2014-2015 Academic Calendar
Note: Dates subject to change without notice.

2014 - 2015 Campus Holidays
Labor Day: Monday, September 1, 2014
Veterans’ Day: Tuesday, November 11, 2014
Thanksgiving: Thursday & Friday, November 27 & 28, 2014
Christmas: Thursday & Friday, December 24 & 25, 2014
New Year: Wednesday & Thursday, December 31, 2014 & January 1, 2015
Martin Luther King, Jr.’s Birthday: Monday, January 19, 2015
Presidents’ Holiday: Monday, February 16, 2015
Cesar Chavez Holiday: Friday, March 27, 2015
Memorial Day: Monday, May 25, 2015
Independence Day: Friday, July 3, 2015

Fall 2014 | Winter 2015 | Spring 2015
--- | --- | ---
First day of instruction | October 2, 2014 | January 5, 2015 | March 30, 2015
Last day of instruction | December 12, 2014 | March 13, 2015 | June 5, 2015
Quarter ends | December 19, 2014 | March 20, 2015 | June 12, 2015
Commencement | | | June 13-14, 2015

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

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

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

Produced by the College of Engineering, Student Advising Division
Glenn Beltz, Associate Dean for Undergraduate Studies
Peter Allen, Publications Director
Ian Barin, Multimedia Designer & Photography

This publication is available at:
www.engineering.ucsb.edu/current_undergraduates/publications

The information in this publication supersedes that in the UCSB General Catalog. All announcements herein are subject to revision without notice.
Welcome to the College of Engineering at UC Santa Barbara. There are many reasons we are one of the top engineering schools in the nation. We bring together an amazing faculty, the members of which are highly acclaimed in the scientific communities in which they work. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. UCSB professors are, in fact, among the most cited by their colleagues worldwide, a testament to the quality and creativity of their research. A high percentage of the faculty has been elected to the prestigious National Academy of Sciences and National Academy of Engineering. We have 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. Students will not be permitted to join the Honors Program once they begin their senior curriculum year.

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

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

Dean’s Honors

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

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

Tau Beta Pi

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

Education Abroad Program (EAP)

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

Student Organizations

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

- American 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 or to change from one engineering major to another will be expected to complete at least 30 units at UCSB before petitioning for a change of major and usually must satisfy the prerequisites of the prospective major. Students who have completed more than 105 units will not be considered for a change of major/change of college in engineering or computer science unless they can demonstrate that they will be able to complete all the degree requirements without exceeding 215 total units.

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

Chemical Engineering. Admission to the Chemical Engineering major is determined by a committee of faculty, 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 at least [course equivalents, and the applicability of requirements are described on page 8].

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 8.

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

International Baccalaureate Credit

Students completing the International Baccalaureate (IB) diploma with a score of 30 or above will receive 30 quarter units total toward their UC undergraduate degree. The university grants 8 quarter units for 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 7.

Note: International Baccalaureate Examinations earned prior to entering the university will not be counted toward minimum 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
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.

Computer Science. A combined B.S./M.S. program in Computer Science provides an opportunity for outstanding undergraduates to earn both degrees in five years. Additional information is available from the computer science graduate program assistant or online at: www.cs.ucsb.edu/undergraduate/. Interested students may apply after completing at least 3 upper division computer science courses, but before the beginning of the final year in the B.S. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework.

Electrical Engineering. A combined B.S./M.S. program in Electrical Engineering provides an opportunity for outstanding undergraduates to earn both degrees in five years. Interested students should contact the Office of Undergraduate Studies early in the junior year, because the junior year class schedule will be different from other undergraduates. Transfer students should notify the Office of their interest in the program at the earliest opportunity. In addition to fulfilling undergraduate degree requirements, B.S./M.S. degree candidates must meet Graduate Division degree requirements, including university requirements for academic residence and units of coursework.

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

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

Students who earn scores of 5, 6, or 7 on International Baccalaureate (IB) Higher Level (HL) Examinations taken before high school graduation will receive 8 units of credit toward graduation at UCSB for each such test completed with the required scores, provided official scores are submitted to the Office of Admissions. Students who complete the IB diploma with a score of 30 or above will receive 30 quarter units total. The university does not grant credit for Standard Level (SL) exams. The application of this credit to the General Education requirements and course equivalents for these exams are listed below.

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

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

## International Baccalaureate Higher Level Exam

<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>MCDB 20</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>None</td>
</tr>
<tr>
<td>Design Technology</td>
<td>8</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Economics</td>
<td>8</td>
<td>D: 2 courses</td>
<td>Econ 1.2</td>
</tr>
<tr>
<td>English A: Literature Score of 5</td>
<td>8</td>
<td>Entry Level Writing Requirement</td>
<td>Writing 1, 1E, 1LK</td>
</tr>
<tr>
<td>Score of 6</td>
<td>8</td>
<td>A1</td>
<td>Writing 1, 1E, 1LK, 2, 2E, 2LK</td>
</tr>
<tr>
<td>Score of 7</td>
<td>8</td>
<td>A1, A2</td>
<td>Writing 1, 1E, 1LK, 2, 2E, 2LK, 50, 50E, 50LK</td>
</tr>
<tr>
<td>English A: Language and Literature Pending</td>
<td>Entry Level Writing Requirement</td>
<td>Writing 1, 1E, 1LK</td>
<td></td>
</tr>
<tr>
<td>Film</td>
<td>8</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Geography</td>
<td>8</td>
<td>D: 1 course</td>
<td>None</td>
</tr>
<tr>
<td>History</td>
<td>8</td>
<td>Pending</td>
<td>None</td>
</tr>
<tr>
<td>History of Africa</td>
<td>8</td>
<td>Pending</td>
<td>None</td>
</tr>
<tr>
<td>History of the Americas</td>
<td>8</td>
<td>Pending</td>
<td>None</td>
</tr>
<tr>
<td>History of Asia and Oceania</td>
<td>8</td>
<td>Pending</td>
<td>None</td>
</tr>
<tr>
<td>History of Europe and the Middle East Pending</td>
<td>Pending</td>
<td>Pending</td>
<td></td>
</tr>
<tr>
<td>Languages Other Than English Mathematics</td>
<td>8</td>
<td>C: 2 course#</td>
<td>Mathematics 3A, 3B, 15, 34A, 34B, or equivalent</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 Anthropology</td>
<td>8</td>
<td>D: 1 course</td>
<td>Anthropology 2</td>
</tr>
<tr>
<td>Theater</td>
<td>8</td>
<td>F: 1 course</td>
<td>None</td>
</tr>
<tr>
<td>Visual Arts</td>
<td>8</td>
<td>F: 1 course</td>
<td>None</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Advanced Placement Exam with score of 3, 4, or 5</th>
<th>Units Awarded</th>
<th>General Ed. Course Credit</th>
<th>UCSB Course Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art History</td>
<td>8</td>
<td>F: 1 course</td>
<td>Art History 1</td>
</tr>
<tr>
<td>*Art Studio 2D Design</td>
<td>8</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>*Art Studio 3D Design</td>
<td>8</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>*Art Studio Drawing</td>
<td>8</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>8</td>
<td>C: 1 course</td>
<td>Art Studio 18, 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></td>
<td></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</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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>A1</td>
<td>Writing 1, 1E, 1LK, 2E, 2LK</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>A1, A2</td>
<td>Writing 1, 1E, 1LK, 2E, 2LK, 50, 50E, 50LK</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>4</td>
<td>C: 1 course</td>
<td>Environmental Studies 2</td>
</tr>
<tr>
<td>European History</td>
<td>8</td>
<td>E: 1 course</td>
<td></td>
</tr>
<tr>
<td>French Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-3</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-4</td>
</tr>
<tr>
<td>With score of 5</td>
<td>8</td>
<td>H: 1 course</td>
<td>French 1-5</td>
</tr>
<tr>
<td>German Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>German 1-5</td>
</tr>
<tr>
<td>Human Geography</td>
<td>4</td>
<td>D: 1 course</td>
<td>Geog 5</td>
</tr>
<tr>
<td>Italian Language &amp; Culture</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>Japanese 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>Latin</td>
<td>4</td>
<td>H: 1 course</td>
<td>Latin 1-3</td>
</tr>
<tr>
<td>*Mathematics – Calculus AB</td>
<td>4</td>
<td>C: 1 course#</td>
<td>Mathematics 3A, 15, 34A, or equivalent</td>
</tr>
<tr>
<td>(or AB subscore of BC exam)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Mathematics – Calculus BC</td>
<td>8</td>
<td>C: 2 courses#</td>
<td>Mathematics 3A, 3B, 15, 34A, 34B, or equivalent</td>
</tr>
<tr>
<td>Music – Theory</td>
<td>8</td>
<td>F: 1 course</td>
<td>Music 11</td>
</tr>
<tr>
<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>
</tr>
<tr>
<td>Spanish Language &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-3</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
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<tr>
<td>Spanish Literature &amp; Culture</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-4</td>
</tr>
<tr>
<td>With score of 3</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-5</td>
</tr>
<tr>
<td>With score of 4</td>
<td>8</td>
<td>H: 1 course</td>
<td>Spanish 1-6</td>
</tr>
<tr>
<td>Statistics</td>
<td>4</td>
<td>C: 1 course#</td>
<td>Communication 87</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PSTAT 5AA-ZZ, Psychology 5</td>
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</tbody>
</table>
College Board Advanced Placement Placement Credit Cont.

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

A Level Examination Credit

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

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

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

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

# course also satisfies the Quantitative Relationships Requirement
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.

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, 168B, 174, 188C
   - Economics 113A-B, 119
   - English 133AA-ZZ, 134AA-ZZ, 191
   - Environmental Studies 173
   - Feminist Studies 155A, 159B
   - Military Science 27
   - Political Science 12, 115, 127, 151, 153, 155, 157, 158, 162, 165, 167, 180, 185
   - Religious Studies 7, 14, 61A-B, 151A-B, 152
   - Sociology 137E, 140, 144, 155A, 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 GOLDS system for General Education courses offered during a particular quarter.

It should be noted that for College of Engineering transfers who completed IGETC (Interssegmental 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. Approved by the academic senate.

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 50A-B-C, 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)
• Labor Studies (History)
• Latin American and Iberian Studies
• Lesbian, Gay, Bisexual, Transgender, and Queer Studies (Feminist Studies)
• Linguistics
• Music
• Philosophy
• Portuguese
• Russian
• Sociocultural Linguistics
• Spanish
• Theatre
• Theatre - Production and Design
• Women, Culture, and Development (Global Studies)

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

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

**Other Regulations:**

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

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

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

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

**GENERAL EDUCATION COURSES**

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

**Area A – English Reading and Composition**

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropology 2</td>
<td>Introductory Cultural Anthropology</td>
</tr>
<tr>
<td>Anthropology 3</td>
<td>Introductory Archaeology</td>
</tr>
<tr>
<td>Anthropology 7</td>
<td>Introduction to Biocultural Anthropology</td>
</tr>
<tr>
<td>Anthropology 103A</td>
<td>Anthropology of China</td>
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<tr>
<td>Anthropology 103B</td>
<td>Anthropology of Japan</td>
</tr>
<tr>
<td>Anthropology 103C</td>
<td>Anthropology of Korea</td>
</tr>
<tr>
<td>Anthropology 109</td>
<td>Human Universals</td>
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<tr>
<td>Anthropology 110</td>
<td>Technology and Culture</td>
</tr>
<tr>
<td>Anthropology 122</td>
<td>Anthropology of World Systems</td>
</tr>
<tr>
<td>Anthropology 130A-B</td>
<td>Third World Environments</td>
</tr>
<tr>
<td>Anthropology 131</td>
<td>North American Indians</td>
</tr>
<tr>
<td>Anthropology 134</td>
<td>Modern Cultures of Latin America</td>
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* This course applies toward the writing requirement.  
@ This course applies toward the American History & Institutions requirement.  
^ This course applies toward the European Traditions requirement.
### Area E: Culture and Thought

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

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<td>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.</td>
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| **Art History 1** | Visual Literacy |
| **Art History 6** | The Intersections of Art and Life |
| **Art History 106W** | Introduction to 2D/3D Visualizations in Architecture |
| **Art History 125** | Art Since 1950 |
| **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 6D** | 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** | Survey: Architecture and Planning |
| **Art History 6H** | Survey: History of Photography |
| **Art History 6I** | Pre-Columbian Art |
| **Art History 6J** | Islamic Art and Architecture |
| **Art History 6K** | Roman Architecture |
| **Art History 6L** | Roman Art: From the Republic to Empire (509 BC to AD 337) |
| **Art History 6M** | Greek Architecture |
| **Art History 6N** | Medieval Architecture: From Constantine to Charlemagne |
| **Art History 6O** | The Origins of Romanesque Architecture |
| **Art History 6P** | Late Romanesque and Gothic Architecture |
| **Art History 6Q** | Art and Society in Late Medieval Tuscany |
| **Art History 6R** | Painting in Fifteenth-Century Netherlands |
| **Art History 6S** | Painting in Sixteenth-Century Netherlands |
| **Art History 6T** | Italian Renaissance Art 1400-1500 |
| **Art History 6U** | Italian Renaissance Art 1500-1600 |
| **Art History 6V** | Art as Technique, Labor, and Idea in Renaissance Italy |
| **Art History 6W** | Art and the Formation of Social Subjects in Early Modern Italy |
| **Art History 6X** | Michelangelo |
| **Art History 6Y** | Italian Journeys |
| **Art History 6Z** | Leonardo Da Vinci: Art, Science and Technology in Early Modern Italy |
| **Art History 6A** | Dutch Art in the Age of Rembrandt |
| **Art History 6B** | Dutch Art in the Age of Vermeer |
| **Art History 6C** | Rethinking Rembrandt |
| **Art History 6D** | Seventeenth-Century Art in Southern Europe |
| **Art History 6E** | Seventeenth-Century Art in Italy |
| **Art History 6F** | Bernini and the Age of the Baroque |
| **Art History 6G** | Eighteenth-Century Art 1750-1810 |
| **Art History 6H** | Eighteenth-Century British Art and Culture |
| **Art History 6I** | Eighteenth-Century Art in Italy: The Age of the Grand Tour |
| **Art History 6J** | Nineteenth-Century Art 1848-1900 |
| **Art History 6K** | Nineteenth-Century British Art and Culture |
| **Art History 6L** | Impressionism and Post-Impressionism |
| **Art History 6M** | Art in the Modern World |
| **Art History 6N** | Contemporary Art |
| **Art History 6O** | Expressionism to New Objectivity, Early Twentieth-Century German Art |
| **Art History 6P** | Art in the Post-Modern World |
| **Art History 6Q** | Early Twentieth-Century European Art 1900-1945 |
| **Art History 6R** | Art of the Postwar Period 1945-1968 |
| **Art History 6S** | Critical Approaches to Visual Culture |
| **Art History 6T** | American Art from the Revolution to Civil War 1700-1860 |
| **Art History 6U** | Reconstruction, Renaissance, and Realism in American Art 1860-1900 |

* This course applies toward the writing requirement.  ^ This course applies toward the European Traditions requirement.  & This course applies toward the ethnicity requirement. @ This course applies toward the American History & Institutions requirement.
ART HISTORY 130A  Pre-Columbian Art of South America
* Film & Media Studies 134 Pre-Columbian Art of Mexico
* Film & Media Studies 130 Experimental Film
* Film & Media Studies 175 Pre-Columbian Art of the Maya
* Film & Media Studies 144 From Modernism to Postmodernism in European Architecture
* Film & Media Studies 169 Pre-Hispanic Art of the Americas
* Film & Media Studies 127P Pre-Columbian Art of the Maya
* Film & Media Studies 144L Pre-Hispanic Art of the Maya
* Film & Media Studies 144K Pre-Hispanic Art of the Maya
* Film & Media Studies 144J Pre-Hispanic Art of the Maya
* Film & Media Studies 144I Pre-Hispanic Art of the Maya
* Film & Media Studies 144H Pre-Hispanic Art of the Maya
* Film & Media Studies 144G Pre-Hispanic Art of the Maya
* Film & Media Studies 144F Pre-Hispanic Art of the Maya
* Film & Media Studies 144E Pre-Hispanic Art of the Maya
* Film & Media Studies 144D Pre-Hispanic Art of the Maya
* Film & Media Studies 144C Pre-Hispanic Art of the Maya
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* Film & Media Studies 144A Pre-Hispanic Art of the Maya
* Film & Media Studies 144 Pre-Hispanic Art of the Maya
* Film & Media Studies 143 Pre-Hispanic Art of the Maya
* Film & Media Studies 142 Pre-Hispanic Art of the Maya
* Film & Media Studies 141 Pre-Hispanic Art of the Maya
* Film & Media Studies 140 Pre-Hispanic Art of the Maya

** Area G: Literature

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

* This course applies toward the writing requirement.
& This course applies toward the ethnicity requirement.
^ This course applies toward the American History & Institutions requirement.
@ This course applies toward the European Traditions requirement.
**General Education**

18 • generAl eDUCATion

- * German 182  
  Vampirism in German Literature and Beyond
- * German 187  
  Satan in German Literature and Beyond
- * Greek 100  
  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”
- Italian 126AA-ZZ  
  Literature in Italian
- * Italian 138AX  
  Cultural Representations in Italy
- * Italian 142X  
  Women in Italy
- * Italian 144AX  
  Gender and Sexuality in Italian Culture
- Italian 179X  
  Fiction and Film in Italy
- * Japanese 80  
  Masterpieces in Japanese Literature
- * Japanese 112  
  Survey of Modern Japanese Literature
- Japanese 115  
  Twentieth-Century Japanese Literature
- Japanese 134F  
  Arts of Japan
- Japanese 134G  
  Japanese Painting
- Japanese 134H  
  Ukiyo-e: Pictures of the Floating World
- Korean 113  
  Korean Literature Survey
- * Latin 100  
  Introduction To Latin Prose
- * Latin American & Iberian Studies 102  
  Interdisciplinary Approaches to the Cultures, Languages and Literature
- * Music 187  
  Strauss and Hofmannsthal
- Portuguese 105A-B-C  
  Survey of Portuguese Literature
- Portuguese 106A-B-C  
  Survey of Brazilian Literature
- Portuguese 115AA-ED-E0  
  Brazilian Literature
- * Portuguese 120A-ZZ  
  Portuguese Literature in English Translation
- Religious Studies 114X  
  Dante’s “Divine Comedy”
- Religious Studies 129  
  Religions of the Ancient Near East
- * Religious Studies 189C  
  Modern Arabic Literature in Translation
- Slavic 117F  
  Chekhov
- * Slavic 117G  
  Dostoevsky
- * Slavic 117H  
  Tolstoy
- Slavic 122A-B  
  Nineteenth Century Russian Literature
- Slavic 123C-D  
  Twentieth Century Russian Literature
- * Slavic 151C  
  Literature of Central Europe
- * Slavic 164A  
  Death and Its Representations
- Slavic 164B  
  Science Fiction in Eastern Europe
- * Slavic 164C  
  Women in Russian Literature
- Spanish 102L  
  Introduction to Hispanic Literary Studies
- * Spanish 120A-B  
  Contemporary Spanish American Fiction in English Translation
- Spanish 131  
  Spanish Golden Age Poetry
- ** Spanish 135  
  Survey of Chicano Literature
- Spanish 137A-B  
  Golden Age Drama
- Spanish 138  
  Contemporary Mexican Literature
- Spanish 140A-B  
  Cervantes: Don Quijote
- Spanish 174  
  The Hispanic Novel and Cinema
- ** Spanish 179  
  Chicano Novel

**Literature Courses Taught in the Original Language**

- * Chinese 124A-B  
  Readings in Modern Chinese Literature
- * Chinese 132A  
  Special Topics in Classical Chinese Poetry
- Chinese 142  
  Tang Poetry
- French 101A-B-C  
  Introduction to Literary and Cultural Analysis
- * French 147A  
  Renaissance Poetry
- French 147B  
  French Theater
- * French 148C  
  Women in the Middle Ages
- * French 148E  
  The Age of Louis XIV
- French 149B  
  The Politics of Paradise
- * French 149C  
  Paris in Nineteenth-Century Literature & Art
- * French 149D  
  Post-War Avant-Gardes
- * French 149E  
  Belgian Literature in French
- * German 115A-B-C  
  Survey of German Literature
- * Greek 100  
  Introduction to Greek Prose
- * Greek 101  
  Introduction to Greek Poetry
- * Hebrew 114A-B-C  
  Modern Hebrew Prose and Poetry
- Italian 101  
  Modern Italy
- Italian 102  
  Advanced Reading and Composition: Medieval and Renaissance Italy
- Italian 111  
  Italian Short Fiction
- Italian 126-AA-AB-BB  
  Literature in Italian
- * Latin 100  
  Introduction to Latin Prose
- * Latin 101  
  Introduction to Latin Poetry
- Portuguese 105A-B-C  
  Portuguese Literature
- Portuguese 106A-B-C  
  Portuguese Literature
- Religious Studies 129  
  Religions of the Ancient Near East
- Spanish 30  
  Introduction to Hispanic Literature
- Spanish 131  
  Spanish Golden Age Poetry I
- Spanish 137A-B  
  Golden Age Drama
- Spanish 138  
  Contemporary Mexican Literature
- Spanish 140A-B  
  Cervantes: Don Quijote
- Spanish 174  
  Hispanic Novel and Cinema

**Area H: Foreign Language**

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

- Chinese 2-3  
  Elementary Modern Chinese
- Chinese 2NH-3NH  
  First Year Chinese Heritage
- Chinese 4-5-6  
  Intermediate Modern Chinese
- Chinese 4NH-5NH-6NH  
  Second Year Chinese Heritage
- French 2-3  
  Elementary French
- French 4-5-6  
  Intermediate French
- French 6GG  
  Intermediate French: Global Studies- Political Sci.
- German 2-3  
  Elementary German
- German 4-5-6  
  Intermediate German
- German 95B  
  Intermediate Yiddish
- German 95C  
  Advanced Yiddish
- Global Studies 60B-D-C-E-F  
  Punjab (II-III-V-VI)
- Greek 2  
  Elementary Greek
- Greek 12-13  
  Modern Greek
- Hebrew 2-3  
  Elementary Hebrew
- Hebrew 4-5-6  
  Intermediate Modern Hebrew
- Italian 2-3  
  Elementary Italian
- Italian 4-5-6  
  Intermediate Italian
- Japanese 2-3  
  First Year Japanese
- Japanese 4-5-6  
  Second Year Japanese
- Latin 2  
  Elementary Latin
- Latin 3  
  Intermediate Latin
- Portuguese 2-3  
  Elementary Portuguese
- Portuguese 4-5-6  
  Intermediate Portuguese
- Religious Studies 10B-C-D-E-F  
  Arabic (II-III-V-VI)
- Religious Studies 11B-C-D-E-F  
  Hindi (II-III-V-VI)
- Religious Studies 17B-C  
  Biblical Hebrew (II-III)
- Religious Studies 30B-C-D-E-F  
  Tibetan (II-III-V-VI)
- Religious Studies 45B-C-D-E-F  
  Pashto (II-III-V-VI)
- Religious Studies 57B-C-D-E-F  
  Persian (II-III-V-VI)
- Religious Studies 60B-C-D-E-F  
  Punjabi (II-III-V-VI)
- Religious Studies 65B-C-D-E-F  
  Turkish (II-III-V-VI)
- Religious Studies 122B  
  Syriac (II-III)
- Religious Studies 157A-B-C  
  Advanced Persian (I-II-III)
- Religious Studies 159B-C  
  Elementary Sanskrit
- Slavic 2-3  
  Elementary Russian
- Slavic 4-5-6  
  Intermediate Russian
- Spanish 2-3  
  Elementary Spanish
- Spanish 25S-35S  
  Intensive Elementary Spanish
- Spanish 4-5-6  
  Intermediate Spanish
- Spanish 4SS-5SS-6SS  
  Intensive Intermediate Spanish

**Special Subject Area Supplementary List of Courses**

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

- Anthropology 116A  
  Myth, Ritual, and Symbol
- Anthropology 116B  
  Anthropological Approaches to Religion
- Anthropology 132B  
  Contemporary Issues in South Asia
- Anthropology 134  
  Introduction to Contemporary Social Theory
- Anthropology 148A  
  Comparative Ethnicity
- Anthropology 172  
  Colonialism and Culture
- Art History 186AA-ZZ  
  Seminar in Advanced Studies in Art History
- Asian American Studies 100CC  
  Filipino Americans

* This course applies toward the writing requirement.
- This course applies toward the American History & Institutions requirement.
^ This course applies toward the European Traditions requirement.
& This course applies toward the American History & Institutions requirement.
<table>
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<td>&amp;* Asian American Studies 121</td>
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<td>&amp; Asian American Studies 124</td>
<td>Asian American Literature in Comparative Frameworks</td>
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<td>&amp; Asian American Studies 134</td>
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<td>&amp; Asian American Studies 148</td>
<td>Introduction to Video Production</td>
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<td>&amp; Asian American Studies 149</td>
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<td>Blacks in the Media</td>
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<td>* Chinese 166L</td>
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<td>Global Communication, International Relations and the Media</td>
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<td>* Comparative Literature 36</td>
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<td>Old Comedy/New Comedy</td>
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<td>Biomedical Ethics</td>
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<td>* Physics 13AH</td>
<td>Honors Experimental Physics</td>
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<td>* Physics 128AL-BL</td>
<td>Advanced Experimental Physics</td>
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<td>@ Political Science 6</td>
<td>Introduction to Comparative Politics</td>
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<td>Introduction to International Relations and Affairs</td>
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<td>@ Political Science 127</td>
<td>American Foreign Policy and Relations in the United States, Europe, and Asia in theTwenty-First Century</td>
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<td>@ Political Science 129</td>
<td>American Foreign Policy and Relations in the United States, Europe, and Asia in theTwenty-First Century</td>
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<td>Criminal Justice</td>
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<td>@ Political Science 167</td>
<td>Constitutional Law: The Bill of Rights</td>
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<td>Constitutional Law: Civil Rights</td>
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@ Political Science 176 Black Politics in America
@ Political Science 180 Bureaucracy and Public Policy
@ * Political Science 185 Government and the Economy
* Psychology 90A-B-C First-Level Honors Seminar
* Psychology 110L Laboratory in Perception
* Psychology 111L Laboratory in Biopsychology
* Psychology 112L Laboratory in Social Behavior
* Psychology 114L Laboratory in Personality
* Psychology 116L Laboratory in Animal Learning
* Psychology 117L Laboratory in Human Memory and Cognition
* Psychology 118L Laboratory in Attention
* Psychology 120L Advanced Research Laboratory
* Psychology 135A-B-C Field Experience in Psychological Settings
* Psychology 143S Seminar in Social Development
* Religious Studies 106 Modernity and the Process of Secularization
&* Religious Studies 110D Ritual Art and Verbal Art of the Pacific Northwest
&* Religious Studies 114D Religion and Healing in Native America
* Religious Studies 127B Christian Thought and Cultures of the Middle Ages
&* Religious Studies 131F The History of Anti-Semitism
* Religious Studies 131J Introduction to Rabbinic Literature
* Religious Studies 140A Islamic Traditions
* Religious Studies 140B Religion, Politics, and Society in the Persian Gulf Region
* Religious Studies 140C Islamic Mysticism and Religious Thought
& Religious Studies 140E Islam in America
* Religious Studies 141C Sociology of Religion: Church and State Relations
* Religious Studies 145 Patterns in Comparative Religion
* Religious Studies 163 Images of Japan: The Ideology of Representation
* Religious Studies 166A Taoist Traditions of China
* Religious Studies 166B Confucian Traditions: The Classical Period
* Religious Studies 166E The Flowering of Chinese Buddhism
* Religious Studies 178 The Body Religious in Chinese Culture
* Religious Studies 189A History of Arabic Literature in Translation
* Religious Studies 189B Critical Readings in Medieval Arabic Literature in Translation
& Religious Studies 193 Religion and Ecology of the Americas
&* Sociology 128 Interethic Relations
* Sociology 130 Development and its Alternatives
* Sociology 130LA Development and Social Change in Latin America
* Sociology 130ME Development and Social Change in the Middle East
* Sociology 134R The Sociology of Revolutions
* Sociology 134RC Radical Social Change
@& Sociology 137E Sociology of the Black Experience
& Sociology 139A Black and White Relations
@ Sociology 140 Aging in American Society
* Sociology 154A Sociology of the Family
&* Sociology 154F The Chicano Family
@ Social 155A Women in American Society
& Social 155M Contemporary U.S. Women’s Movements
Social 155W Chicanas and Mexican Women in Contemporary Society
* Sociology 156A Introduction to Women, Culture, and Development
@ Sociology 157 Radicalism in Contemporary Life
* Sociology 170 Sociology of Deviant Behavior
* Sociology 176A Sociology of AIDS
& Spanish 109 Spanish in the United States: The Language and its Speakers
* Speech & Hearing Sciences 50 Introduction to Communication Disorders
* Theater 1 Play Analysis
* Theater 91 Summer Theater in Orientation
& Theater 180F Asian American Theater
* Theater 185TH Theory
* Writing 110L Advanced Legal Writing
* Writing 110MK Professional Communications in Marketing and Public Relations
* Writing 160 Theory and Practice of Writing Center Consulting

* 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.
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: Francis J. Doyle III
Vice-Chairs: Todd M. Squires

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, Assistant 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)

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

M. Scott Shell, Ph.D. Princeton, 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

*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 (theroretical 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)

Orrville 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 requirements, safeguarding the environment, ensuring national security, and delivering health care at an affordable cost. Because of their broad technical background, chemical engineers are uniquely qualified to make major contributions to the resolution of these and other important problems.

Chemical engineers develop processes and products that transform raw materials into useful products.

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

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

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

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

Under the direction of the Associate Dean for Undergraduate Studies, academic advising services are jointly provided by advisors in the College of Engineering, as well as advisors in the department. Each undergraduate also is assigned a faculty advisor, to assist in selection of elective courses, plan academic programs, and provide advice on professional career objectives. Undergraduates in other majors who plan to change to a major in the Department of Chemical Engineering should consult the department academic advisor for the requirements.

Mission Statement

The program in Chemical Engineering has a dual mission:

• Education. Our program seeks to produce chemical engineers who will contribute to the process industries worldwide. Our program provides students with a strong fundamental technical education designed to meet the needs of a changing and rapidly developing technological environment.

• Research. Our program seeks to develop innovative science and technology that addresses the needs of industry, the scientific community, and society.

Objectives for the Undergraduate Program

Educational Objectives

• Our graduates will be innovative, competent, contributing chemical engineers.

• Our graduates will demonstrate their flexibility and adaptability in the work-
place, so that they remain effective engineers, take on new responsibilities, and assume leadership roles.

- Our graduates will continually develop new skills and knowledge through formal and informal mechanisms.

**Student Learning Outcomes**

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

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 education necessary to understand the impact of engineering solutions in a global/societal context; a knowledge of contemporary issues; an understanding of professional and ethical responsibility.

**Undergraduate Program**

**Bachelor of Science—Chemical Engineering**

A minimum of 194 units is required for graduation. A complete list of requirements for the major can be found on page 46. Schedules should be planned to meet both General Education and major requirements. Courses required for the major, inside or outside of the Department of Chemical Engineering, cannot be taken for the pass/no pass grading option. They must be taken for letter grades.

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

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

**Chemical Engineering Courses**

**LOWER DIVISION**

1A. Engineering and the Scientific Method

**1B. Engineering and the Scientific Method**

**TAFF**

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**

**DAUGHERTY, GORDON**

Prerequisites: Chemistry 1A-B-C or 2A-B-C; Mathematics 3A-B and 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**

**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**

**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

**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

**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

**STAFF**

Prerequisite: Chemical Engineering 110A; Mathematics 5A or Mathematics 4B; Engineering majors only.

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

119. Current Events in Chemical Engineering

**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

**SQUIRES, MITAGOTRI**

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

**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 exchanger equipment and use.

120C. Transport Processes

**PETERS**

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

**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

**THEODORANOS**

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

Same course as ME 124.


125. Principles of Bioengineering

**MITAGOTERI**

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
(3) SCOTT
Prerequisites: Chemical Engineering 10 and 110A-B; open to College of Engineering majors only.

Basic principles and design techniques of equilibrium-stage separation processes. Emphasis is placed on binary distillation, liquid-liquid extraction, and multicomponent distillation.

132A. Analytical Methods in Chemical Engineering
(4) FREDRICKSON, GORDON
Prerequisite: Mathematics 5A or Mathematics 4B; Mathematics 5B or Mathematics 6A-B.

Develop analytical tools to solve elementary partial differential equations and boundary value problems. Separation, Laplace transforms, Sturm–Liouville theory, generalized Fourier analysis, and computer math tools.

132B. Computational Methods in Chemical Engineering
(3) FREDRICKSON, GORDON
Prerequisite: Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.


132C. Statistical Methods in Chemical Engineering
(3) THEOFANOUS
Prerequisites: Chemical Engineering 120A-B-C, or Mechanical Engineering 151C and 152A.

Same course as ME 136.

Development from basic concepts and techniques of fluid mechanics and heat transfer, to local behavior in multiphase flows. Key multiphase phenomena from chemical engineering. Extension of local conservation principles to usable formulations in multiphase flows. Modelling approaches. Practical examples.

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

Same course as ME 136.


140A. Chemical Reaction Engineering
(3) MCFARLAND, SCOTT
Prerequisites: Chemical Engineering 110A and 120A-B.

Fundamentals of chemical reaction engineering with emphasis on kinetics of homogenous and heterogeneous reacting systems. Reaction rates and reaction design and analysis of chemical conversion and selectivity. Batch and continuous reactor designs with and without catalysts are examined.

140B. Chemical Reaction Engineering
(3) CHMELKA, MCFARLAND
Prerequisites: Chemical Engineering 110A, 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
(3) MCFARLAND
Prerequisite: 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
(4) DOYLE
Prerequisite: 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
(3) DOYLE
Prerequisite: Chemical Engineering 152A.

The theory, design, and experimental application of advanced process control strategies including feedback control, cascade control, enhanced single- loop strategies, and model predictive control. Analysis of multi-loop control systems. Introduction to on-line optimization.

154. Engineering Approaches to Systems Biology
(3) DOYLE
Prerequisite: Chemical Engineering 170 and Mathematics 5A or Mathematics 4B; Mathematics 5B-C or Mathematics 6A-B.

Applications of engineering tools and methods to solve problems in systems biology. Emphasis is placed on integrative approaches that address multi-scale and multi-rate phenomena in biological regulation, Modeling, optimization, and sensitivity analysis tools are introduced.

160. Introduction to Polymer Science
(3) KRAMER
Prerequisite: Chemistry 109A-B.

Same course as Materials 160.

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

170. Molecular and Cellular Biology for Engineers
(3) SHELL
Prerequisite: Chemical Engineering 120A-B-C, 140A and Chemistry 109C.

Not open for credit to students who have completed Ch E 172.

Introduction to molecular and cellular biology from an engineering perspective. Topics include protein structure and function, transcription, translation, post- translational processing, cellular organization, molecular transport, and trafficking, and cellular models.

171. Introduction to Biochemical Engineering
(3) DAUGHERTY
Prerequisite: Chemical Engineering 170.

Introduction to biochemical engineering covering cell growth kinetics, bioreactor design, enzyme processes, biotechnologies for modification of cellular information, and molecular and cellular engineering.

179. Biotechnology Laboratory
(4) DAUGHERTY
Prerequisite: Chemical Engineering 170 or MCDB 1A or Chemistry 142A-B or Consent of Instructor. Must have an overall grade point average of 3.3 or above.

This course will provide an introduction to theoretical principles and practical methods used in modern biotechnology, genetic engineering, and synthetic biology. Topics will include protein and cellular engineering using recombinant DNA technologies, mutagenesis, library construction, and biosynthetic display technologies.

180A Chemical Engineering Laboratory
(3) STAFF
Prerequisites: Chemical Engineering 110A and 120A-B.

Experiments in thermodynamics, fluid mechanics, heat transfer, mass transfer, and chemical processing. Analysis of results, and preparation of reports.

180B Chemical Engineering Laboratory
(3) STAFF
Prerequisites: Chemical Engineering 120C, 128, 140A, and 152A.

Experiments in mass transfer, reactor kinetics, process control, and chemical and biochemical processing. Analysis of results, and preparation of reports.

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


184B. Design of Chemical Processes
(3) STAFF
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
Prerequisite: Upper-division standing, completion of 2 upper-division courses in Chemical Engineering; consent of the instructor.

Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated for up to 12 units. Not more than 3 units may be applied to departmental electives.

Research opportunities for undergraduate students. Students will be expected to give regular oral presentations, actively participate in a weekly seminar, and prepare at least one written report on their research.

198. Independent Studies in Chemical Engineering
(1-4) 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 99, 199/199/199/199/199/199 courses combined. Directly individual studies.

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

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

Director: Frederic T. Chong
Associate Director: Forrest Brewer

Faculty

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

Kaustav Banerjee, Ph.D., UC Berkeley, Professor (high performance VLSI and mixed signal system-on-chip designs and their design automation methods; single electron transistors, 3D and optoelectronic integration)

Forrest D. Brewer, Ph.D., University of Illinois at Urbana-Champaign, Professor (VLSI and computer system design automation, theory of design and design representations, symbolic techniques in high level synthesis)

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

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

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

Chandra Krintz, Ph.D., University of California, San Diego, Professor (dynamic and adaptive compilation systems, high-performance internet (mobile) computing, runtime and compiler optimizations for Java/CIL, efficient mobile program transfer formats)

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

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

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

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

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 nanoarchitectures, host systems, bioensors, block co-polymery 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 Program seeks to produce graduates who:

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

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

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

4) Experienced design-oriented challenges that exercise and integrate skills and knowledge acquired during their course of study. These challenges may include design of components or subsystems with performance specifications. Graduates should be able to demonstrate an ability to design and test a system, analyze experimental results, and draw logical conclusions from them.

5) Learned to function well in multidisciplinary teams and collaborative environments. To this end, students must develop communication skills, both written and oral, through teamwork and classroom participation. Teamwork and individual originality will be evidenced through written reports, webpage preparation, and public presentations.

Program Outcomes

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.

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

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 classroom participation. Teamwork and individual originality will be evidenced through written reports, webpage preparation, and public presentations.

6) Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This outcome provides for the ability to understand the impact of engineering solutions in a global and societal context. A required course in engineering ethics will have prepared students for making professional contributions while maintaining institutional and individual integrity.

Undergraduate Program

Bachelor of Science—Computer Engineering

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

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

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

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

The upper-division requirements consist of a set of required courses and a minimum of 40 units (10 classes) of additional departmental elective courses comprised of at least two sequences chosen from a set of eight specialty sequences. Each sequence must consist of two or more courses taken from the same course/sequence group.

The department electives must also include a capstone design project (CMPSC 189A-B/ECE 189A-B). Upper-division courses required for the major are: Computer Science 130A, 170; ECE 152A, 154, 156A; either ECE 139 or PSTAT 120A; Engineering 101.

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

The defined sequences from which upper-division departmental electives may be chosen are:

- Computer Systems Design: ECE/CMPSC 153A, ECE 153B
- Computer Networks: ECE 155A/CMPSC 176A, ECE 155B/CMPSC 176B
- Distributed Systems: ECE 151/CMPSC 171 and one or both of the Computer Networks courses
- Programming Languages: CMPSC 160, 162
- Real-Time Computing & Control: ECE 147A-B, 157
- Multimedia: ECE 178, ECE/CMPSC 181B, ECE 160/CMPSC 182
- VLSI: ECE 124A, 124D
- Signal Processing: ECE 130A-B

Satisfactory Progress and Prerequisites

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

Computer Engineering Courses

See listings for Computer Science starting on page 25 and Electrical and Computer Engineering starting on page 30.
McKinley is an essential component of the University of California at Santa Barbara's (UCSB) Department of Computer Science. The department 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 can gain remote access to machines at the NSF Supercomputing Centers. Additional computer 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.

**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.

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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 50. Schedules should be planned to meet both General Education and major requirements.

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

Students applying for major status in the BS program who have completed more than 105 units will not be considered for a change of major/change of college 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), with 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 25.

Computer Science Courses

LOWER DIVISION

1. Seminar on the Field of Computer Science
   (1) FRANKLIN
   Prerequisites: Overview of computer science and algorithms. Topics include the impact of computers on society, ethical and moral implications, and recent advances in computing technologies. For students with little to no programming experience.

2. Introduction to Computer Science
   (4) CONRAD, KIRKLAND
   Prerequisites: Computer Science 16 with a grade of C or better. 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
   (4) FRANKLIN
   Prerequisites: Computer Science 16 with a grade of C or better, and Math 3B (may be taken concurrently). Legal repeat for CMPSC 10.
   Intermediate 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 I
   (4) FRANKLIN, COSTANZO
   Prerequisites: Computer Science 16 with a grade of C or better, and Math 3B (may be taken concurrently). Legal repeat of CMPSC 10.
   Prerequisites: 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.

24. Problem Solving with Computers II
   (4) FRANKLIN, COSTANZO
   Prerequisites: Computer Science 24 with a grade of C or better. Legal repeat of CMPSC 10.
   Intermediate 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.

32. Object Oriented Design and Implementation
   (4) HOLLINGER
   Prerequisites: Computer Science 24 with a grade of C or better. Legal repeat of CMPSC 24.
   Prerequisites: Introduction to object-oriented programming. Topics include encapsulation, data hiding, inheritance, polymorphism, compilation, linking and loading, memory management, and debugging.

40. Foundations of Computer Science
   (4) VAN DAM, SU
   Prerequisites: 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.
Prerequisites: Computer Science 16 with a grade of C or better; and Mathematics 3C.

Introduction to the theoretical underpinnings of computer science. Topics include propositional predicate logic, set theory, functions and relations, counting, mathematical induction and recursion (generating functions).

48. Computer Science Project

(4) CAPPELLO
Prerequisite: Computer Science with a grade of C or better, and Computer Science 56 with a grade of C or better (can be taken concurrently).

Team-based project development. Topics include software engineering and professional development practices, interface design, advanced library support, skill development, 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 32 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 high-level, virtual-machine-based language. Topics include generic programming, exception handling, programming language implementation; automatic memory management, and application development, management, and maintenance tools; event handling, concurrency and threading, and advanced library use.

64. Computer Organization and Logic Design

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

Not open for credit to students who have completed ECE 15 or ECE 15B or Computer Science 30.

Repeat Course Counts as a legal repeat of CMPSC 30.

Assembly language programming and advanced computer organization; Digital logic design topics including gates, combinational circuits, flip-flops, and the design and analysis of sequential circuits.

95AA-ZZ. Undergraduate Seminar in Computer Science

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

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

99. Independent Studies in Computer Science

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

Independent studies in computer science for advanced students.

UPPER DIVISION

111. Introduction to Computational Science

(4) PETZOLD
Prerequisites: Mathematics 6A, and Computer Science 24 with a grade of C or better.

Not open for credit to students who have completed Computer Science 110A.

Introduction to computational science, emphasizing basic numerical algorithms and the informed use of mathematical software. Matrix computation, systems of linear and nonlinear equations, interpolation and zero finding, differential equations, numerical integration. Students learn and use the MATLAB computer environment.

130A. Data Structures and Algorithms I

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

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

130B. Data Structures and Algorithms II

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

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

138. Automata and Formal Languages

(4) ECECIOLGU
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) GIBERT
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) KRINTZ, BREWER
Prerequisite: Upper-division standing in computer science, computer engineering, or electrical engineering.

Same course as ECE 153A.

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

154. Computer Architecture

(4) SHERWOOD, CHONG
Prerequisite: ECE 152A.

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

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

160. Translation of Programming Languages

(4) SHERWOOD
Prerequisites: Computer Science 64; Computer Science 130A; and Computer Science 138; open to computer science and computer engineering majors only.

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

162. Programming Languages

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

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

165A. Artificial Intelligence

(4) TURK
Prerequisite: Computer Science 130A.

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

165B. Machine Learning

(4) SINGH
Prerequisite: Computer Science 130A.

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

167. Introduction to Bioinformatics

(4) SINGH
Prerequisite: Computer Science 130B.

Not open to students who have completed Computer Science 190N.

Review of the fundamentals of molecular biology and genetics; pairwise sequence alignment: dynamic programming, database searching; multiple sequence alignment; microarray data analysis; protein structure alignment; phylogeny construction: distance and character based methods; other current topics.

170. Operating Systems

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

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

171. Distributed Systems

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

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

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

174A. Fundamentals of Database Systems

(4) SU
Prerequisite: Computer Science 130A.

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

Database system architectures, relational data model, data model, join algorithms, relational calculus, SQL, QBE, query processing, integrity constraints (key constraints, referential integrity), database design, ER and object-oriented data model, functional dependencies, lossless join and dependency preserving decompositions, Boyce-Codd and Third Normal Forms.
174B. Design and Implementation Techniques of Database Systems  
(4) 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) ALMEROATH, BELDING  
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 in networking, the OSI model, error detection codes, flow control, routing, medium access control, and high-speed networks.

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

176C. Advanced Topics in Internet Computing  
(4) BELDING, ZHENG  
Prerequisite: Computer Science 176B.  
General overview of wired and mobile networking, multimedia, a 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.  
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, TUNG  
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) ALMEROATH, ZHENG  
Not open for credit to students who have completed ECE 160.  
Introduction to multimedia and applications. Topics include streaming media, conferencing, webcasting, digital libraries, multimedia system architectures, standards (including JPEG and MPEG), and multimedia storage and retrieval. A key emphasis is on using the Internet for delivery of multimedia data.

185. Human-Computer Interaction  
(4) HOLLEREN  
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 Japanese or programming language, some experience with user interface programming.  
The study of human-computer interaction enables system architects to design useful, efficient, and enjoyable computer interfaces. This course teaches the theory, design guidelines, programming practices, and evaluation procedures behind effective human interaction with computers.

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

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

189B. Senior Computer Systems Project  
(4) BULTAN  
Prerequisite: 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-ZZ. Special Topics in Computer Science  
(1-4) STAFF  
Prerequisite: consent of instructor.  
May be repeated to a maximum of 8 units with consent of the department chair but only 4 units may be applied to the major.

Projects in computer science for advanced undergraduate students.

193. Internship in Industry  
(1-4) STAFF  
Prerequisites: consent of instructor and department chair.  
Not more than 4 units per quarter; may not be used as a field elective and may not be applied to science electives. May be repeated with faculty/chair approval to a maximum of 4 units.

Special projects for selected students. Offered in conjunction with selected industrial and research firms under direct faculty supervision. Prior departmental approval required. Written proposal and final report required.

196. Undergraduate Research  
(2-4) 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.  
Must have a minimum 3.0 grade-point average for the preceding three quarters. May be repeated with consent of chair. Students are limited to 5 units per quarter and 30 units total in all 198/199 courses combined.  
Independent study in computer science for advanced students.

GRADUATE COURSES

Graduate courses for this major can be found in the UCSB General Catalog.
Electrical & Computer Engineering

Department of Electrical and Computer Engineering, Building 380, Room 101; Telephone (805) 893-2269 or (805) 893-3821
Web site: www.ece.ucsb.edu

Chair: 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)

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)

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., Ecole Polytechnique Fédérale de Lausanne, Associate Professor (image processing, optical microscopy, In Vivo biological imaging)

Upamanyu Madhow, Ph.D., University of Illinois, Professor (spatial 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).

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

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

Umesh Mishra, Ph.D., Cornell University, Professor (hybrid circuits, 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 Laboratory, 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)

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

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

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

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

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

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

Herbert Kroemer, Dr. rer. nat., University of Göttingen, Donald W. Whittier Professor in Electrical Engineering, 2000 Physics Nobel Laureate (general solid-state and device physics, heterostructures, molecular beam epitaxy, compound semiconductor materials and devices, superconductivity) *1

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

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

James L. Merz, Ph.D., Harvard University, Professor Emeritus (optical properties of semiconductors, including guided-wave and integrated optical devices, semiconductor lasers, optoelectronic devices, native defects in semiconductors, low-dimensional quantum structures) *1

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

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

Pierre M. Petroff, Ph.D., UC Berkeley, Professor (self assembling nanostructures in semiconductors and ferromagnetic materials, spectroscopy of nanostructures, nanostructure devices, semiconductor device reliability) *1

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

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

*1 Joint appointment with Materials

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)

Francis Doyle, Ph.D., (Chemical Engineering)

Chandra Krintz, Ph.D. (Computer Science)

Eric McFarland, Ph.D., (Chemical Engineering)

Shuji Nakamura, Ph.D. (Materials)

Bradley E. Paden, Ph.D. (Mechanical Engineering)

Tim Sherwood, Ph.D. (Computer Science)

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 education and research, is accessible to California’s high schools and for postgraduate students, both domestic and international.

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

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

Educational Objectives

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

1. We expect our graduates to make positive contributions to society in fields including, but not limited to, engineering.

2. We expect our graduates to have acquired the ability to be flexible and adaptable, showing that their educational background has given them the foundation needed to remain effective, take on new responsibilities and as-
sume leadership roles.

3. We expect some of our graduates to pursue their formal education further, including graduate study for master’s and doctoral degrees.

**Program Outcomes**

The EE program expects our students upon graduation to have:

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

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

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

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

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

6. Completed a well-rounded and balanced education through required studies in selected areas of fine arts, humanities, and social sciences. This provides 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 52. 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 25.

**Electrical & Computer Engineering Courses**

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

**LOWER DIVISION**

1A. Computer Engineering Seminar

(1 STAFF)

Prerequisite: open to pre-computer engineering and computer engineering majors only. Seminar: 1 hour.

Introductory seminar to expose students to a wide 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

(6 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-McClusky 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 experienced in pursuing careers within science and engineering through discussions with researchers, lectures on ethics, funding, intellectual property, and commercial innovation. Students prepare a focused research proposal that is pursued in the second quarter of the course.

121B. The Practice of Science

(4 HU, AWSCHALOM)
Prerequisites: 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) THEODARAJAN

Prerequisites: ECE 2A-B-C with a minimum grade of C- in each of those courses; open to both electrical engineering and computer engineering majors only.

Introduction to high-performance digital circuit design techniques. Basics of device physics including deep submicron effects; device sizing and 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

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

Introduction to CMOS digital VLSI design: CMOS devices and manufacturing technology; transistor level design of static and dynamic logic gates and components and interconnections; circuit characterization: delay, noise margins, and power dissipation; 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

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

Design, simulation, fabrication, and characterization of NMOS integrated circuits. Circuit design and layout is performed using commercial layout software and 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

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


130B. Signal Analysis and Processing

(4) CHANDRASEKARAN

Prerequisites: 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. Discrete Fourier transforms. Sampling and aliasing.

130C. Signal Analysis and Processing

(4) CHANDRASEKARAN

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

Basic techniques for the analysis of linear models in electrical engineering: Gaussian elimination, vector spaces and linear equations, orthogonality, determinants, eigenvectors and eigenvalues, systems of linear differential equations, positive definite matrices, singular value decomposition.

132. Introduction to Solid State Electronic Devices

(4) MISHRA

Prerequisites: 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 switching properties of P-N junctions; introduction of bipolar transistors, MOSFET’s and JFET’s.

134. Introduction to Fields and Waves

(4) DAGLI, YORK

Prerequisites: Physics 3 or 23 with a minimum grade of C-; Mathematics 5A-B with a minimum grade of C; and Mathematics 5C with a minimum grade of C-. open to EE and computer engineering majors only. Lecture, 3 hours; discussion, 2 hours.

Introduction to applied electromagnetics and wave phenomena in high frequency electronic circuits and systems. Wave on transmission-lines, elements of electrostatics and magnetostatics and applications, plane waves, examples and applications to RF, microwave, and optical systems.

135. Optical Fiber Communication

(4) DAGLI

Prerequisites: ECE 132 and 134 with a minimum grade of C- in both. Lecture, 3 hours; discussion, 1 hour.

Optical fiber as a transmission medium, dispersion and nonlinear effects in fiber transmission, fiber and semiconductor optical amplifiers and lasers, optical modulators, photo detectors, optical receivers, wavelength division multiplexing components, optical filters, basic transmission system analysis and design.

137A. Circuits and Electronics I

(4) ROEDWELL

Prerequisites: ECE 2A-B-C, 130A, and 132 with a minimum grade of C- in all; open to EE majors only. Lecture, 3 hours; laboratory, 3 hours.

Analysis and design of single stage and multistage transistor circuits including biasing, gain, impedances and maximum signal levels.

137B. Circuits and Electronics II

(4) ROEDWELL

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

Analysis and design of single stage and multistage transistor circuits at low and high frequencies. Transistor operation. Analysis and design of feedback circuits. Stability criteria.

139. Probability and Statistics

(4) ELTS

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 Nano-electromechanical and Microelectromechanical Systems (NEMS/MEMS)

(3) PENNATUR, TURNER

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

Same course as ME 141A. Lecture, 3 hours. Introduction to nano- and microtechnology. Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonics, electronics, and fluids will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples.

141B. MEMS: Processing and Device Characterization

(4) PENNATUR, TURNER

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

Same course as ME 141B. Lecture, 2 hours; laboratory, 6 hours. Introduces experience with lithography, patterning, etching, and nano-lithography and laboratory on semiconductor-based processing for MEMS. Description of key equipment and characterization tools used for MEMS and design, fabrication, characterization and testing of MEMS. Emphasis on current MEMS devices including accelerometers, comb drives, micro-reactors and capacitor-actuators.

141C. Introduction to Microfluidics and BioMEMS

(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.

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 drives.

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 principles, metal and dielectric waveguides, resonant cavities, antennas. Microstrip and device examples and experience with modern microwave and CAD software.

145A. Communication Electronics

(5) ROEDWELL

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) Smith
Prerequisites: ECE 130A-B, 140 and 146A with minimum grades of C-. open to EE majors only. Lecture, 3 hours; laboratory, 6 hours.
Link design: power-bandwidth tradeoffs, link budget analysis.

147A. Feedback Control Systems - Theory and Design (5) TEEL, SMITH
Prerequisites: ECE 130A-B with a minimum grade of C- in both; 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
Prerequisites: ECE 147A with a minimum grade of C-. open to EE and computer engineering majors only. Lecture, 3 hours; laboratory, 6 hours.
Analysis of sampled data feedback systems; state space description of linear systems; observability, controllability, pole assignment, state feedback, observers. Design of digital control systems. (W)

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

148. Applications of Signal Analysis and Processing (4) LEE
Prerequisites: ECE 130A-B with a minimum grade of C- in both. Lecture, 3 hours; discussion, 2 hours.
A sequence of engineering applications of signal analysis and processing techniques; in 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 170, 176, or ECE 149. 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++.

151A. Introduction to Computer Networks (4) MOSER
Prerequisites: ECE 154A with a minimum grade of C-; and, Computer Science 5JA or 10 or 11JA with a minimum grade of C-.
Not open for credit to students who have completed Computer Science 176B or ECE 194A. Lecture, 3 hours; discussion, 1 hour.
Topics in this course include client/server computing, threads, Java applets, Java sockets, Java RMI, Java servlets, Java Server Pages, Java Database Connectivity, Enterprise Java Beans, HyperText Markup Language, extensible Markup Language, Web Services, programming networked applications in Java.

151A. Digital Design with VHDL and Synthesis (4) WANG
Prerequisite: ECE 152A with a minimum grade of C-.
Lecture, 3 hours; laboratory, 3 hours.
Introduction to VHDL basic elements. VHDL simulation concepts. VHDL concurrent statements with examples and applications. VHDL subprograms, packages, libraries and design units. Writing VHDL for synthesis. Writing VHDL for finite state machines. Design case study.

151B. Computer-Aided Design of VLSI Circuits (4) WANG
Prerequisite: ECE 156A with a minimum grade of C-.
Lecture, 3 hours; laboratory, 3 hours.
Introduction to computer-aided simulation and synthesis tools for VLSI. VLSI system design flow, role of CAD tools, layout synthesis, circuit simulation, logic simulation, logic synthesis, behavior synthesis and test synthesis.
158. Digital Signal Processing
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.

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

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

183. Nonlinear Phenomena
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.

189A. Senior Computer Systems Project
Prerequisites: ECE 152B; senior standing in Computer Engineering, Computer Science or EE.
Not open for credit to students who have completed Computer Science 189A-B.
Student groups design a significant computer-based project. Groups work independently with interaction among groups via interface specifications and informal meetings.

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

194A-AA. Special Topics in Electrical and Computer Engineering
Prerequisites: 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 9899/198/199/199DC/199RA courses combined.
Directed individual study, normally experimental.

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

LOWER DIVISION

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

99. Introduction to Research
   (1-5) 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 in all 98/99/198/199/199AA-ZZ courses combined. Directed study to be arranged with individual faculty members. Course offers exceptional students an opportunity to participate in a research group.

UPPER DIVISION

101. Ethics in Engineering
   (3) STAFF
   Prerequisite: senior standing in engineering.

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
   (1-5) 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 intersections, imaging/telecommunications, human spaceflight history, reduced/alternating gravity experimentation, space systems design/ utilization.

199. Independent Studies in Engineering
   (1-5) STAFF
   Prerequisite: Upper-division standing; consent of instructor.
   Students must have a minimum 3.0 GPA for the preceding three quarters. May be repeated for credit to a maximum of 10 units.
   Directed individual study.
methods development, electrochemical energy storage materials, high temperature structural materials corrosion)

Chris Van de Walle, Ph.D., Stanford University, Professor (novel electronic materials, wide-bandgap semiconductors, oxides)

Claude Weisbuch, Ph.D., Université Paris VII, Ecole Polytechnique-Palaiseau, Professor (semiconductor physics; fundamental and applied optical studies of quantized electronic structures and photonic-controlled structures; electron spin resonance in semiconductors, optical semiconductor microcavities, photonic bandgap materials)

Francis W. Zok, Ph.D., McMaster University, Professor (mechanical and thermal properties of materials and structures)

Emeriti Faculty

Anthony K. Cheetham, Ph.D., Oxford University, Professor Emeritus (catalysis, optical materials, X-ray, neutron diffraction)  

David R. Clarke, Ph.D., University of Cambridge, Professor Emeritus (electrical ceramics, thermal barrier coatings, piezospectroscopy, mechanics of microelectronics)  

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

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

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

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

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

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

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

Affiliated Faculty

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

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

Mahn Won Kim, Ph.D. (Physics)

Gary Leal, Ph.D. (Chemical Engineering)

Gene Lucas, Ph.D. (Chemical Engineering)

The Department of Materials was conceptualized and built under two basic guidelines: to educate graduate students in advanced materials and to introduce them to novel ways of doing research in a collaborative, multidisciplinary environment. Advancing materials technology today—either by creating new materials or improving the properties of existing ones—requires a synthesis of expertise from the classic materials fields of metallurgy, ceramics, and polymer science, and such fundamental disciplines as applied mechanics, chemistry, biology, and solid-state physics. Since no individual has the necessary breadth and depth of knowledge in all these areas, solving advanced materials problems demands the integrated efforts of scientists and engineers with different backgrounds and skills in a research team.

The department has effectively transferred the research team concept, which is the operating mode of the high technology industry, into an academic environment.

The department has major research groups working on a wide range of advanced inorganic and organic materials, including advanced structural materials, ceramics and polymers; high performance composites; thermal barrier coatings and engineered surfaces; organic, inorganic and hybrid semiconductor and photonic material systems; catalysts and porous materials, magnetic, ferroelectric and multiferroic materials; biomaterials and biosurfaces, including biomedically relevant systems; colloids, gels and other complex fluids; lasers, LEDs and optoelectronic devices; packaging systems; microscale engineered systems, including MEMS. The groups are typically multidisciplinary involving faculty, postdoctoral researchers and graduate students working on the synthesis and processing, structural characterization, property evaluation, microstructure-property relationships and mathematical models relating micromechanisms to macroscopic behavior.
Materials Courses

UPPER DIVISION

100A. Structure and Properties I
(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 190. 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) SAFINYA
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
Prerequisites: Chemistry 109A-B.
Same course as Chemical Engineering 160. Introductory course covering synthesis, characterization, structure, and mechanical properties of polymers. The course is taught from a materials perspective and includes polymer thermodynamics, chain architecture, measurement and control of molecular weight as well as crystallization and glass transitions.

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

162B. Fundamentals of the Solid State
(4) COLDREN, PETROFF
Prerequisites: ECE 162A with a minimum grade of C-: open to EE and materials majors only.
Same course as ECE 162B.

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

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

188. Topics in Materials
(2) VANDERVAAL
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) 993-2430
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 algorithm) *1
Otger Camps, Ph.D., Curie Institute (Paris) and University of Barcelone, Assistant Professor (physical biology, systems biology, quantitative biology, morphogenesis and self-organization of living matter)
Frederic Gibou, Ph.D., University of California, Los Angeles, Professor (computational science and engineering) *2
Stephen Laguette, M.S., University of California, Los Angeles, Lecturer (biomedical engineering design)
Carlos Levi, Ph.D., University of Illinois at Urbana-Champaign, Professor (conceptual design, synthesis and evolution in service of structural and inorganic materials, especially for high temperature applications) *3
Gene Lucas, Ph.D., Massachusetts Institute of Technology, Professor (mechanical properties of structural materials, environmental effects, structural reliability) *1
Eric F. Matthis, Ph.D., California Institute of Technology, Professor (heat transfer, fluid mechanics, rheology)
Robert M. McMeeking, Ph.D., Brown University, Professor (mechanics of materials, fracture mechanics, plasticity, computational mechanics) *3
Eckart Meiburg, Ph.D., University of Karlsruhe, Professor (computational fluid dynamics, fluid mechanics)
Carl D. Meinhardt, Ph.D., University of Illinois at Urbana-Champaign, Professor (wall turbulence, microfluidics, flows in complex geometries)
Igor Mezic, Ph.D., California Institute of Technology, Professor (applied mechanics, non-linear dynamics, fluid mechanics, applied mathematics)
Jeffrey M. Moxihis, 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) *3
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/nanofluidic flow phenomena)
Linda R. Petzold, Ph.D., University of California, San Francisco, 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 Homsey, Ph.D., University of Illinois, Professor Emeritus (hydrodynamic stability, thermal convection, thin film hydrodynamics, flow in microgeometries and in porous media, polymer fluid mechanics)

Keith T. Kedward, Ph.D., University of Wales, Professor Emeritus (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 hydraulic) *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

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

Mission Statement

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

Educational Objectives for the Undergraduate Program

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

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

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

Program Outcomes

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

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

Undergraduate Program

Bachelor of Science— Mechanical Engineering

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

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

The mechanical engineering elective courses allow students to acquire more in-depth knowledge in one of several areas of specialization, such as those related to: the environment; design and manufacturing; thermal and fluid sciences; structures, mechanics, and materials; and dynamics and controls. A student's specific elective course selection is subject to the approval of the department advisor. Courses required for the pre-major or major, inside or outside of the Department of Mechanical Engineering, cannot be taken for the passed/not passed grading option. They must be taken for letter grades.

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

Mechanical Engineering Courses

LOWER DIVISION

6. Basic Electrical and Electronic Circuits
(4) STAFF
Prerequisites: Physics 3-5; 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. Videos, demonstrations, and tours illustrate modern industrial practice. Selection of appropriate processes.

12S. Introduction to Machine Shop
(1) STAFF
Prerequisite: ME majors only.
Basic machine shop skills course. Students learn to work safely in a machine shop. Students are introduced to the use of hand tools, the lathe, the milling machine, drill press, saws, and precision measuring tools. Students apply these skills by completing a project.

14. Statics
(4) BELTZ, SHUGAR, TURNER
Prerequisite: Physics 1 and Mathematics 3B; open to ME majors only.
Introduction to applied mechanics. Forces, moments, couples, and resultants; vector algebra; construction of free body diagrams; equilibrium in 2- and 3- 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, BAMIHE
Prerequisites: Physics 2; ME 14 with a minimum grade of C-; and, Mathematics 5C or 6B; (may be taken concurrently); open to ME majors only.
Not open for credit to students who have completed ME 163A.

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

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

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

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

UPPER DIVISION

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

104. Mechatronics
(3) BAMIHE, PADEN
Prerequisites: 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, MATHYS, VALENTINE
Prerequisites: ME 151B, 152B, 163; and, Materials 101 or 100B.
Introduction to fundamental engineering laboratory measurement techniques and report writing skills. Experiments from thermosciences, fluid mechanics, mechanics, materials science and environmental engineering. Introduction to modern data acquisition and analysis techniques. (S)

106A. Advanced Mechanical Engineering Laboratory
(3) BAMIHE
Prerequisite: ME 155A.
An advanced lab course with experiments in dynamical systems and feedback control design. Students design, troubleshoot, and perform detailed, multi-session experiments.

106B. Mechanics, Materials and Structures Laboratory
(3) ZOK
Prerequisites: ME 15; ME 154; ME 156A; and Materials 108B 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 thermofluid experiments that emphasize elements of thermodynamics, heat transfer, and fluid mechanics. This laboratory course stresses critical thinking skills required to construct and perform experiments independently, and to investigate physical phenomena experimentally.

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

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

119. Introduction to Coastal Engineering
(1) STAFF
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.  
Introduction to nano- and microtechnology.  
Scaling laws and nanoscale physics are stressed. Individual subjects at the nanoscale including materials, mechanics, photonic, electronics, and fluids will be described, with an emphasis on differences of behavior at the nanoscale and real-world examples.

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

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

146. Molecular and Cellular Biomechanics  
(3) VALENTINE  
Prerequisites: ME 151C.  
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 1  
(4) BENNETT  
Prerequisites: Physics 2; ME 14 with a minimum grade of C- and, Mathematics 5C or 6B.  
Basic concepts of thermsciences, dynamics, system analysis, energy, thermodynamic laws, and cycles. (F)

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

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

152A. Fluid Mechanics  
(4) MEINHART, PENNATHUR  
Prerequisite: Mathematics 5C or 6B; and ME 16 with a minimum grade of C-.  
Introduction to the fundamental concepts in fluid mechanics and basic fluid properties. Basic equations of fluid flow. Dimensional analysis and similarity. Hydrodynamics. (F)

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

153. Introduction to Mechanical Engineering Design  
(3) BELTZ, TURNER, KEDWARD  
Prerequisites: ME 10 and 16; open to ME majors only.  

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

155A. Control System Design  
(3) BAMIHI, BULLO  
Prerequisites: ME 17 with a minimum grade of C-; ME 140A (may be taken concurrently); and ME 163.  
The discipline of control and its application. Dynamics and feedback. The mathematical models: transfer functions and state space descriptions. Simple control design (PID assessment of a control problem, specification, fundamental limitations, codesign of system and control).

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

155A. Mechanical Engineering Design - I  
(3) TURNER, LUCAS  
Prerequisite: ME 151C, 152B, and 153; and MATR 101 or 100B; open to ME majors only.  
The rational selection of engineering materials, and the utilization of Ashby- charts, stress, strain, strength, and fatigue failure consideration as applied to the design of machine elements. Lectures also support the development of system design concepts using assigned projects and involves the preparation of engineering reports and drawings.

155B. Mechanical Engineering Design II  
(3) KEDWARD  
Prerequisites: ME 156A; open to ME majors only.  
Machine elements including gears, bearings, and shafts. Joint design and analysis; bolts, rivets, adhesive bonding and welding. Machine dynamics and fatigue. Design for reliability and safety. Codes and standards. Topics covered are applied in practical design projects.

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

162. Introduction to Elasticity  
(3) MCMEEKING, BELTZ  
Prerequisites: ME 15 and 140A.  
Equations of equilibrium, compatibility, and
165. Engineering Mechanics: Vibrations
(3) MEZC, MCR
Prerequisites: ME 16 with a minimum grade of C-; open to ME majors only.
Not open for credit to students who have completed ME 163C.
Topics relating to vibration in mechanical systems; exact and approximate methods of analysis, matrix methods, generalized coordinates and Lagrange’s equations, applications to systems. Basic feedback systems and controlled dynamic behavior.

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

167. Structural Analysis
(3) YANG
Prerequisites: ME 15 or 165; and ME 140A.
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.

168. Manufacturing and Materials
(3) LEVI, ODETTE
Prerequisites: ME 15 and 151C; and, 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.

176. Control Systems Synthesis
(3) BAIMEN
Prerequisite: ME 155A.
Not open for credit to students who have completed ECE 147A.
An introduction to control systems. Control laws, state models, feedback design, open-loop and closed-loop systems, system stability, and performance analysis. Emphasis on practical, hands-on experience, and the integration of analytical and design skills acquired in the companion ME 156 courses.

193. Internship in Industry
(1) STAFF
Prerequisite: consent of instructor and prior departmental approval needed.
Cannot be used as a departmental elective. May be repeated to a maximum of 2 units.
Students obtain credit for a mechanical engineering related internship and/or industrial experience under faculty supervision. A 6-10 page written report is required for credit.

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

199. Independent Studies in Mechanical Engineering
Directed individual study.
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.

Technology Management
Technology Management Program
Phelps Hall, Room 1332
Telephone (805) 893-5133
Web site: www.tmp.ucsb.edu
Chair: Robert A. York
Vice Chair: David Seibold
Faculty
John E. Bowers, Ph.D., Stanford University, Professor
Gary S. Hansen, Ph.D., University of Michigan, Associate Professor
David Seibold, Ph.D., Michigan State University, Professor
Robert A. York, Ph.D., Cornell University, Professor
**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.

**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.**

**TMP 122. Entrepreneurship**

(4) 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.
- **Learn how to start any time of venture; for profit, non-profit, service, sole-proprietorship, with a focus on high-tech ventures.**

**TMP 124. Entrepreneurial Marketing**

(2) STAFF

- **Offered through UC Extension**
- **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 Basic Marketing Concepts and How Such Concepts Can Be Applied to Any Organization, Particularly Technology Firms.**

**TMP 126. New Venture Finance**

(2) STAFF

- **Offered through UC Extension**
- **Recommended Preparation:** Economics 3A or equivalent.
- **Presents the tools necessary for the strategic analysis and understanding of financial information particular to new ventures. Provides insight into how financial information can be used to design optimal 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**

(3) STAFF

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

**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.
- **Provides emerging inventors, entrepreneurs, and scientists with a working knowledge of intellectual property (patents, copyrights, trademarks, and trade secrets), with the main focus being on patents. Will cover the basic functions of patents, structure of patents, and patent protection.**

**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; and upper division standing.
- **Provides a framework for conducting projects using PMI’s Project Management Body of Knowledge.**

**TMP 133. New Product Development**

(4) BOWERS

- **Prerequisite:** Writing 2 with a minimum grade of B; and Writing 50 or equivalent (ENGL 10, WRIT 50*, WRIT 105*, WRIT 107*, or 109*) with a minimum grade of B; and upper division standing.
- **Provides a high level introduction to modern systems.**

**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.
- **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 135. 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.
- **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 2014-15

**PREPARATION FOR THE MAJOR**

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**UPPER DIVISION MAJOR**

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* see note on next page

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

**Technical Elective requirement**

12

**Approved Technical Elective Requirement classes:**

| CH E 102 | CHEM 126 | MCDB 111 |
| CH E 121 | CHEM 142A-B-C | MCDB 126A-B-C |
| CH E 124 | CHEM 145 | MCDB 133 |
| CH E 125 | CHEM 147 | MCDB 138 |
| CH E 136 | CHEM 150 | ME 110 |
| CH E 138 | ECE 130A-B-C | ME 112 |
| CH E 141 | ECE 183 | ME 119 |
| CH E 152B | ENGR 101 | ME 128 |
| CH E 154 | ENGR 103 | ME 134 |
| CH E 160 | ENV S 105 | ME 169 |
| CH E 171 | MATH 122A-B | ME 185 |
| CH E 196¹ | MATRL 100A-C | PHYS 123A-B |
| CH E 198¹ | MATRL 160 | PHYS 127AL |
| CHEM 115A-B-C | MATRL 185 | PHYS 127BL |
| CHEM 123 | MCDB 101A-B |

¹Three units maximum from CH E 196 and CH E 198 combined; only for students with GPA of 3.0 or higher.

Technical electives taken:

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

**UNIVERSITY REQUIREMENTS**

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<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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**GENERAL EDUCATION**

**General Subject Areas**

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

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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**

36

General Education and Free Electives taken:

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**TOTAL UNITS REQUIRED FOR GRADUATION** 194
CHEMICAL ENGINEERING 2014-15

FRESHMAN YEAR

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SOPHOMORE YEAR

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JUNIOR YEAR

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SENIOR YEAR

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* If applying to the BS/MS Materials program, juniors must take MATRL 100A in Fall, MATRL 100B in Winter, and MATRL 100C in Spring.
## COMPUTER ENGINEERING 2014-15

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<td>15</td>
</tr>
<tr>
<td>ECE 15A</td>
<td>4</td>
</tr>
<tr>
<td>MATH 3A-B, 4A-B</td>
<td>16</td>
</tr>
<tr>
<td>PHYS 1, 2, 3, 3L, 4, 4L</td>
<td>16</td>
</tr>
</tbody>
</table>

### Upper Division Major

**Units:** 68

- CMPSC 130A
- CMPSC 170
- ECE 139 or PSTAT 120A
- ECE 152A
- ECE 154A
- ECE 156A
- ENGR 101

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.**

| CMPSC 130B | ECE 123 |
| CMPSC 138  | ECE 124A, 124D |
| CMPSC 153A/ECE 153A | ECE 130A-B |
| CMPSC 160  | ECE 147A-B |
| CMPSC 162  | ECE 150   |
| CMPSC 165A-B | ECE 153B |
| CMPSC 171/ECE 151 | ECE 154B |
| CMPSC 176A-B/ECE 155A-B | ECE 156B |
| CMPSC 176C | ECE 160/CMPSC 182 |
| CMPSC 177  | ECE 178   |
| CMPSC 178  | ECE 179D, 179P |
| CMPSC 181B/ECE 181B | ECE 189A-B/ CMPSC 189A-B |

Computer Engineering electives taken:

General Education and Free Electives taken:

### UNIVERSITY REQUIREMENTS

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

- UC Entry Level Requirement: English Composition
  
  **Must be fulfilled within three quarters of matriculation**

  Satisfied by: ...

### GENERAL EDUCATION

#### General Subject Areas

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

- A-1: __________ A-2: __________

Areas D & E: Social Sciences, Culture and Thought

  (2 courses minimum)

Areas F & G: The Arts, Literature

  (2 courses minimum)

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

#### Special Subject Areas

Depth:

- __________

Ethnicity (1 course):

European Traditions (1 course):

Writing (4 courses required):

- __________

### NON-MAJOR ELECTIVES

**Units:** 44

General Education and Free Electives taken:

### TOTAL UNITS REQUIRED FOR GRADUATION

**190**
### COMPUTER ENGINEERING 2014-15

#### FRESHMAN YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
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<tr>
<td>CHEM 1A or 2A</td>
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<td>CMPSC 16</td>
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<td>Math, Science,</td>
<td>ECE 1B</td>
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<td>MATH 3A</td>
<td>or Engr. Elective</td>
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<td>WRIT 50E or G.E. Elective</td>
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<td>WRIT 2E or 50E</td>
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**TOTAL** 17  17  17

#### SOPHOMORE YEAR

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<td>ECE 2C</td>
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<td>ECE 152A</td>
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<td>PHYS 4L</td>
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**TOTAL** 17  17  18

#### JUNIOR YEAR

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<td>CMPSC 130A</td>
<td>CMPSC 170</td>
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<td>ECE 156A</td>
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<td>CMPEN Elective</td>
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**TOTAL** 16  16  12

#### SENIOR YEAR

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<th>SPRING</th>
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<td>CMPEN Electives</td>
<td>CMPEN Electives</td>
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<td>Free Elective</td>
<td>ENGR 101</td>
<td>Free Elective</td>
</tr>
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</table>

**TOTAL** 16  15  12

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

\(^2\) PSTAT 120A is offered each quarter. ECE 139 is offered only in spring quarter, and is better suited for future upper division electives for the Computer Engineering major.
## COMPUTER SCIENCE 2014-15

### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<td>CMPSC 24</td>
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<td>CMPSC 40</td>
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</tr>
<tr>
<td>CMPSC 56</td>
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<td>CMPSC 64</td>
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<td>PSTAT 120A</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>CMPSC 170</td>
<td>4</td>
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<tr>
<td>ECE 152A</td>
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<tr>
<td>ENGR 101</td>
<td>3</td>
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<tr>
<td>PSTAT 120B</td>
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Major Field Electives (selected from the following list (at least 8 units must be CMPSC courses)

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>CMPSC 178</td>
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<td>CMPSC 180</td>
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<tr>
<td>CMPSC 140</td>
<td>CMPSC 181B/ECE 181B</td>
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<td>CMPSC/ECE 153A</td>
<td>CMPSC 182/ECE 160</td>
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<tr>
<td>CMPSC 165A-B</td>
<td>CMPSC 185</td>
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<tr>
<td>CMPSC 167</td>
<td>CMPSC 186</td>
</tr>
<tr>
<td>CMPSC 171/ECE 151</td>
<td>CMPSC 189 A-B</td>
</tr>
<tr>
<td>CMPSC 172</td>
<td>CMPSC 190 AA-ZZ</td>
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<tr>
<td>CMPSC 174A-B</td>
<td>CMPSC 192</td>
</tr>
<tr>
<td>CMPSC 176A-B-C</td>
<td>CMPSC 196</td>
</tr>
<tr>
<td>CMPSC 177</td>
<td></td>
</tr>
</tbody>
</table>

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.

Major Field Electives taken:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<tr>
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<td></td>
</tr>
</tbody>
</table>

### GENERAL EDUCATION

#### 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:

#### NON-MAJOR ELECTIVES

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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### SCIENCE COURSES

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<tr>
<td>Science Electives (see Dept. for list)</td>
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</table>

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td></td>
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</table>

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

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.E. Elective or CMPSC 8*</td>
<td>CMPSC 16</td>
<td>CMPSC 24</td>
</tr>
<tr>
<td>MATH 3A</td>
<td>MATH 3B</td>
<td>MATH 4A</td>
</tr>
<tr>
<td>WRIT 1, 2, or G.E. Elective</td>
<td>PHYS 1</td>
<td>PHYS 2</td>
</tr>
<tr>
<td>G.E. Elective</td>
<td>WRIT 1, 2, or G.E. Elective</td>
<td>Science or Free Elective</td>
</tr>
<tr>
<td>TOTAL</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

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

### SOPHOMORE YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPSC 32</td>
<td>CMPSC 56</td>
<td>CMPSC 48</td>
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<tr>
<td>CMPSC 40</td>
<td>CMPSC 64</td>
<td>MATH 6A</td>
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<tr>
<td>MATH 4B</td>
<td>PSTAT 120A</td>
<td>G.E. Elective</td>
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<tr>
<td>PHYS 3</td>
<td>WRIT 50</td>
<td>Science or Free Elective</td>
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<tr>
<td>PHYS 3L</td>
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<td>TOTAL</td>
<td>16</td>
<td>16</td>
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### JUNIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPSC 130A</td>
<td>CMPSC 130B</td>
<td>CMPSC 154</td>
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<tr>
<td>CMPSC 138</td>
<td>ECE 152A</td>
<td>PSTAT 120B</td>
</tr>
<tr>
<td>G.E. Elective</td>
<td>Free Elective</td>
<td>Field or Free Elective</td>
</tr>
<tr>
<td>Science or Free Elective</td>
<td>G.E. Elective</td>
<td>G.E. Elective</td>
</tr>
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<td>TOTAL</td>
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<td>16</td>
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### SENIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
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</thead>
<tbody>
<tr>
<td>CMPSC 111 **</td>
<td>CMPSC 160</td>
<td>Field or Free Elective</td>
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<td>CMPSC 170</td>
<td>CMPSC 162</td>
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<tr>
<td>Field or Free Elective</td>
<td>ENGR 101</td>
<td>G.E. or Free Elective</td>
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<tr>
<td>TOTAL</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>

** Or you may take CMPSC 140 in Winter Quarter to satisfy this requirement.
# ELECTRICAL ENGINEERING 2014-15

## UNIVERSITY REQUIREMENTS

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

## GENERAL EDUCATION

### General Subject Areas

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

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

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

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

### Special Subject Areas

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

## NON-MAJOR ELECTIVES

### General Education and Free Electives taken:

| 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 |

---

### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Units</th>
<th>CHEM 1A, 1AL, 1B, 1BL or 2A, 2AC, 2B, 2BC</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CMPSC 16</td>
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<tr>
<td></td>
<td>CMPSC 24</td>
</tr>
<tr>
<td></td>
<td>ECE 2A-B-C</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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<td>PHYS 1, 2, 3, 3L, 4, 4L, 5, 5L</td>
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### UPPER DIVISION MAJOR

<table>
<thead>
<tr>
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<td>ENGR 101</td>
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<tr>
<td></td>
<td>Departmental electives selected from the following list:</td>
</tr>
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</table>

For these courses, 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:

- ECE 148
- ECE 150
- ECE 153A-B
- ECE 154A-B
- ECE 155A-B
- ECE 156A-B
- ECE 158
- ECE 160
- ECE 162A-B-C
- ECE 178

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.
## ELECTRICAL ENGINEERING 2014-15

### FRESHMAN YEAR

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<th>WINTER</th>
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<tbody>
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### SOPHOMORE YEAR

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### JUNIOR YEAR

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<th>SPRING</th>
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<tbody>
<tr>
<td>ECE 130A</td>
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<td>G.E. or Free Elective</td>
<td>G.E. or Free Elective</td>
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### SENIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>WINTER</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE Electives</td>
<td>ECE Electives</td>
<td>ECE Electives</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>8</td>
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<tr>
<td>G.E. or Free Elective</td>
<td>G.E. or Free Electives</td>
<td>ENGR 101</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>G.E. or Free Electives</td>
</tr>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>16</strong></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.
### 54 • MAJOR REQUIREMENTS

### MECHANICAL ENGINEERING 2014-15

#### PREPARATION FOR THE MAJOR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A, 1AL, 1B, 1BL or 2A, 2AC, 2B, 2BC</td>
<td>10</td>
</tr>
<tr>
<td>ENGR 3</td>
<td>3</td>
</tr>
<tr>
<td>MATH 3A-B, 4A-B, 6A-B</td>
<td>24</td>
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<tr>
<td>ME 6</td>
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<tr>
<td>ME 10</td>
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<tr>
<td>ME 14</td>
<td>4</td>
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<tr>
<td>ME 15</td>
<td>4</td>
</tr>
<tr>
<td>ME 16</td>
<td>4</td>
</tr>
<tr>
<td>ME 17</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 1, 2, 3L, 4, 4L</td>
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</table>

#### UNIVERSITY REQUIREMENTS

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

#### 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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>CHEM 109A</td>
<td>ME 110</td>
</tr>
<tr>
<td>CHEM 123</td>
<td>ME 112</td>
</tr>
<tr>
<td>ECE 147A,C</td>
<td>ME 114</td>
</tr>
<tr>
<td>ECE 181A,C</td>
<td>ME 119</td>
</tr>
<tr>
<td>ENGR 101</td>
<td>ME 124</td>
</tr>
<tr>
<td>ENGR 103, 120, 122</td>
<td>ME 125AA-ZZ</td>
</tr>
<tr>
<td>(max 1 course)</td>
<td>ME 128</td>
</tr>
<tr>
<td>ENV S 105</td>
<td>ME 134</td>
</tr>
<tr>
<td>MATRL 100A</td>
<td>ME 136</td>
</tr>
<tr>
<td>MATRL 100C</td>
<td>ME 138</td>
</tr>
<tr>
<td>MATRL 186</td>
<td>ME 140B</td>
</tr>
<tr>
<td>MATRL 188</td>
<td>ME 141A-B-C</td>
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<tr>
<td>ME 106A-B-C</td>
<td>ME 146</td>
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</table>

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

Engineering Electives taken:

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

TOTAL UNITS REQUIRED FOR GRADUATION ...... 190
# MECHANICAL ENGINEERING 2014-15

## FRESHMAN YEAR

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

<table>
<thead>
<tr>
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<th>WINTER</th>
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</thead>
<tbody>
<tr>
<td>MATH 4B</td>
<td>4</td>
<td>MATH 6A</td>
<td>4</td>
<td>MATH 6B</td>
<td>4</td>
</tr>
<tr>
<td>ME 14</td>
<td>4</td>
<td>ME 6</td>
<td>4</td>
<td>ME 16</td>
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<tr>
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<td>ME 15</td>
<td>4</td>
<td>ME 17</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 3L</td>
<td>1</td>
<td>PHYS 4</td>
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<td>G.E. Elective</td>
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<td>PHYS 4L</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>16</strong></td>
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</table>

## JUNIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
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</thead>
<tbody>
<tr>
<td>ME 104</td>
<td>3</td>
<td>MATRL 101 or</td>
<td>3</td>
<td>ME 105</td>
<td>4</td>
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<tr>
<td>ME 140A</td>
<td>3</td>
<td>MATRL 100B*</td>
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<td>ME 153</td>
<td>3</td>
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<tr>
<td>ME 151A</td>
<td>4</td>
<td>ME 151B</td>
<td>4</td>
<td>ME 151C</td>
<td>3</td>
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<tr>
<td>ME 152A</td>
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<td>ME 152B</td>
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<td>ME 155A</td>
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<td>G.E. or Free Elective</td>
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<td>ME 163</td>
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<td>G.E. or Free Elective</td>
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<td>G.E. or Free Elective</td>
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<td>4</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td></td>
<td><strong>17</strong></td>
<td><strong>17</strong></td>
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</table>

## SENIOR YEAR

<table>
<thead>
<tr>
<th>FALL</th>
<th>units</th>
<th>WINTER</th>
<th>units</th>
<th>SPRING</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 154</td>
<td>3</td>
<td>ME 156B</td>
<td>3</td>
<td>ME 189C</td>
<td>2</td>
</tr>
<tr>
<td>ME 156A</td>
<td>3</td>
<td>ME 189B</td>
<td>2</td>
<td>Departmental Electives</td>
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</tr>
<tr>
<td>ME 189A</td>
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<td>Departmental Electives</td>
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<td>G.E. or Free Electives</td>
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<tr>
<td>Departmental Electives</td>
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<td>G.E. or Free Elective</td>
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</tr>
<tr>
<td>G.E. or Free Elective</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td></td>
<td><strong>15</strong></td>
<td><strong>12</strong></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>Chemical Engineering</td>
<td>(805) 893-2809</td>
<td><a href="mailto:coe-info@engr.ucsb.edu">coe-info@engr.ucsb.edu</a></td>
<td>Harold Frank Hall, Rm. 1006</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>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 Science</td>
<td>893-4321</td>
<td><a href="mailto:ugradinfo@ece.ucsb.edu">ugradinfo@ece.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>893-8292</td>
<td><a href="mailto:ugradv@cs.ucsb.edu">ugradv@cs.ucsb.edu</a></td>
<td>Frank Hall, Rm. 2104</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>893-8198</td>
<td><a href="mailto:meugrad@engr.ucsb.edu">meugrad@engr.ucsb.edu</a></td>
<td>Trailer 380, Rm. 101</td>
</tr>
<tr>
<td>Technology Management</td>
<td>893-2729</td>
<td><a href="mailto:ddoyle@tmp.ucsb.edu">ddoyle@tmp.ucsb.edu</a></td>
<td>Engr.II, Rm. 2335</td>
</tr>
<tr>
<td>Program</td>
<td></td>
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</tbody>
</table>
Policy on Academic Conduct

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

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

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

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

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

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

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

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