than computer science major can petition to the Department of Computer Science for consideration for admission via change-of-major once they complete the minimum requirements (specified on the departmental web pages) for doing so. Computer Science majors have priority when registering for all Computer Science courses.

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

Undergraduate Program

Bachelor of Science—Computer Science
A minimum of 184 units is required for graduation. A complete list of requirements for the major can be found on page 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 UCSB) of a grade of B or better of CMPSC 16, 24, and 40.
3. Satisfactory completion (preferably at UCSB) 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 second time in the next quarter. Petitions denied a second time will not be reconsidered.

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

Bachelor of 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: 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 1.
   - Legal repeat for CMPSC 5AA-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, KRINTZ
   - 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 comput-
ing. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging. Recent advances in design and development tools, practices, libraries, and operating system support.

40. Foundations of Computer Science
(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
Prerequisites: 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.

Not open for credit to students who have completed Computer Science 20.

Advanced applications programming using a highlevel, 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 Comments: Course counts as a legal repeat of CMPS 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 1110A.

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, 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
Prerequisite: Computer Science 130A.

Design and analysis of computer algorithms. Correctness proofs and solution of recurrence relations. Design and analysis of 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) EGECIOLGU
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 110B.

Fundamentals of high performance computing and parallel algorithm design for numerical computation. Topics include parallel architecture and clusters, parallel programming with message-passing libraries and threads, program parallelization methodologies, parallel performance evaluation and optimization, parallel numerical algorithms and applications with different performance trade-offs.

153A. Hardware/Software Interface
(4) KRINZ, 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
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) HARDEKOPF, KRINZ
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 generality 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.

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

167. Introduction to Bioinformatics
(4) KRUEGEL, ZHAO
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; distribution of 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 ABBAD
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 Form.

174B. Design and Implementation Techniques of Database Systems
(4) SU, 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, serializability, two-phase locking, timestamping, logging, checkpointing, transaction abort and commit, crash recovery, distributed databases.

176A. Introduction to Computer Communication Networks
(4) ALMOROTH, BULTAN
Prerequisites: PSTAT 120A or ECE 139, CMPSC 32 with a grade of C or better; 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 of networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks.

176B. Network Computing
(4) ZHANG, VIGNA
Prerequisite: Computer Science 176A.
Not open for credit to students who have completed ECE 155B or 194W.
Focus on networking and web technologies used in the Internet. The class covers socket programming and web-based techniques that are used to build distributed applications.

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

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

178. Introduction to Cryptography
(4) EGECIOGLU
Prerequisites: Computer Science 24 and Computer Science 40 with a grade of C or better; and PSTAT 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 130A or consent of instructor.
Overview of OpenGL graphics standard, OpenGL state machine, other 3D graphics libraries, 3D graphics pipeline, 3D transformations and clipping, color model, shading model, shadow algorithms, texturing, curves and curved surfaces, graphics hardware, interaction devices and techniques.

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

182. Multimedia Computing
(4) ALMOROTH, ZHENG
Not open for credit to students who have completed ECE 180.
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) GOLDER
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 systems 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.

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: CMPSC 172 or CMPSC 189A; Senior standing in computer engineering, computer science, or electrical engineering; consent of instructor.
Not open for credit to students who have completed ECE 189A or ECE 189B.
Student groups design a significant computer-based project. Multiple groups may cooperate toward one large project. Each group works independently; interaction among groups is via interface specifications and informal meetings. Project for course may be different from that in first course.

190AA-2Z. 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 8 units with consent of the department chair but only 4 units may be applied to the major.
Projects in computer science for advanced undergraduate students.

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

196. Undergraduate Research
(1-4) STAFF
Prerequisites: upper-division standing, 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. 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.
May 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: Joao Hespanha
Vice Chair: B.S. Manjunath

Faculty

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

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, photonic packet switching, signal processing in semiconductor optical devices, wavelength conversion, microwave photonics)

John E. Bowers, Ph.D., Stanford University, Professor (high-speed photonic and electronic devices and integrated circuits, fiber optic communication, semiconductors, laser physics and mode-locking phenomena, compound semiconductor materials and processing)

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) 1

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 semiconductors, indium phosphide and gallium nitride, photonic devices) 1

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

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

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

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

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

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

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)

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

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

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

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

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

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

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 holography, 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)

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)
Affiliated Faculty

David Awschalom, Ph.D. (Physics)
Elizabeth Belding, Ph.D. (Computer Science)
Francesco Bullo, Ph.D. (Mechanical Engineering)
Frederick Chong, Ph.D. (Computer Science)
Chandra Krintz, Ph.D. (Computer Science)
Eric McFarland, Ph.D. (Chemical Engineering)
Shoji Nakamura, Ph.D. (Materials)
Bradley E. Paden, Ph.D. (Mechanical Engineering)
Tim Sherwood, Ph.D. (Computer Science)
Hyongsook Tom Soh, Ph.D. (Mechanical Engineering)

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 strength in the fundamental principles but also experience with the practical skills that are needed to contribute to the complex technological infrastructure of our society. This approach will enable each of our graduates to continue learning throughout an extended career.

• 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.

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

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

The undergraduate major in Electrical Engineering prepares students for a wide range of positions in business, government, and private industrial research, development, and manufacturing organizations. Students who complete a major in electrical engineering may be eligible to pursue a California teaching credential. Interested students should consult the credential advisor in the Graduate School of Education.

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College 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.

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

1. We expect our graduates to make positive contributions to society in fields including, but not limited to, engineering.
2. We expect our graduates to have acquired the ability to be flexible and adaptable, showing that their educational background has given them the...
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 for the ability to understand the impact of engineering solutions in a global and societal context. A course in engineering ethics is also required of all undergraduates.

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 course program must be approved by a departmental faculty advisor. The advisor will check the program to ensure satisfaction of the departmental requirements. A wide variety of elective programs will be considered acceptable.

Three matters should be noted: (1) students who fail to attain a grade-point average of at least 2.0 in the major may be denied the privilege of continuing in the major, (2) a large majority of electrical and computer engineering courses have prerequisites which must be completed successfully. Successful completion of prerequisite courses means receiving a grade of C- or better in prerequisite courses except for Mathematics 3A-B-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

1A. Computer Engineering Seminar
(1) STAFF
Prerequisite: open to pre-computer engineering and computer engineering majors only. Seminar: 1 hour. Introductory seminar to expose students to a broad range of topics in Computer Engineering.

1B. Ten Puzzling Problems in Computer Engineering
(1) PARHAMI
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; diodes and I-V characteristics; basic op-amp circuits; first-order transient analysis; AC analysis and phasors. Introduction to the use of test instruments.

2B. Circuits, Devices, and Systems
(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 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: 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-ZZ. Group Studies in Electrical and Computer Engineering

(1-4) STAFF
Prerequisite: consent of instructor.

Group studies intended for small number of advanced students who share an interest in a topic not included in the regular departmental curriculum.

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

123. High-Performance Digital Circuit Design
(4) THEOGARAJAN
Prerequisite: ECE 2A-B-C with a minimum grade of C- in each of those courses; open to both electrical engineering and computer engineering majors only.
Introduction to high-performance digital circuit design techniques. Basics of device physics including deep submicron effects; device sizing and logical effort; Circuit design styles; clocking & timing issues; memory & datapath design; Low-power design; VLSI design flows and associated EDA tools.

124A. VLSI Principles
(4) BANERJEE
Prerequisite: ECE 132 (may be taken concurrently) and ECE 152A with a minimum grade of C- in both.
Introduction to CMOS digital VLSI design: MOS 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; System considerations in combinatorial and sequential circuits; arithmetic operations and memories.

124B. Integrated Circuit Design and Fabrication
(4) BOWERS
Prerequisite: 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
(4) BOWERS
Prerequisite: 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 using commercial layout software. Circuits are fabricated using modern VLSI processing techniques. Circuit and discrete device electrical performance are analyzed.

124D. VLSI Architecture and Design
(4) BREWER
Prerequisite: 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 interfacing standards, electrical packaging for high-speed and high-performance design. On-chip noise and crosstalk, clock and power distribution, architectural and circuit design constraints, interconnection limits and transmission line effects.

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

130A. Signal Analysis and Processing
(4) MADHOW
Prerequisite: Mathematics 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) CHANDRASEKARAN
Prerequisite: ECE 130A with a grade of C- or better; open to EE and computer engineering majors only.
Lecture, 3 hours; discussion, 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) CHANDRASEKARAN
Prerequisite: 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: Gaussian estimation, vector spaces and linear equations, orthogonality, determinants, eigenvalues and eigenvectors, systems of linear differential equations, positive definite matrices, singular value decomposition.

132. Introduction to Solid State Electronic Devices
(4) MISHRA
Prerequisite: Physics 4 or 24 with a minimum grade of C-; Mathematics 5A 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 capacitance; 2 hours.
Introduction of bipolar transistors, MOSFET’s and JFET’s.

134. Introduction to Fields and Waves
(4) DAGLI, YORK
Prerequisite: Physics 3 or 23 with a minimum grade of C; 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 electron circuits and systems. Wave on transmission-lines, elements of electrodynamics and magnetostatics; optical fibers, filter designs, and applications to RF, microwave, and optical systems.

135. Optical Fiber Communication
(4) DAGLI
Prerequisite: ECE 132 and 134 with a minimum grade of C- in both.
Lecture, 3 hours; discussion, 1 hour.
Optical fiber as a transmission medium, dispersion and nonlinear effects in fiber transmission, fiber and semiconductor optical amplifiers and lasers, optical modulators, photo detectors, optical receivers, wavelength division multiplexing components, optical fibers, basic transmission system analysis and design.

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

137B. Circuits and Electronics II
(4) RODWELL
Prerequisite: 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
(4) ILTIS
Prerequisite: Open to Electrical Engineering, Computer Engineering and Pre-Computer Engineering majors only. Lecture, 3 hours; discussion, 2 hours.
Fundamentals of probability, conditional probability, Bayes rule, random variables, functions of random variables, expectation and high-order moments, Markov chains, hypothesis testing.

141A. Introduction To Nanoelectro-mechanical and Microelectromechanical Systems (NEMS/MEMS)
(4) PENNATHUR, TURNER
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 as ECE 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
(4) PENNATHUR, TURNER
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- and capacitive elements, and pressure sensors.

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

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

144. Electromagnetic Fields and Waves
(4) YORK
Prerequisite: ECE 134 with a minimum grade of C-.
Lecture, 3 hours; laboratory, 3 hours.
Waves on transmission lines, Maxwell’s equations, skin effect, propagation and reflection of electromagnetic waves, microwave integrated circuit and CAD software.

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

145C. Communication Electronics III
(5) STAFF
Prerequisites: ECE 137B with a minimum grade of C-. Lecture, 4 hours.

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

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

147C. Control System Design Project
(5) HESPAHNA
Prerequisite: ECE 147A or ME 159B 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 communications, 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) ILTIS
Prerequisite: Upper-division standing; open to EE majors only.
Designed for juniors to take right after ECE 130AB. 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, distributed networks, sensitivity and the modern design techniques, and applications of active filters.

150. Mobile Embedded Systems
(4) CHENG
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) KODOPLO
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.

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

153B. Sensor and Peripheral Interface Design
(4) BUTNER
Prerequisite: 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 design; 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) PARRAH
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, multiprocessor designs; Cache and virtual memory, Disk arrays; Shared- and distributed-memory systems, supercomputers, Reconfigurable and application-specific circuits.

155A. Introduction to Computer Networks
(4) MOSER
Prerequisite: ECE 154 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 12 or 60 with a minimum grade of C-.
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 networked applications in Java.

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

156B. Computer-Aided Design of VLSI Circuits
(4) WANG
Prerequisite: ECE 156A with a minimum grade of C-.
Introduction to computer-aided simulation and synthesis tools for VLSI. 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
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
Prerequisites: upper-division standing; open to EE, computer engineering, computer science, and creative studies majors only. Lecture, 3 hours; laboratory, 3 hours.
Introduction to multimedia and applications, including WWW, image/video databases and video streaming. Covers media content analysis, media data organization and indexing (image/video databases), and media data distribution and interaction (video-on-demand and interactive TV).

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

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

162C. Optoelectronic Materials and Devices
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
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
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.

179F. Introduction to Robotics: Planning and Kinematics
Prerequisites: ENGR 3; and either ME 17 or ECE 130C (may be taken concurrently). Not open for credit to student who have completed Mechanical Engineering 170A or ECE 181A.
Motion planning and kinematics topics with an emphasis on geometric reasoning, planning, 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
Prerequisite: 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
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
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
Prerequisites: ECE 168A 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.

193. Internship in Industry
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.

194AA-ZZ. Special Topics in Electrical and Computer Engineering
Prerequisite: consent of instructor. Variable hours.

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

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

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

LOWERING DIVISION

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

99. Introduction to Research (1-5) 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. All 98/99/198/199/199A-AA 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.

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.

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

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 interactions, imaging/telecommunications, human spaceflight history, reduced/alternating gravity experimentation, space systems design/ utilization.

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

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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 100B. Students interested in following the BS Engineering/MS Materials program should not take this course.

135. Biophysics and Biomolecular Materials
(3) SAFIYAH
Prerequisites: Physics 5 or 6C or 25.
Same course as Physics 135.
Structure and function of cellular molecules (lipids, nucleic acids, proteins, and carbohydrates). Genetic engineering techniques of molecular biology. Biomolecular materials and biomedical applications (e.g., bio-sensors, drug delivery systems, gene carrier systems).

160. Introduction to Polymer Science
(3) KRAMER
Prerequisite: Chemistry 109A-B.
Same course as Chemical Engineering 160.
Introductory course covering synthesis, characterization, structure, and mechanical properties of polymers. Emphasis 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, Schrodinger’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) CORDER, 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
Prerequisite: Materials 100B or 101.
Same course as ME 185. Lecture, 3 hours.
Introduces the student to the main families of materials and the principles behind their development, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials
(3) LEVIN
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) VANDERGRIMM
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: Francesco Bullo
Vice Chair: Frederic Gibou

Faculty

Bassam Bamieh, Ph.D., Rice University, Professor (control systems design with applications to fluid flow problems)
Matthew R. Begley, Ph.D., University of California, Santa Barbara, Professor (mechanics of materials with applications to multilayered devices such as microfluidics, MEMS and protective coatings)
Glenn E. Beltz, Ph.D., Harvard, Professor (solid mechanics, materials, aeronautics, engineering education)
Ted D. Bennett, Ph.D., UC Berkeley, Associate Professor (thermal science, laser processing)
David Bothman, B.S., UC San Diego, Lecturer
Francesco Bullo, Ph.D., California Institute of Technology, Professor (motion planning and coordination, control systems, distributed and adaptive algorithms)
Otger 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)
Stephen Laguette, M.S., University of California, Los Angeles, Lecturer (biomedical engineering design)
Carlos Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (conceptual design, synthesis and evolution in service of structural and inorganic materials, especially for high temperature applications)
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. Meinhart, 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, 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)

Linda R. Petzold, Ph.D., University of Illinois at Urbana-Champaign, Professor, Director of Computational Science and Engineering Graduate Emphasis (computational science and engineering; systems biology)  *2

Hyongsok Tom Soh, Ph.D., Stanford University, Professor (microelectromechanical systems, integrated biosensors, multi-functional biomaterials)

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)  *3

Roy S. Hickman, Ph.D., UC Berkeley, Professor Emeritus (fluid mechanics, physical gas dynamics, computer-aided design)

George Homsy, Ph.D., University of Illinois, Professor Emeritus (hydrodynamic stability, thermal convection, thin film hydrodynamics, flow in microgeometries and in porous media, polymer fluid mechanics)

Keith T. Redward, Ph.D., University of Wales, Professor (design of composite systems)

Wilbert J. lick, Ph.D., Rensselaer Polytechnic Institute, Professor Emeritus (oceanography and limnology, applied mathematics)

Noel C. MacDonald, Ph.D., UC Berkeley, Kavli Professor in MEMS Technology (microelectromechanical systems, applied physics, materials, mechanics, nanofabrication)  *3

Ekkehard P. Marschall, Dr. Ing., Technische Hochschule Hannover, Professor Emeritus (thermodynamics, heat and mass transfer, desalination, energy conversion, experimental techniques)

Stephen R. McLean, Ph.D., University of Washington, Professor Emeritus (fluid mechanics, physical oceanography, sediment transport)

Frederick Milstein, Ph.D., UC Los Angeles, Professor Emeritus (mechanical properties of materials)  *3

Thomas P. Mitchell, Ph.D., California Institute of Technology, Professor Emeritus (theoretical and applied mechanics)

Marshall Tulin, M.S., Massachusetts Institute of Technology, Professor Emeritus, Ocean Engineering Laboratory Director (hydrodynamics, aerodynamics, turbulence, cavitation phenomena, drag reduction in turbulent flows)

Theofanis G. Theofanous, Ph.D., University of Minnesota, Professor, Director of Center for Risk Studies and Safety (nuclear and chemical plant safety, multiphase flow, thermal hydraulics)  *1

Walter W. Yuen, Ph.D., UC Berkeley, Professor (thermal science, radiation heat transfer, heat transfer with phase change, combustion)

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

Affiliated Faculty

Paul J. Atzberger (Mathematics)

Katie A. Byl (Electrical and Computer Engineering)

Patricia Holden (Bren School of Environmental Science and Management)

Arturo Keller (Bren School of Environmental Science and Management)

L. Gary Leal (Chemical Engineering)

The undergraduate program in mechanical engineering is accredited by the Engineer ing 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:

• Successfully practice in either the traditional or the emerging technologies comprising mechanical engineering;

• Are successful in a range of engineering graduate programs including those in mechanical, environmental and materials engineering;

• Have a solid background in the fundamentals of engineering allowing them to pass the Fundamentals of Engineering examination;

• 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: microscopic 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.
Mechanical Engineering

LOWER DIVISION

6. Basic Electrical and Electronic Circuits

(4) STAFF
Prerequisite: 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. Develop CAD 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, computer aided design, numerical control programming.

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- dimensions; analysis of frames, machines, trusses and beams; distributed forces; friction.

15. Strength of Materials

(4) BELTZ, KEDWARD
Prerequisite: 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, MEZIC, BAMBIEH
Prerequisite: 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 163.


17. Mathematics of Engineering

(3) MOHELIS, GIROU
Prerequisite: Engineering 3; Mathematics 5B or 6A; (may be taken concurrently); open to ME majors only.

May be repeated concurrently.

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 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. PI/ 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) BAMBIEH, PADOEN
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 1006.

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) BAMBIEH
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
Prerequisite: 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 thermo/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
Prerequisite: ME 14 and 152A.

Concepts from aerodynamics, including lift and drag analysis for airfoils as well as aircraft sizing/scaling issues. Structural mechanics concepts
112. Energy
(3) MATTHYS, MARSHALL
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) THEOFANOUS
Prerequisites: Chemical Engineering 120A-B-C, or ME 151A-B and ME 152A.
Same course as Chemical Engineering 124.

125AA-ZZ. Special Topics in Mechanical Engineering
(3) 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.

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

134. Advanced Thermal Science
(3) MATTHYS, 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 techniques, materials processing, manufacturing, engines, HVAC, non-Newtonian fluids, etc.

136. Introduction to Multiphase Flows
(3) THEOFANOUS
Prerequisites: Chemical Engineering 120A-B-C; or, ME 151C and 152A.
Same course as Chemical Engineering 136.

140A. Numerical Analysis in Engineering
(3) MOEHLIS, GIBOU, MEIBURG
Prerequisites: ME 17 with a minimum grade of C- or Chemical Engineering 132A; open to ME and Chemical Engineering majors only.
Numerical analysis and 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) MOEHLIS, GIBOU, MEIBURG
Prerequisites: 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
Prerequisites: 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.

141B. MEMS: Processing and Device Characterization
(3) TURNER, PENNATHUR
Prerequisites: ME 141A, ME 163 (may be concurrent); or ECE 141A.
Same course as ECE 141B.

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.

146. Molecular and Cellular 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) BENNET
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
(3) BENNET
Prerequisites: ME 151A and 152A
Introduction to heat transfer processes, steady and unsteady state conduction, multidimensional analysis. Introduction to convective heat transfer. (W)

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

152A. Fluid Mechanics
(4) MEINHART, PENNATHUR
Prerequisites: 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.
158. Computer Aided Design and Manufacturing
188. BOTH
Prerequisites: ME 10 and 156A; open to ME majors only.
Geometric 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) PADEN
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 electromechanical problems, developing skills in brainstorming, concept selection, spatial reasoning, teamwork and communication. Robots are controlled with micro-controllers using C programming interfaced to sensors and 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
Prerequisites: Materials 100B or 101.
Same course as Materials 185. Introduces the student to the main families of materials and the principles behind their development, selection, and behavior. Discusses the generic properties of metals, ceramics, polymers, and composites more relevant to structural applications. The relationship of properties to structure and processing is emphasized in every case.

186. Manufacturing and Materials
3) LEVI, 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.

193. Internship in Industry
1) STAFF
Prerequisites: consent of instructor and prior departmental approval needed.
Not open for credit to students who have completed ME 189A-B-C. 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.

ME 189C. Capstone Mechanical Engineering Design Project
2) LAGUETTE
Prerequisites: ME 189A-B-C
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.

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
(1-5) 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.
The Technology Entrepreneurship Professional Certificate

The Technology Entrepreneurship Professional Certificate program provides students a solid foundation in business fundamentals and entrepreneurship as it applies to new technologies and technology-oriented companies. This certificate serves as an official recognition that the student has a solid grounding in fundamental business strategies and models, opportunity recognition and new-venture creation, entrepreneurial marketing and finance, foundations of team building, organization behavior and talent management.

Students will gain an understanding of the wide range of concepts and business principles considered during start-up, growth, and operation of technology-oriented companies. The program provides access to many professionals familiar with the demands of starting new businesses as well as running existing companies. Students will be able to directly apply their knowledge from TEC courses to operate effectively in the business environment or launch a new venture.

TMP also offers an undergraduate Technology Entrepreneurship certificate in partnership with UC Extension.

Technology Management Program Courses

TMP 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.
Enrollment Comments: Quarters usually offered: Fall, Winter, Spring. “Writing 50 or equivalent” in the prerequisites is intended to include: ENGL 10, WRIT 50*, WRIT 105*, WRIT 107* & WRIT 109*
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.

TMP 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.

TMP 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 time 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.

TMP 124. Entrepreneurial Marketing
(2) STAFF
(Offered through UC Extension)
Prerequisite: Writing 2 with a minimum grade of B- and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*), 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 and organization is critical to the organization’s success.

TMP 126. New Venture Finance
(2) STAFF
(Offered through UC Extension)
Recommended Preparation: Economics 3A or equivalent.
Prepares students for the strategic planning and understanding of financial information particular to new ventures. Provides insight into how financial information can be used to design optimal financing strategies, prepare valuation models for new ventures, and assist in strategic planning for the venture.

TMP 127. Organization Teams and Talent Management
(3) STAFF
(Offered through UC Extension)
Prerequisite: Writing 2 with a minimum grade of B and Writing 50 with a minimum grade of B or equivalent, upper division standing.
Focuses on the important link between the business and talent strategy including talent value chain, recruitment/selection strategies for rewards/incentives, employee relations, leadership and team formation; conflict resolution, problem solving, and decision-making, importance of organization culture; culture diversity and global village.

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

TMP 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.
Focuses on the important link between the business and talent strategy including talent value chain, recruitment/selection strategies for rewards/incentives, employee relations, leadership and team formation; conflict resolution, problem solving, and decision-making, importance of organization culture; culture diversity and global village.

TMP 132. Business Planning for New Ventures
(4) STAFF
Prerequisite: Engineering 120 or Engineering 122; and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B-.
Analysis and creation of a business plan for a new business venture including demand forecasting, financial modeling, of the new business idea, and other issues for current business conditions.

TMP 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.
TMP 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.

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

TMP 144. Market Research for Business
(3) STAFF
Prerequisite: Writing 2 with a minimum grade of B, and Writing 50 or equivalent with a minimum grade of B, and upper division standing.
Enrollment Comments: Students must have a cumulative 3.0 for the proceeding 3 quarters.
Quarters usually offered: Winter, Spring.
Provides a high level introduction to modern marketing research. Course will cover the fundamental principles and techniques for market validation that are critical to launch, grow, and sustain a viable business.

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

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

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

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

GRADUATE COURSES
Graduate courses for this program can be found in the UCSB General Catalog.
### CHEMICAL ENGINEERING 2013-14

#### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
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<td>CH E 10</td>
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<tr>
<td>CH E 12A, 1B, 1C, or 2A, 2B, 2C</td>
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<td>CHEM 6A-B</td>
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#### UNIVERSITY REQUIREMENTS

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

**General Subject Areas**

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<tr>
<th>Area</th>
<th>Courses</th>
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<tr>
<td>A-1</td>
<td>(2 required)</td>
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<tr>
<td>A-2</td>
<td>(2 required)</td>
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</table>

| Areas D & E: Social Sciences, Culture and Thought | (2 courses minimum) |
| Areas F & G: The Arts, Literature | (2 courses minimum) |

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

#### Special Subject Areas

<table>
<thead>
<tr>
<th>Subject</th>
<th>Courses</th>
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<tr>
<td>Depth</td>
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<tr>
<td>Ethnicity (1 course):</td>
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<tr>
<td>European Traditions (1 course):</td>
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#### NON-MAJOR ELECTIVES

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<td>MATRL 101 or MATRL 100B</td>
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Total units required for graduation: 194

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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 2013-14

## FRESHMAN YEAR

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<th>FALL</th>
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<td>CHEM 1CL or 2CC</td>
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<td>or ENGR 3</td>
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**TOTAL** 17/18 17 16/17

## SOPHOMORE YEAR

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<td>CHEM 109C</td>
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<tr>
<td>PHYS 3</td>
<td>3</td>
<td>MATH 6A</td>
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<td>MATH 6B</td>
<td>4</td>
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<tr>
<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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**TOTAL** 15 18 18

## JUNIOR YEAR

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<td>CH E 120A</td>
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<td>CH E 132C</td>
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<td>CH E 140A</td>
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<td>CH E 128</td>
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<td>CHEM 113B</td>
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<td>CH E 180A</td>
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<td>CH E 132A</td>
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<td>CHEM 113C</td>
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<td>Technical or Free Elective</td>
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**TOTAL** 16 16 16

## SENIOR YEAR

<table>
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</thead>
<tbody>
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<td>G.E. Elective</td>
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</tbody>
</table>

**TOTAL** 16 14 14

* 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 2013-14

## PREPARATION FOR THE MAJOR

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<th>Course</th>
<th>Units</th>
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<td>CMPSC 24</td>
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<td>CMPSC 32</td>
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<td>CMPSC 40</td>
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## UPPER DIVISION MAJOR

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<tr>
<td>CMPSC 170</td>
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<td>ECE 139 or PSTAT 120A</td>
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<td>ECE 152A</td>
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<td>ECE 154A</td>
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<tr>
<td>ECE 156A</td>
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<tr>
<td>ENGR 101</td>
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</table>

Computer Engineering electives selected from the following list: ___________40__

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

Must include at least 2 sequences and 8 units of senior computer systems project CMPSC 189 A-B/ECE 189A-B.

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<tr>
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<th>Units</th>
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<td>CMPSC 138</td>
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<tr>
<td>CMPSC 153A/ECE 153A</td>
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<td>CMPSC 160</td>
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<td>CMPSC 162</td>
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<tr>
<td>CMPSC 165A-B</td>
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<tr>
<td>CMPSC 171/ECE 151</td>
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<tr>
<td>CMPSC 176C</td>
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<td>CMPSC 177</td>
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<tr>
<td>CMPSC 178</td>
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<tr>
<td>CMPSC 181B/ECE 181B</td>
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Computer Engineering electives taken:

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<th>Units</th>
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</thead>
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## UNIVERSITY REQUIREMENTS

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<tr>
<th>Requirement</th>
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<tr>
<td>American History and Institutions – (one 4-unit course)</td>
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<tr>
<td>UC Entry Level Requirement: English Composition</td>
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<td>Must be fulfilled within three quarters of matriculation</td>
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<td>Satisfied by:</td>
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## GENERAL EDUCATION

### General Subject Areas

- **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

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<th>Course</th>
<th>Units</th>
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General Education and Free Electives taken:

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TOTAL UNITS REQUIRED FOR GRADUATION ...... 190

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.
# COMPUTER ENGINEERING 2013-14

## FRESHMAN YEAR

<table>
<thead>
<tr>
<th></th>
<th>FALL units</th>
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<td>CHEM 1AL or 2AC</td>
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<td>Math, Science,</td>
<td>ECE 1B</td>
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<tr>
<td>MATH 3A</td>
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<td>or Engr. Elective</td>
<td>MATH 4A</td>
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<tr>
<td>G.E. Elective or CMPSC 8¹</td>
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<td>MATH 3B</td>
<td>PHYS 2</td>
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<tr>
<td>WRIT 1E or 2E</td>
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## SOPHOMORE YEAR

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<td>CMPSC 32</td>
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<td>ECE 2C</td>
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## JUNIOR YEAR

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</table>

¹ CMPS 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.
## Preparation for the Major

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<thead>
<tr>
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<td>CMPSC 64</td>
<td>4</td>
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<tr>
<td>MATH 3A-B</td>
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<tr>
<td>MATH 4A-B</td>
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<td>MATH 6A</td>
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**Upper Division Major**

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<td>CMPSC 138</td>
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<td>CMPSC 154</td>
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<td>CMPSC 162</td>
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<td>PSTAT 120B</td>
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Major Field Electives: 20 units

Prior approval of the student's major field electives must be obtained from the undergraduate adviser.

### Science Courses

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## University Requirements

### General Education

**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:**

### Upper Division Major

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<td>3</td>
</tr>
<tr>
<td>PSTAT 120B</td>
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Major Field Electives: 20 units

Prior approval of the student's major field electives must be obtained from the undergraduate adviser.

### Special Subject Areas

- **Depth:**
- **Ethnicity (1 course):**
- **European Traditions (1 course):**
- **Writing (4 courses required):**

### Non-Major Electives

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**Total Units Required for Graduation:** 184

---

1. CMPSC 111 or CMPSC 140 can be used as an elective if not taken as a major course.
2. Four units maximum from CMPSC 192 and CMPSC 196 combined; only for students with GPA of 3.0 or higher.

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.
## COMPUTER SCIENCE 2013-14

### FRESHMAN YEAR

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<tbody>
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<td>MATH 3B</td>
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<td>MATH 4A</td>
<td>4</td>
</tr>
<tr>
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<td>PHYS 1</td>
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<td>PHYS 2</td>
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<tr>
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<td>WRIT 1, 2, or G.E. Elective</td>
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### SOPHOMORE YEAR

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<th>SPRING</th>
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<td>CMPSC 40</td>
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<td>CMPSC 56</td>
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<td>PSTAT 120A</td>
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<td>MATH 4B</td>
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<td>MATH 6A</td>
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<tr>
<td>PHYS 3</td>
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<td>WRIT 50</td>
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### JUNIOR YEAR

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<th>SPRING</th>
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</thead>
<tbody>
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<td>Free Elective</td>
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<td>Field or Free Elective</td>
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<td>G.E. Elective</td>
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### SENIOR YEAR

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</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.
# ELECTRICAL ENGINEERING 2013-14

## PREPARATION FOR THE MAJOR

<table>
<thead>
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<th>Course</th>
<th>Units</th>
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<td>CMPSC 24</td>
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<td>ECE 15A</td>
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<td>ENGR 3</td>
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<td>MATH 3A-B, 4A-B, 6A-B</td>
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<tr>
<td>PHYS 1, 2, 3, 3L, 4, 4L, 5, 5L</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)
- **UC Entry Level Requirement: English Composition**
  - Must be fulfilled within three quarters of matriculation
  - Satisfied by:

## GENERAL EDUCATION

### 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

## UPPER DIVISION MAJOR

<table>
<thead>
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<th>Course</th>
<th>Units</th>
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<tr>
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<td>ECE 152A</td>
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</table>

**Departmental electives selected from the following list:** ____________________

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

### Approved Departmental Electives:

- ECE 123
- ECE 124A-B-C-D
- ECE 125
- ECE 130C
- ECE 135
- ECE 141A-B-C
- ECE 142
- ECE 144
- ECE 145A-B-C
- ECE 146A-B
- ECE 147A-B-C

### Departmental Electives taken:

- ____________________
- ____________________
- ____________________
- ____________________

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

## TOTAL UNITS REQUIRED FOR GRADUATION

... 194
### FRESHMAN YEAR

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### SOPHOMORE YEAR

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### JUNIOR YEAR

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### SENIOR YEAR

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<tr>
<td>TOTAL</td>
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</tbody>
</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 2013-14

### Preparation for the Major

<table>
<thead>
<tr>
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<th>Units</th>
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<td>ME 16</td>
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<td>ME 17</td>
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### Upper Division Major

<table>
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<tr>
<td>ME 163</td>
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</tbody>
</table>

* see note on next page

### Third Year

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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<tbody>
<tr>
<td>MATRL 101 or MATRL 100B*</td>
<td>3</td>
</tr>
<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>
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<tr>
<td>ME 153</td>
<td>3</td>
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<td>ME 155A</td>
<td>3</td>
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<td>ME 163</td>
<td>3</td>
</tr>
<tr>
<td>ME 154</td>
<td>3</td>
</tr>
<tr>
<td>ME 156A-B</td>
<td>6</td>
</tr>
<tr>
<td>ME 189A-B-C</td>
<td>6</td>
</tr>
<tr>
<td>Engineering Electives</td>
<td>15</td>
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</tbody>
</table>

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

### Fourth Year

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>CHEM 109A</td>
<td>ME 110</td>
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<tr>
<td>ME 111</td>
<td>ME 155B</td>
</tr>
<tr>
<td>ME 112</td>
<td>ME 156</td>
</tr>
<tr>
<td>ME 114</td>
<td>ME 162</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>ME 119</td>
</tr>
<tr>
<td>ENGR 103, TMP 120,</td>
<td>ME 124</td>
</tr>
<tr>
<td>TMP 122 (max 1 course)</td>
<td>ME 125AA-ZZ</td>
</tr>
<tr>
<td>ENV S 105</td>
<td>ME 128</td>
</tr>
<tr>
<td>ME 132</td>
<td>ME 169</td>
</tr>
<tr>
<td>MATRL 100A</td>
<td>ME 132</td>
</tr>
<tr>
<td>MATRL 100C</td>
<td>ME 134</td>
</tr>
<tr>
<td>MATRL 100C</td>
<td>ME 136</td>
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<tr>
<td>MATRL 186</td>
<td>ME 138</td>
</tr>
<tr>
<td>MATRL 188</td>
<td>ME 140B</td>
</tr>
<tr>
<td>ME 140A-B-C</td>
<td>ME 141A-B-C</td>
</tr>
<tr>
<td>1 Four units maximum from ME 197 and ME 199 combined.</td>
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</table>

### Approved Engineering Electives:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CHEM 109A</td>
<td>ME 110</td>
</tr>
<tr>
<td>ME 111</td>
<td>ME 155B</td>
</tr>
<tr>
<td>ME 112</td>
<td>ME 156</td>
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<td>ME 114</td>
<td>ME 162</td>
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<tr>
<td>ENGR 101</td>
<td>ME 119</td>
</tr>
<tr>
<td>ENGR 103, TMP 120,</td>
<td>ME 124</td>
</tr>
<tr>
<td>TMP 122 (max 1 course)</td>
<td>ME 125AA-ZZ</td>
</tr>
<tr>
<td>ENV S 105</td>
<td>ME 128</td>
</tr>
<tr>
<td>ME 132</td>
<td>ME 169</td>
</tr>
<tr>
<td>MATRL 100A</td>
<td>ME 132</td>
</tr>
<tr>
<td>MATRL 100C</td>
<td>ME 134</td>
</tr>
<tr>
<td>MATRL 100C</td>
<td>ME 136</td>
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<td>MATRL 186</td>
<td>ME 138</td>
</tr>
<tr>
<td>MATRL 188</td>
<td>ME 140B</td>
</tr>
<tr>
<td>ME 140A-B-C</td>
<td>ME 141A-B-C</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
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<tbody>
<tr>
<td>General Education and Free Electives taken:</td>
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</table>

### Total Units Required for Graduation

... 190
## MECHANICAL ENGINEERING 2013-14

### FRESHMAN YEAR

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

<table>
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<th>WINTER</th>
<th>SPRING</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
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<td>MATH 6A</td>
<td>MATH 6B</td>
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<td>ME 14</td>
<td>ME 6</td>
<td>ME 16</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 3</td>
<td>ME 15</td>
<td>ME 17</td>
<td>3</td>
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<tr>
<td>PHYS 3L</td>
<td>PHYS 4</td>
<td>G.E. Elective</td>
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<td>G.E. Elective</td>
<td>PHYS 4</td>
<td>G.E. Elective</td>
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**JUNIOR YEAR**

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
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<th>Units</th>
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<tbody>
<tr>
<td>ME 104</td>
<td>MATRL 101 or</td>
<td>ME 105</td>
<td>3</td>
</tr>
<tr>
<td>ME 140A</td>
<td>MATRL 100B*</td>
<td>ME 153</td>
<td>3</td>
</tr>
<tr>
<td>ME 151A</td>
<td>ME 151B</td>
<td>ME 151C</td>
<td>3</td>
</tr>
<tr>
<td>ME 152A</td>
<td>ME 152B</td>
<td>ME 155A</td>
<td>3</td>
</tr>
<tr>
<td>G.E. or Free Elective</td>
<td>ME 163</td>
<td>G.E. or Free Elective</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>18</strong></td>
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**SENIOR YEAR**

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 154</td>
<td>ME 156B</td>
<td>ME 189C</td>
<td>3</td>
</tr>
<tr>
<td>ME 156A</td>
<td>ME 189B</td>
<td>Departmental Electives</td>
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</tr>
<tr>
<td>ME 189A</td>
<td>Departmental Electives</td>
<td>G.E. or Free Electives</td>
<td>6</td>
</tr>
<tr>
<td>Departmental Electives</td>
<td>G.E. or Free Elective</td>
<td>G.E. or Free Electives</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</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></td>
<td>(805) 893-2809</td>
<td><a href="mailto:coe-info@engr.ucsb.edu">coe-info@engr.ucsb.edu</a></td>
<td>Frank Hall, Rm. 1006</td>
</tr>
<tr>
<td>Departmental Advisors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>Laura Crownover 893-8671</td>
<td><a href="mailto:laura@engr.ucsb.edu">laura@engr.ucsb.edu</a></td>
<td>Engr.II, Rm. 3357</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>Alex Reyes 893-8292</td>
<td><a href="mailto:ugradinfo@ece.ucsb.edu">ugradinfo@ece.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Computer Science</td>
<td>Benji Dunson 893-4321</td>
<td><a href="mailto:ugradv@cs.ucsb.edu">ugradv@cs.ucsb.edu</a></td>
<td>Frank Hall, Rm. 2104</td>
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<tr>
<td>Electrical Engineering</td>
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<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>Suzi See 893-8198</td>
<td><a href="mailto:meugrad@engr.ucsb.edu">meugrad@engr.ucsb.edu</a></td>
<td>Engr.II, Rm. 2335</td>
</tr>
<tr>
<td>Technology Management</td>
<td>Diana Doyle 893-2729</td>
<td><a href="mailto:ddoyle@tmp.ucsb.edu">ddoyle@tmp.ucsb.edu</a></td>
<td>Phelps 1333</td>
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Notes
Notes